[Section D, Revised reclamation plan]. Volume II

Exxon Minerals Company
[s.l.]: Exxon Minerals Company, [s.d.]

CRANDON PROJECT

SECTION D

REVISED
RECLAMATION PLAN

EXXON MINERALS COMPANY
RHINELANDER, WISCONSIN

DECEMBER 1985

Rev.

RECLAMATION PLAN

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1.0 GENERAL DESCRIPTION OF PHYSICAL FACILITIES AND BACKGROUND ENVIRONMENT

1.1 Introduction

During a mining operation, varying degrees of land disturbance are necessary. The degree and type of disturbance are dependent upon the mineral being extracted from the land, the mining method, and waste disposal system used. Over the past 20 years considerable knowledge and experience have been gained to aid in minimizing the environmental impact of mining. This information has been utilized by Exxon Minerals Company (Exxon) in developing the Reclamation Plan for the proposed Crandon Project in compliance with Wisconsin Administrative Code, NR 132.08.

Understanding of the mining operation for the Crandon Project, as described in Volume I of the Mining Permit Application, is prerequisite to review of the Reclamation Plan. This operation, in a number of instances, will create surface land disturbances which cannot be returned completely to the original site condition after cessation of mining. This will be particularly true of changes in local topography caused by mine site development and the disposal of tailings; however, these changes, particularly in view of the Reclamation Plan, are not considered detrimental.

Various reclamation plans were considered in the planning stages of the Project to determine the most beneficial land revitalization and final use of the site at the cessation of mining. As a result of that consideration, the Project site will be restored to a condition commensurate with the natural landscape, native vegetation,

and wildlife and final land use will be compatible with existing land use on adjacent undisturbed areas at the time of final reclamation.

Reclamation began with the Project's initial site investigation when areas disturbed during exploration and subsequent delineation of the orebody were revegetated. Attention to reclamation continued during the planning phases of the mine/mill surface facilities, mine waste disposal facility (MWDF), and routing of the access road and railroad spur. Consideration was given to existing site conditions, including soils, vegetation, wildlife, topography, ground water, drainage, aesthetic characteristics, and climate. Assessments were made of the potential construction impacts on the existing site conditions; and specific drainage, erosion, grading, landscape, and facility siting plans were prepared to minimize anticipated site disturbance.

These assessments also were utilized in planning reclamation procedures to be used during mine construction, operation, and abandonment. The Reclamation Plan is consistent with the requirements for land reclamation of the Wisconsin Administrative Code identified as Chapter NR 132 - Metallic Mineral Mining; and Chapter NR 182 - Regulation of Metallic Mining Wastes. The recognition of these requirements and their correlation with specific section(s) of the Reclamation Plan are addressed in Appendix 1.1A.

Many of the concepts discussed herein will be subject to refinement as engineering progresses to completion and as operational experience is gained. Accordingly, to the extent it may be required, this Reclamation Plan will be supplemented to reflect the resulting refinements.

1.2 Project Location

The proposed Crandon Project is located in the Northern Highlands of northeastern Wisconsin. Crandon, the county seat of Forest County, is located 5 miles due north of the Project site area (Figure 1.1).

Other communities in the region include Rhinelander, 28 miles west; Antigo, 45 miles south; and Iron Mountain and Iron River, Michigan, 75 miles and 44 miles east and north of Crandon, respectively. The Crandon Project site is 2 miles east of State Highway 55 on Sand Lake Road.

The ore deposit occurs in Section 25, Township 35 North, Range 12 East, Nashville Township, and in Section 30, Township 35 North, Range 13 East, Lincoln Township. The deposit lies 0.25 mile north of Little Sand Lake and 1 mile south of Swamp Creek.

1.3 Overall Site Development Plan

The facilities described herein for the Crandon Project include an underground mine, a mill to process ore at an average rate of 7,400 tons per day, a mine waste disposal facility (MWDF), a mine refuse disposal facility (MRDF), and ancillary facilities. The two types of ore (massive, a zinc-copper-lead ore in pyrite gangue, and stringer, a copper-zinc ore in a quartz matrix) will be mined sequentially. The massive ore will be mined in operation years 1-16 and the stringer ore in years 17-29. The facilities will be designed to produce concentrates in the most efficient manner possible, based on proven, established technology and consistent with all applicable environmental and regulatory requirements. *

The mine/mill surface facilities will require a cleared area of approximately 115 acres. About 70 percent of this area will be covered by buildings, roadways, parking lots, and ancillary facilities; and the remaining area will be landscaped for reasons of aesthetics and erosion control.

The mine/mill surface facilities will be located in an area surrounding or adjacent to the main shaft and headframe. These include offices, warehouses, shops, service building, fuel and explosives storage, water systems, sewage treatment facility, transportation, and utility facilities required to support the operation of the mine and mill facilities. The general design objective was to unify as many of these facilities as practical and to locate them close to the mine and mill facilities to reduce travel time for personnel and to prevent duplication of facilities.

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*Vertical lines in the margin indicate revisions in text and tables.

The MWDF will be located in an area about 2 miles southeast of the mine/mill site. The function of this facility will be to provide an area for safe surface disposal of the waste materials generated from the mining and processing of the ore. Most of the waste materials will come from the orebody and will essentially consist of finely ground rock produced during the milling of the ore. The waste disposal facility will consist of bentonite modified soil lined earthen ponds constructed primarily of site materials. It will be constructed and reclaimed in stages over the operational life of the mine, and will ultimately comprise about 360 acres.

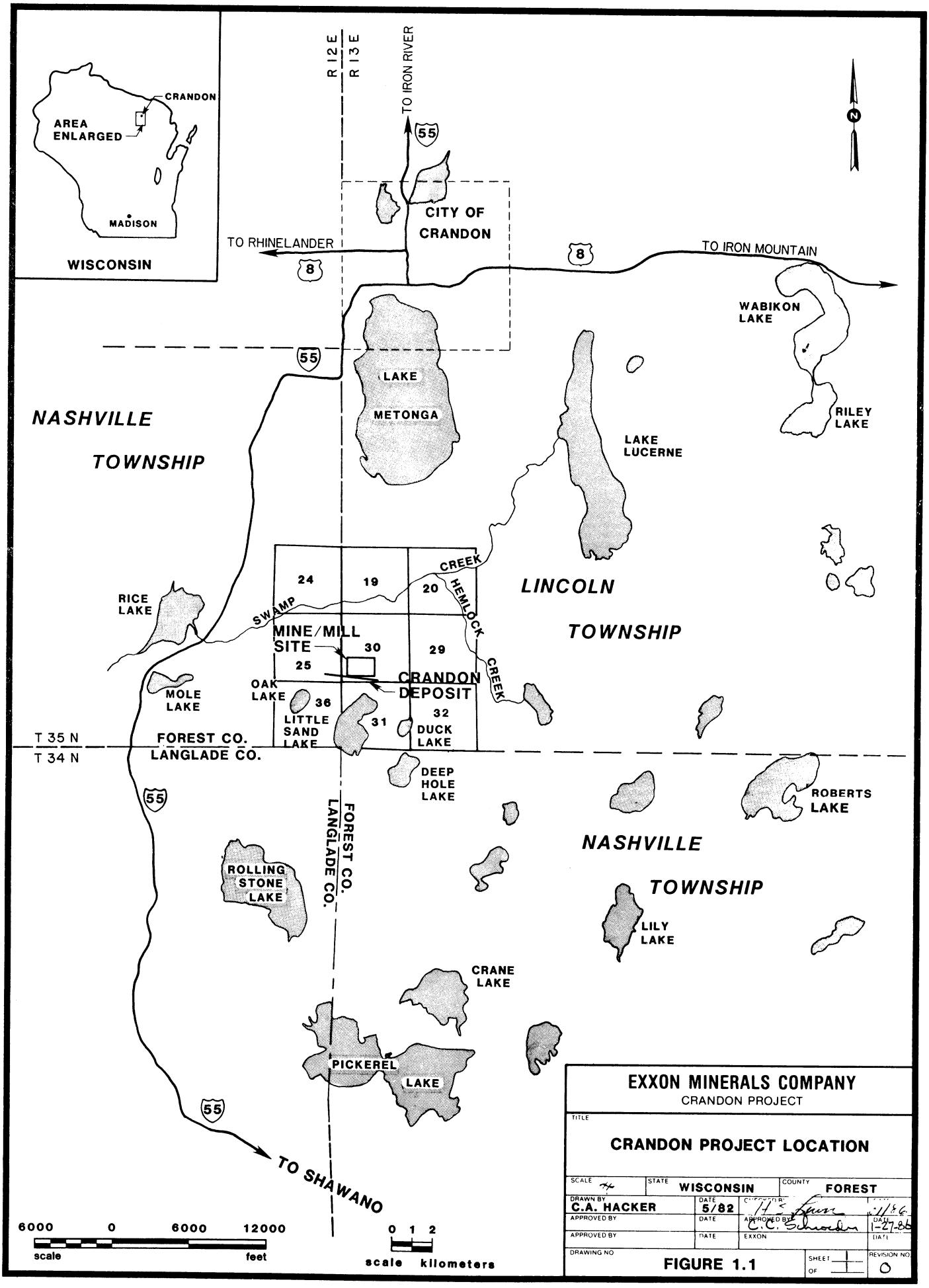
The MWDF was sized based on the orebody size and the fraction or percentage of the orebody that becomes waste or fine tailings during processing of the ore. The Crandon Project orebody is estimated at 67.4 million tons of mine recoverable reserves. With a 40 percent fraction of tailings fines, approximately 27.0 million tons of tailings will be generated for disposal in the MWDF.

The MRDF will be a 10-acre (when filled) solid waste landfill located on the north side of the MWDF. Non-hazardous waste and other Project refuse will be disposed in the MRDF.

A railroad system will be required to transport concentrates from the mine/mill facilities. The Soo Line Railroad is located about 2 miles northeast of the mine/mill site and the railroad spur will be routed from this main line into the mine/mill site. This spur will be a single track about 2.7 miles long with three 3,280-foot sidings located near the connection to the trunk line.

A new access road will be provided to accommodate traffic generated by Project personnel. This new access road will connect with State Highway 55 approximately 3 miles northwest of the mine/mill site. This access road will be routed in a 100-foot wide corridor, and the main electrical power line into the mine/mill site will parallel the access road also in a 100-foot wide corridor.

The locations of the mine/mill surface facilities, access road, railroad spur, water discharge pipeline route, MRDF, reclaim pond and the MWDF relative to each other and to the surrounding area are shown on Figure 1.2. A more detailed depiction of the mine/mill surface facilities is shown on Figure 1.3. Detailed descriptions of the above facilities are presented in the Mining Plan, MWDF Feasibility Report, MRDF Feasibility Report and the Environmental Impact Report (EIR).



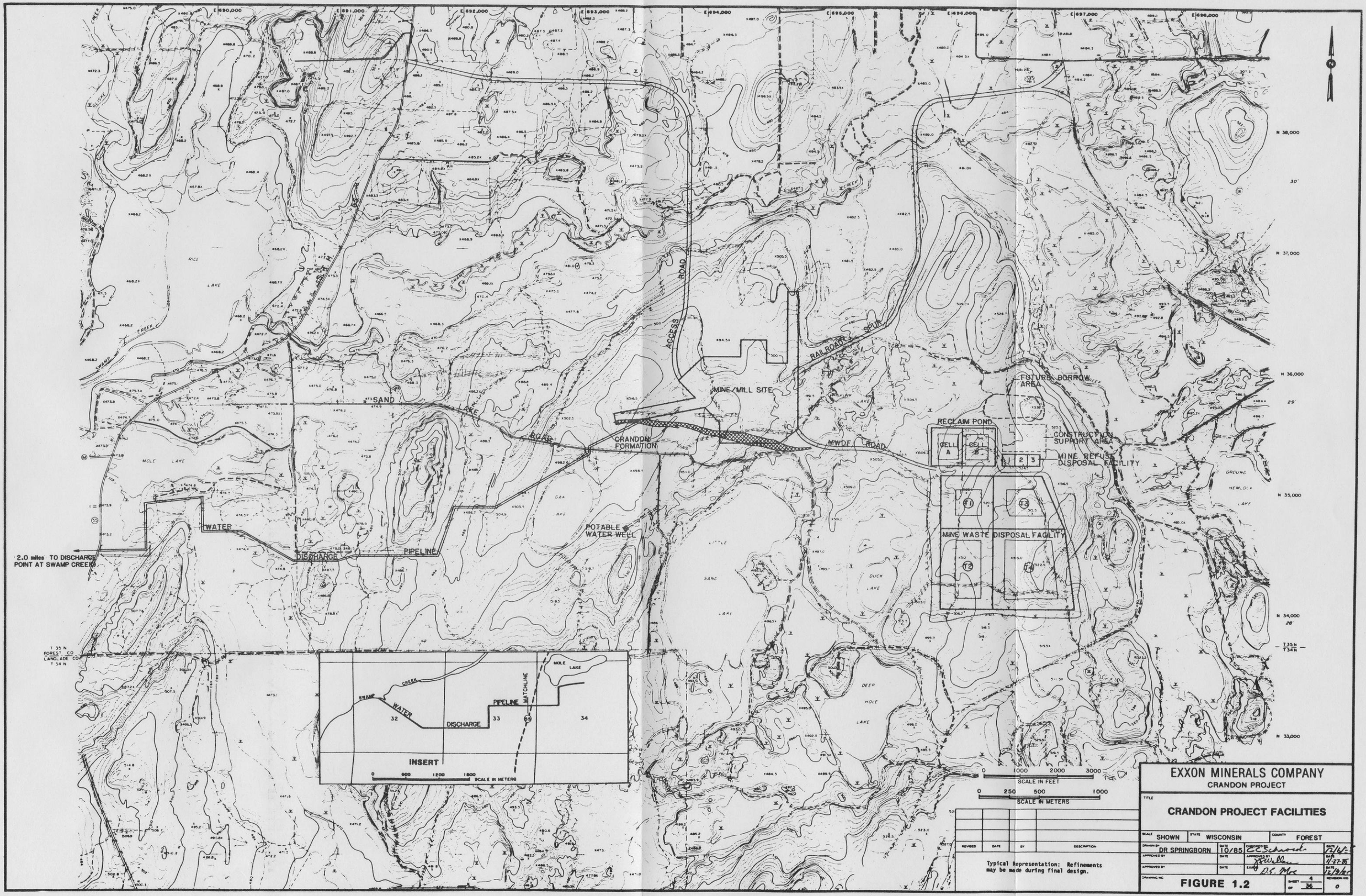
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE

CRANDON PROJECT LOCATION

SCALE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY C.A. HACKER	DATE 5/82	CHECKED BY	DATE 11/86
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 1-27-86
APPROVED BY	DATE	EXXON	DATE
DRAWING NO		SHEET OF	REVISION NO. 0

FIGURE 1.1



REVISED	DATE	BY	DESCRIPTION

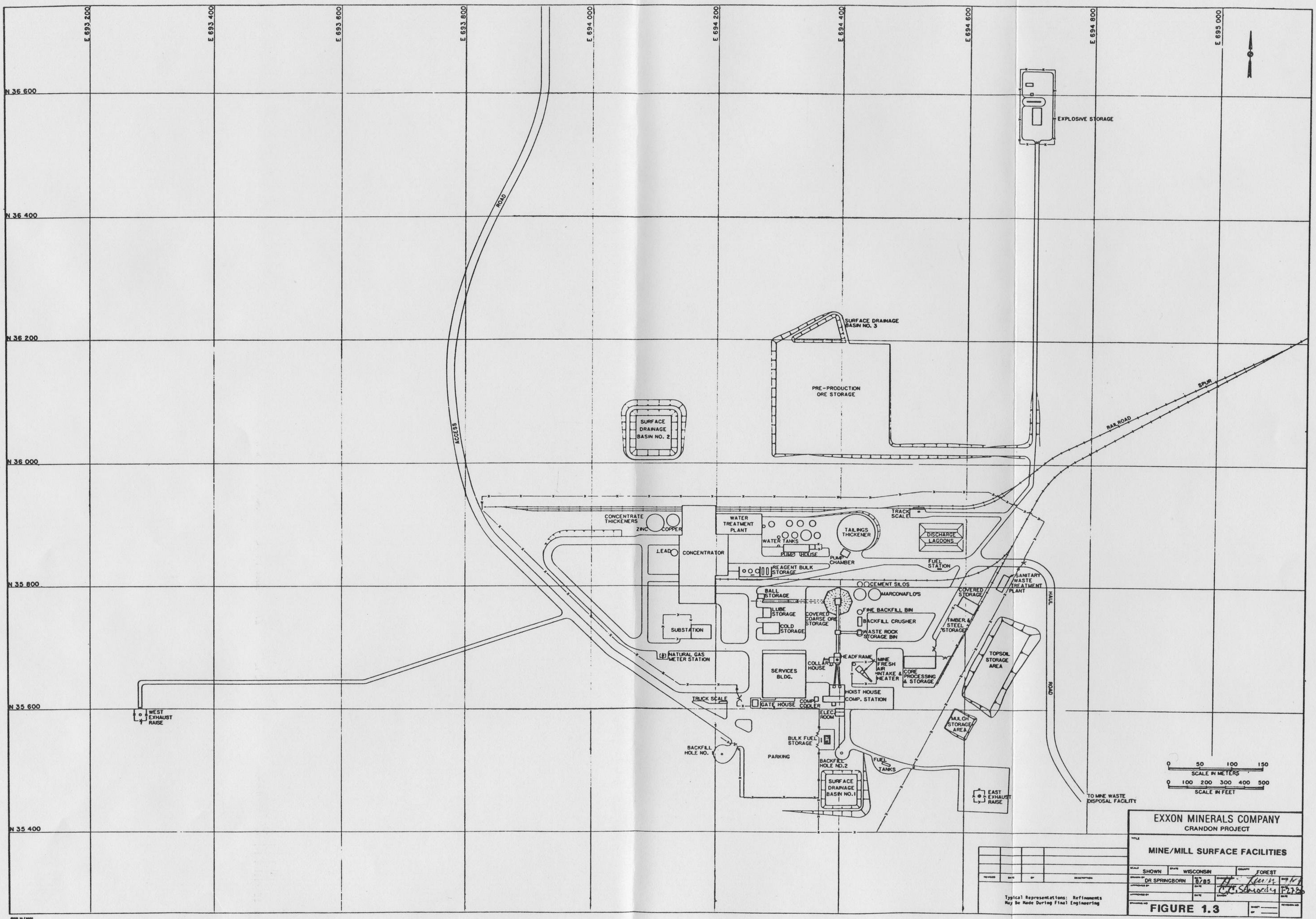
Typical Representation: Refinements may be made during final design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CRANDON PROJECT FACILITIES

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY C.C. Schroeder	DATE 12/6/85
APPROVED BY	DATE	APPROVED BY K.W. Allen	DATE 11-27-85
APPROVED BY	DATE	EXAM D.S. Mac	DATE 12/9/85
DRAWING NO			SHEET 4 OF 36 REVISION NO 0

FIGURE 1.2


E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
E 694 400
E 694 600
E 694 800
E 695 000
N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400
EXPLOSIVE STORAGE
ACCESS ROAD
SURFACE DRAINAGE BASIN NO. 3
PRE-PRODUCTION ORE STORAGE
SURFACE DRAINAGE BASIN NO. 2
RAILROAD SPUR
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR
WATER TREATMENT PLANT
WATER TANKS
PUMP HOUSE
TAILINGS THICKENER
PUMP CHAMBER
TRACK SCALE
DISCHARGE LAGOONS
REAGENT BULK STORAGE
FUEL STATION
CEMENT SILOS
MARCONAFLO'S
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
COVERED STORAGE
SANITARY WASTE TREATMENT PLANT
TIMBER & STEEL STORAGE
SUBSTATION
NATURAL GAS METER STATION
SERVICES BLDG.
COLLAR HOUSE
HEADFRAME
MINE FRESH AIR INTAKE & HEATER
CORE PROCESSING & STORAGE
TOPSOIL STORAGE AREA
HAUL ROAD
HOIST HOUSE
COMP. STATION
TRUCK SCALE
GATE HOUSE
COMP. COOLER
ELEC. ROOM
MULCH STORAGE AREA
WEST EXHAUST RAISE
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO. 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
EAST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY
0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET
Typical Representations: Refinements May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
MINE/MILL SURFACE FACILITIES
SHOWN
WISCONSIN
FOREST
DR SPRINGBORN
8/85
FIGURE 1.3

1.4 Description of Existing Environment

An environmental perspective of the Project area is presented below addressing climate, soils, flora, fauna, archaeology, and land use. References to the Crandon Project EIR (Exxon Minerals Company, 1985) are included for more detailed descriptions of the existing environment.

1.4.1 Climate

The climate of the regional study area is continental, modified slightly by Lake Michigan 80 miles to the east and Lake Superior 93 miles to the north. During most of the year, this area is in the path of eastwardly moving pressure systems in the prevailing westerly air movements (EIR, Section 2.1).

Temperatures are mild to warm in summer and cold in winter. Summer days are generally mild but temperatures may exceed 95°F on the hottest few days of the year. Winter temperatures generally range from 0 to 25°F and occasionally will be below -30°F (National Oceanic and Atmospheric Administration, 1974).

Average annual precipitation in the area is 30.55 inches (Black, 1981). Precipitation is greatest during late spring and early summer and least during mid-winter when it generally occurs as snow. Snowfall ranges from 40 to 60 inches per year (Environmental Science Service Administration, 1968). On the average, the wettest month is June, with almost 15 percent of the annual precipitation, and the driest is February, with only 3.3 percent.

The normal annual growing season for cultivated plants (tender vegetable crops) is 62 days (threshold growth temperature 40°F); for common agricultural crops it is 117 days (32°F), and for native plants 138 days (26°F) (Wang and Suomi, 1957). Estimated evapotranspiration (annual precipitation - minus annual total runoff) is approximately 19 inches according to Burley (1964).

1.4.2 Physiography

Ground surface elevation in the mine/mill area ranges from less than 1,600 feet MSL near Little Sand and Skunk lakes to more than 1,739 feet MSL between Oak and Little Sand lakes. The area consists of a series of southwest-northeast trending drumlin ridges with flat and pitted outwash plains and lake beds forming the lowlands. These landforms reflect the southwesterly advance of the Langlade ice lobe, which deposited till and outwash on the uplands and valleys, respectively. The ground surface in the mine/mill area varies from nearly flat in the outwash plains to a grade of approximately 15 percent and greater on the sides of ridges.

Ground surface elevation in the MWDF area is less than 1,580 feet MSL along the flood plain of Hemlock Creek. The highest elevation, 1,760 feet, occurs at the top of a drumlin ridge between Skunk Lake and Hemlock Creek. The area consists of a broad drumlin ridge oriented in a north-south direction with flat and pitted outwash plains and lake beds forming lowlands on the east and west between Little Sand Lake and Hemlock Creek. The ground surface in the MWDF area varies from nearly flat in the outwash plains to a grade of approximately 25 percent on the sides of ridges adjacent to Hemlock Creek.

1.4.3 Surface Soils

A detailed soil survey of the proposed Project area was undertaken in 1978 (USDA-Soil Conservation Service, 1978). Soils of the Iron River series predominate throughout the area, with soils of the Monico series forming the next most common group (Figure 1.4). The Iron River Variant Stony Loam soil can be described as a silt loam, 28 to 42 inches thick developed from 24 inches of silty sediment over acid sandy loam till, moderately well-drained and commonly found on upland areas. The Monico Stony Loam is a coarse, somewhat poorly drained soil with a solum (A and B horizons) 20 to 40 inches thick, and developed in less than 24 inches of silty sediment over acid sandy loam glacial till.

The 1978 soil survey included a description of soil limitations and major features affecting forest productivity, wildlife habitat suitability, and recreation use (Tables 1.1, 1.2, and 1.3). Soil limitations and major features affecting forest productivity and wildlife habitat suitability are not an index of topsoil quality. The topsoil quality characteristics of the Iron River and Monico soil series are described in subsection 2.4.1, Topsoil Removal and Preservation.

1.4.4 Unconsolidated Deposits

The survey of surface soils was restricted to the initial 60 inches of surface. A detailed survey of unconsolidated material was conducted by Golder Associates (1981), D'Appolonia (1982) and STS Consultants Ltd. (1984) to determine, in part, the suitability of such materials for construction purposes and MWDF seepage attenuation.

TABLE 1.1

SOIL LIMITATIONS AND MAJOR FEATURES AFFECTING WOODLAND PRODUCTIVITY

Soil		MANAGEMENT PROBLEMS					POTENTIAL PRODUCTIVITY		
Series	Phase(%)[a]	Erosion Hazard	Equipment Limitations	Seedling Mortality	Windthrow Hazard	Plant Competition	Common Trees	Site Index	Suitable Species to Plant
Monico	0-6	Slight	Slight	Slight	Slight	Moderate	Red Maple Yellow Birch American Basswood Sugar Maple White Ash	MH[b]	Red Maple Black Spruce White Spruce White Ash Eastern White Pine
Iron River	0-18 18+	Slight Severe	Moderate Moderate	Moderate Moderate	Moderate Moderate	Moderate Moderate	Sugar Maple Yellow Birch Basswood	MH	White Spruce

[a]Percent slope.

[b]Medium high productivity potential.

Source: USDA-Soil Conservation Service (1978).

TABLE 1.2

SOIL LIMITATIONS AND MAJOR FEATURES AFFECTING WILDLIFE HABITAT SUITABILITY AND POTENTIAL

Soil		WILDLIFE HABITAT SUITABILITY				WILDLIFE HABITAT POTENTIAL	
Series	Phase (%)[a]	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Openland Wildlife	Woodland Wildlife
Monico	0-6	Good	Good	Good	Good	Good	Good
Iron River	0-5	Good	Good	Good[b]	Good	Good	Good
	5-15	Good	Good	Good	Good	Good	Good
	15-25	Fair	Good	Good	Good	Fair	Good
	25+	Fair	Good	Good	Good	Fair	Good

[a]Percent slope.

[b]Shrubs excluded from this category by USDA/SCS.

Source: USDA-Soil Conservation Service (1978).

TABLE 1.3

SOIL LIMITATIONS AND MAJOR FEATURES AFFECTING RECREATION USE

USE	MONICO SERIES	IRON RIVER SERIES
Camp areas	Severe - wetness	0-15%* severe - wetness 15+% severe - slope, wetness
Picnic areas	Severe - wetness	0-8% moderate - wetness 8-15% moderate - slope, wetness 15+% severe - slope
Playgrounds	Severe - small stones, wetness	0-6% severe - wetness 6+% severe - slope, wetness
Paths and trails	Severe - wetness, erodes easily	severe - erodes easily

*Percent slope.

Source: USDA-Soil Conservation Service (1978).

Thickness of unconsolidated materials varied considerably across the Project site, but generally ranged from 72 to 148 feet for each of the various types of materials identified.

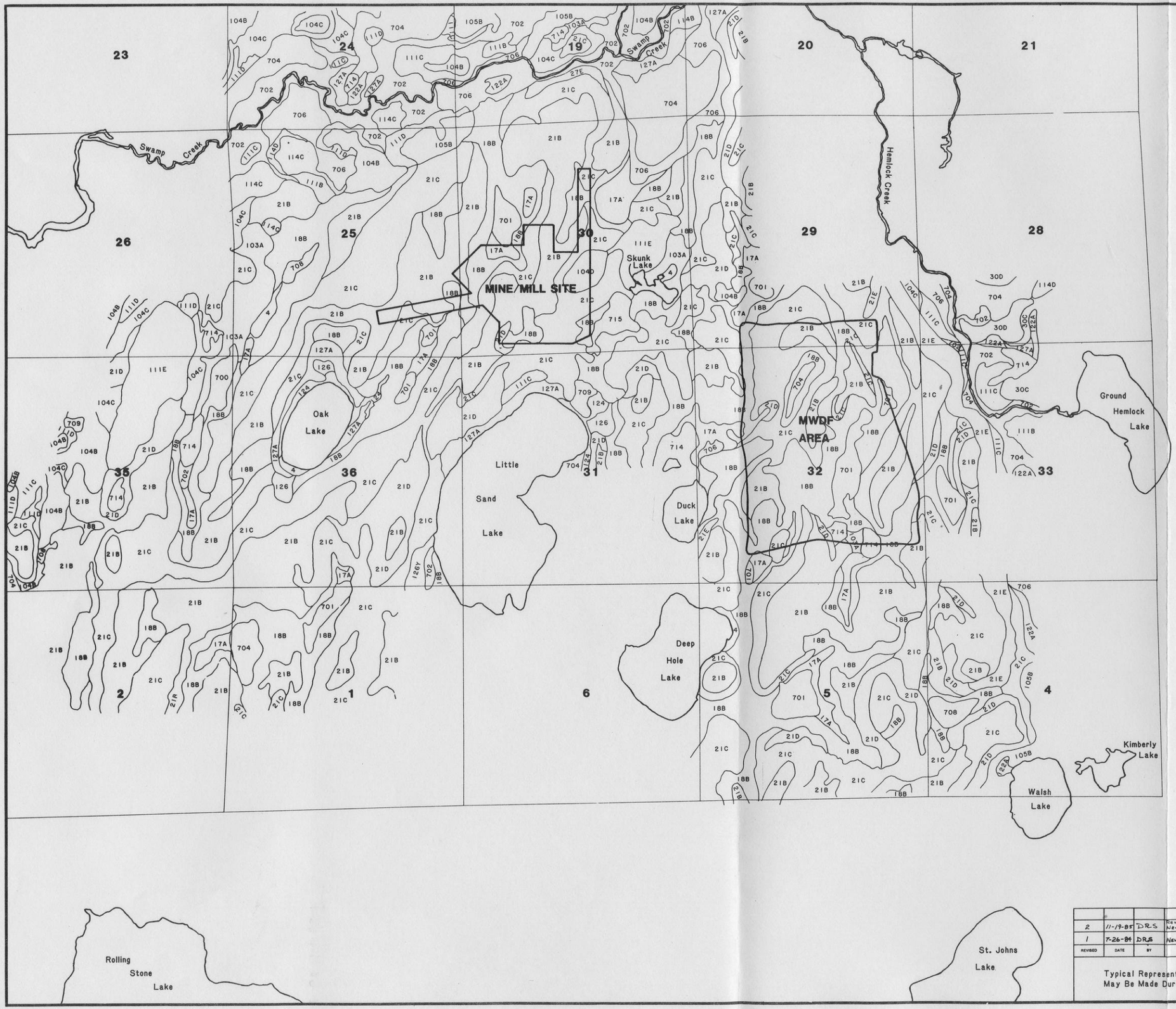
1.4.5 Terrestrial and Aquatic Ecosystems

1.4.5.1 Regional Vegetation - Terrestrial

The area setting for the proposed Crandon Project is a portion of northern Wisconsin known as the Northern Hardwood province of the Laurentian Mixed Forest (Bailey, 1978). The area, which is typical of this part of the northern conifer-hardwood forest, generally consists of heavily forested uplands interspersed with forested lowlands (Curtis, 1959). The Project area lies within an ecotone, a region of overlap between two major biotic communities, that includes the hardwood forests of southern Wisconsin, and the coniferous forest of the northern part of the State.

Forest vegetation of this area consists of three distinct communities: the northern mesic forest, the northern xeric forest, and the northern lowland forest. In the northern mesic forest the dominant species are sugar maple, yellow birch, and hemlock. The northern xeric forest is composed of two segments: the dry segment having jack pine, red pine, and white pine as dominants; and the dry mesic segment dominated by white pine, red maple, and red oak.

The northern lowland forest is also composed of two segments: the wet segment and the wet mesic segment. The wet segment includes the tamarack-black spruce bog forest and the white cedar-balsam fir



LEGEND

4	Histosols, ponded
17A	Cable stony silt loam, (0 to 3 % slopes)
18B	Monico stony loam, (1 to 3 % slopes)
21B	Iron River stony loam, (1 to 6 % slopes)
21C	Iron River stony loam, (6 to 15 % slopes)
21D	Iron River stony loam, (15 to 25 % slopes)
21E	Iron River stony loam, (25 to 45 % slopes)
30C	Vilas loamy sand , rolling (6 to 15 % slopes)
30D	Vilas loamy sand, hilly (15 to 25 % slopes)
103A	Worcester loam, (0 to 3 % slopes)
104B	Padus loam, (0 to 6 % slopes)
104C	Padus loam, rolling (6 to 15 % slopes)
104D	Padus loam, hilly (15 to 25 % slopes)
105B	Padus sandy loam, (0 to 6 % slopes)
110B	Pence loam, (0 to 6 % slopes)
110D	Pence loam, hilly (15 to 25 % slopes)
111B	Pence sandy loam, (0 to 6 % slopes)
111C	Pence sandy loam, rolling (6 to 15 % slopes)
111D	Pence sandy loam, hilly (15 to 25 % slopes)
111E	Pence sandy loam, steep (25 to 45 % slopes)
114B	Sayner loamy sand, (0 to 6 % slopes)
114C	Sayner loamy sand, rolling (6 to 15 % slopes)
114D	Sayner loamy sand, hilly (15 to 25 % slopes)
122A	Worcester sandy loam, (0 to 3 % slopes)
124	Kinross loamy sand
126	Au Gres loamy sand
126Y	Au Gres Variant loamy sand
127A	Croswell loamy sand
700	Seelyeville muck
701	Cathro muck
702	Markey muck
704	Lupton muck
706	Tawas muck
708	Loxley muck
709	Dawson mucky peat
714	Greenwood peat
715	Merwin peat

0 1000 2000 3000 4000 Feet

0 500 1000 Meters

REVISED	DATE	BY	DESCRIPTION
2	11-19-82	DRS	Revised Mine/Mill Site & New MWDF Area
1	7-26-82	DRS	New Mine/Mill Site

Typical Representation: Refinements May Be Made During Final Design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
SURFACE SOILS MAP

SCALE SHOWN	STATE WISCONSIN	COUNTY Forest & Langlade	
DRAWN BY S. J. Harvey	DATE 9/2/82	CHECKED BY C. C. Schrader	DATE 11/23/82
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	EXXON	DATE
DRAWING NO.	**FIGURE 1.4**	SHEET OF	REVISION NO. 2

GBB 5/1981

coniferous swamps. The wet mesic segment of the northern lowland forest is dominated by the black ash-yellow birch-hemlock hardwood swamps (Curtis, 1959).

Areal coverage of vegetation types within the site area (that within approximately 2 miles of the proposed mine/mill facility) is presented in Table 1.4. A comprehensive technical description of the plant communities present in the site area is presented in Section 2.6 of the EIR and Normandeau Associates, Inc. (NAI) and Interdisciplinary Environmental Planning, Inc. (IEP) (1982).

1.4.5.2 Regional Fauna - Terrestrial

Wildlife of the environmental study area (that area within 5 miles of the mine/mill facilities) include species characteristic of both the boreal forests to the north and deciduous forests to the south (NAI and IEP, 1982). Sixty-seven species of mammals occur in Wisconsin and over 75 percent of these have suitable habitat in the environmental study area (EIR, Section 2.6).

Approximately 332 species of birds occur in Wisconsin (Barger et al., 1978) and Vanderschaegen (1981) has documented 244 of these species in Forest, Oneida and Vilas counties. Species typical of the northern coniferous forests, such as raven, ruby-crowned kinglet and evening grosbeak, are found together with those characteristic of the deciduous forests to the south, including great crested flycatcher, black and white warbler and red-eyed vireo (NAI and IEP, 1982). The majority of these species are migratory.

TABLE 1.4

VEGETATION TYPES AND NON-VEGETATED LANDFORMS OF THE SITE AREA WITH APPROXIMATE SIZES AS DETERMINED FROM FIELD STUDIES

Type	Approximate Area (Acres)	Percent of Total
Upland Forest	11,490	59
Swamp Conifer	3,865	20
Shrub Swamp	544	3
Marsh	383	2
Bog	211	1
Urban or Developed	98	<0.5
Water	1,347	7
Old Field and Clearcut	839	4
Agriculture	823	4
TOTALS	19,600	100

Less than 1 percent of the environmental study area is meadow or marsh type wetlands and, therefore, it does not attract large numbers of waterfowl for breeding (EIR, Section 2.6).

The ranges of 34 amphibian and reptile species extend into northeastern and southeastern Wisconsin (NAI and IEP, 1982). Of these, 23 occur in Forest County (EIR, Section 2.6). Species typical of the northern coniferous forests such as the mink frog and blue-spotted salamander are found together in the site area with more southern species such as the water snake, bullfrog, and pickerel frog (NAI and IEP, 1982).

1.4.5.3 Regional Flora and Fauna - Aquatic

Aquatic communities in the region of the proposed Crandon Project are found in surface water which can be classified as recharge and discharge lakes and streams (EIR, Section 2.5). Recharge lakes contain water that is characteristically soft (low in Ca hardness) and low in pH (less than 6), because precipitation and the surface water drainage of their watersheds are the principal water sources. Streams of the region are generally small with base water flow rates derived mostly from ground water sources and they have moderately hard and slightly basic pH (above 7) water quality. Discharge lakes receive water from stream water inputs and contain water that has pH and hardness values similar to those of the streams.

Regional aquatic ecosystems can also be characterized by their major components of zooplankton, benthic macroinvertebrates and fish communities (EIR, Section 2.5). Zooplankton communities of hard water

lakes are dominated by rotifer and copepod species. In soft water lakes, copepods dominate those with clean water, whereas rotifers dominate brown stained, or bog lakes. In the hard water lakes and the Wolf River, fish fauna is dominated by black bullhead, white sucker, yellow perch, and/or some species of the sunfish family. The diversity of fish in hard water lakes is much higher than that in soft water lakes where yellow perch are the dominant species. Large creeks are generally dominated by minnows. Brook trout and molted sculpin dominate the small head water creeks.

1.4.6 Threatened and Endangered Species

There were no federally listed plant species identified in the environmental study area (EIR, Section 2.6). Floating uprooted vegetation was found along the east and southeast shoreline of Duck Lake in July 1978. Among this vegetation were specimens of algal-leaved pondweed (Potamogeton confervoides) which is considered threatened in Wisconsin. A search of the littoral area of Duck Lake specifically for this species in July and October 1980 produced no specimens (EIR, Section 2.5).

No mammals on either the endangered federal or state lists were observed in the area. The federal government and Wisconsin do not list any threatened mammals in Wisconsin (EIR, Section 2.6).

The bald eagle is listed as endangered at the state level. There are four known bald eagle territories in the environmental study area, two of which were active in 1982. The Rolling Stone Lake territory has been the most productive and is located approximately 2.5

miles southwest from the proposed MWDF (EIR, Section 2.6). The area also contained five active osprey nests in 1982. The osprey is listed as endangered at the state level. Of these five nests, three produced a total of eight young in 1982. The Cooper's hawk occurs throughout Wisconsin and is listed as threatened by the state. Cooper's hawks have been observed in the site area (EIR, Section 2.6). None of the mining activities proposed will directly impinge upon nest sites for any of the above bird species.

No amphibians or reptiles that are considered endangered by the federal government occur in Wisconsin. There are 10 species of amphibians and reptiles that are listed by the DNR as endangered or threatened (EIR, Section 2.6). Of these 10 species, two have ranges and habitat preferences that make their occurrence in the environmental study area possible; these are the wood turtle (Clemmys insculpta) and Trembley's salamander (Ambystoma tremblayi).

1.4.7 Archaeology

During the period 1977-1983 investigations were conducted to inventory archaeological and historical resources in the Project area (Salzer and Birmingham, 1978; Overstreet and Brazeau, 1982; MacDonald and Mack Partnership, 1982; Overstreet, 1982, 1983). Two archaeological sites, identified as prehistoric habitation areas, were located adjacent to Oak Lake. No other sites of cultural or historic importance were identified in the study area.

1.4.8 Land Use

The percentage distribution of present land uses within the environmental study area is presented in Table 1.5. Forestry, recreation, residential/institutional, agriculture, and transportation are the primary land uses within this area. Commercial/industrial uses, special use, and multiple use comprise a minor portion of the environmental study area (EIR, Section 2.9).

TABLE 1.5

LAND USES
WITHIN THE ENVIRONMENTAL STUDY AREA

LAND USE	PERCENT OF TOTAL AREA	AREA (SQUARE MILES)
Forestry	76.5	76.5
Recreation	11.8	11.8
Residential	6.4	6.4
Agriculture	5.0	5.0
Transportation	0.3	0.3
TOTALS	100.0	100.0

2.0 EROSION CONTROL TECHNIQUES FOR USE DURING FACILITIES CONSTRUCTION

2.1 Introduction

Erosion control techniques will be employed during Project construction and operation for the purpose of controlling surface water runoff around zones of construction. These techniques will be employed during initial construction of Project facilities when the soils are disturbed during clearing and grubbing activities. These techniques will continue to be used until vegetation is established. The same types of techniques will also be reemployed during final Project reclamation.

All soil surfaces require some type of cover to reduce erosion sediment yields. To successfully establish vegetation on soil, it is important that the slopes be mechanically stable, the area be protected from runoff water, and surface erosion be temporarily minimized with a mulch, alone or in combination with a chemical soil stabilizer. On long slopes it may be necessary to reduce effective slopes with a system of diversion or bench terraces.

Erosion control is a pre-requisite to creating conditions favorable for plant growth. Design criteria for soil erosion and sediment control applicable to construction and mining sites have been described by the USDA-Soil Conservation Service (1972), U.S. Highway Research Board (1973), U.S. Environmental Protection Agency (1975, 1976a,b), and State of Wisconsin (1981).

Erosion control criteria should have these objectives:

1) Temporary control of sediment until more permanent structures and/or vegetation are established.

2) Detention of storm waters on the construction site and the release of these waters at non-erosive velocities.

3) Use of diversion terraces to divert water from the construction site.

4) Establishment of cut-and-fill slopes as flat as feasible consistent with the strengths of soils involved and economics. Slope stability depends on length and steepness, soil strength, moisture content, density, and other factors.

Erosion and sediment control measures may be temporary or permanent and include installation of one or more of the following: (1) sedimentation traps or basins, (2) berms, (3) slope drains, (4) toe-slope ditches, and (5) diversion channels. A summary of the advantages and other considerations of these measures and other erosion control practices has been compiled by the U.S. Highway Research Board (1973) and is presented in Appendix 2.1A

A general description of erosion control techniques that are suitable for use during facilities construction is presented in the following subsections. Specific erosion control measures that will be implemented during construction, operation and closure phases of the mine/mill site, railroad spur, access road, haul road/tailings transport pipeline, and the water discharge pipeline are discussed in Section 3.0 and for the reclaim pond, MRDF, and MWDF in Section 4.0. A consolidated description of the erosion control plan, proposed for implementation during construction, is presented in Section 3.0 of the Mine Plan.

2.2 Design Storm-Permanent Structures

A 100-year, 24-hour storm (total rainfall of 5.1 inches) has been used in determining tailing pond and reclaim pond freeboard heights. Since the MWDF is located in a topographical high area with no large quantities of surface flow through the site, there are no major water diversions or other water handling structures required. During operation of the facilities with the tailing pond(s) open, total runoff in the area of the MWDF will be reduced because all precipitation over the pond areas will be collected in the pond(s).

After reclamation, surface water runoff from the MWDF will be equal to or less than existing conditions because final grades will be less than the average original grades. The design of the reclamation cap drain layer and embankment infiltration zone is not governed by the short duration, high intensity storms because of limitations on the maximum infiltration delivery rates through the overlying soils (Ayres Associates, 1984, 1985).

The sediment basins presented with the construction and reclamation phasing plans for the MWDF are temporary basins, installed prior to a construction phase or reclamation phase and removed after vegetation has been established and erosion control is no longer required. As planned for these purposes, the sediment basins will consist of straw bale dams or small earthen dams with overflow structures to be located in existing drainage swales or depressions. Sedimentation ponds and overflow structures will be used in the larger drainage areas. Hay bale filters are proposed for use in smaller areas.

NR 182.11(1)(1) design storm criteria (100-year, 24-hour) have been applied in the design of these temporary erosion control facilities.

Erosion control facilities for the MWDF area were conservatively sized. The retention areas were sized to retain all erosion siltation occurring during construction and reclamation, assuming the erosion control facilities were left in place throughout the entire operating period and none of the sediments were removed from the basins during this period. This approach would provide erosion control protection throughout the operating period, if required, with minimal maintenance. While the proposed plan suggests removal and later replacement of these facilities, this design approach allows the facilities to be left in place if conditions warrant.

Design calculations and descriptions of MWDF erosion control facilities are included in STS Consultants Ltd. (1985).

The permanent (for the Project operating life) surface drainage basins in the mine/mill site have been sized to contain runoff volumes from a 25-year, 24-hour rainfall event. As part of the erosion control planning, the mine/mill site will be developed so these surface drainage basins will be available from initial construction to provide temporary erosion control protection. Similarly, these basins will be utilized throughout reclamation until final vegetation is established and the soils have stabilized. At that time the basins would be removed and the areas revegetated. Design criteria, design flows, and facilities sizing are included in the erosion control plan for the permanent facilities in the mine/mill area (Section 3.0 of the Mine Plan).

During construction and reclamation phases, temporary erosion control measures will be used in areas of the mine/mill site that do not drain to the basins. Measures to be applied are identified in Section 2.3 and are described in greater detail in Appendix 2.1A. If design calculations are necessary for these temporary facilities, they will be furnished during final engineering for the mine/mill site and would be based on a 25-year, 24-hour storm, similar to the design for the permanent facilities.

Temporary erosion control protection design for the access road, railroad spur, and haul road will be based on a 25-year, 24-hour storm, similar to that for the mine/mill site.

2.3 General Engineering Techniques for Erosion Control

Although various techniques can be used for soil erosion control during construction, some will predominate during construction of the mine/mill surface facilities, reclaim pond, MRDF, MWDF, railroad spur and access road. They are diversion dikes, sediment traps/straw bale filters, filter fabrics, sediment ponds, slope benches, and rip-rap. The individual characteristics of these techniques are detailed in Appendix 2.1A, Table 2.1A-1. The locations where these techniques will be used are described in the description of construction of the various facilities and a summary of the predominant techniques used for each facility are detailed in Appendix 2.1A, Table 2.1A-2.

2.4 Vegetation Techniques for Erosion Control

Revegetation is a key factor in successful erosion control during construction and in long-term rehabilitation of the Project site. Erosion control planning for the Project is primarily centered around activities that will stabilize slopes and revegetate the soils. The plan for establishing stands of vegetation includes the following major steps:

1) Topsoil removal and preservation;
2) Fertilizer use;
3) Plant species selection;
4) Seeding and planting methods;
5) Timing for seeding and planting; and
6) Mulching materials and soil surface stabilizers.

A general discussion of these steps is presented in this subsection. More specific information on these subjects for each of the reclamation management units in the Project area is presented in Sections 3.0 and 4.0.

2.4.1 Topsoil Removal and Preservation

Wisconsin NR 132.08(2)(f) requires that all topsoil from surface areas disturbed by mining operations be removed and stored in an environmentally acceptable manner for use in subsequent reclamation. Topsoil removal (preservation) during construction of the Crandon Project is planned over the land surface disturbed.

Based on the areas of the different soil series (Figure 1.4) that occur within the construction limits of the mine/mill site and the MWDF, estimates of available topsoils were compiled for an approximate topsoil depth range of 9-12 inches (Table 2.1).

The major soil series present in the Project area is the Iron River Series (Figure 1.4). In the Soil Conservation Service soil survey of the proposed Project site (USDA-Soil Conservation Service, 1978), the Iron River Series is described as having poor topsoil characteristics, as is the Monico Soil Series which occurs in limited areas. The official description of the term "poor" (USDA-Soil Conservation Service, 1978), is "Soils rated as poor are very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, soils having large amounts of gravel, stones or soluble salt, steep soils and poorly drained soils."

The lack of surface material that can be classified as topsoil is also indicated by the descriptions of the soils of the Iron River Series by Hole (1976). During routing surveys conducted for the access road and railroad spur (Foth & Van Dyke, 1982a,b), soils data obtained from auger samples provided additional information on topsoil availability in the Project area. Along the proposed railroad spur route, material classified as topsoil ranged in depth from 1.6 to 39.4 inches with a mean depth of 9.05 inches. The mean topsoil depth along the proposed access road route was 9.8 inches and, with one exception, all sample points occurred within the range of 6.3 to 11.0 inches.

Other evidence from numerous test pits and borings associated with various site investigations in the Project area generally indicates

TABLE 2.1

SOIL SERIES TOPSOIL VOLUME ESTIMATES
(FOR 9 TO 12-INCH DEPTH)

Soil Series Code	Soil Series Name	Area Within MWDF Layout (Acres)	Area Within Mine/Mill Site (Acres)	Total Area (Acres)	Volume (Acre-feet) 9-inch depth	Volume (Acre-feet) 12-inch depth
21B	Iron River loam	69	40	109	82	109
21C	Iron River loam	130	41	171	128	171
21D	Iron River loam	5	1	6	5	6
18B	Monico loam	163	21	184	138	184
17A	Cable loam	1	5	6	5	6
701	Cathro muck	25	-	25	19	25
704	Lupton muck	5	-	5	4	5
714	Greenwood peat	7	-	7	5	7
103A	Worcester loam	2	-	2	2	2
104D	Padus loam	-	7	7	5	7
Unknown	--	2	-	2	2	2
	Totals	409	115	524	395	524

a thin layer (4 to 6 inches) of dark organic soils with relatively uniform sandy underlying materials. Tests of the underlying materials from various locations have generally indicated higher silt content for the upper few feet of the materials.

These data suggest that the upper soil layers possess some improved qualities over the lower soils. While overall topsoil quantity and quality would be considered poor or marginal by most standards, the upper soils will be better for use in reclamation than the lower soils and therefore will be stripped and salvaged. Clearing and grubbing activities will mix the thin layer of organic material to an estimated depth of 6 to 9 inches. Therefore, salvaging topsoil to this depth ensures all of the organic material plus a portion of the higher silt content lower material will also be recovered. Topsoil recovery will occur following clearing and grubbing and will be accomplished with self-propelled scrapers in two or three passes with the equipment. Performing the topsoil recovery in this manner will result in blended organic and mineral soils which will be stockpiled and stored for use during final reclamation.

The construction plan that has been developed for the mine/mill site includes clearing and grubbing of 115 acres within the area designated for the mine/mill surface facilities. Stripping the topsoils in this area to a depth of 9 to 12 inches results in a topsoil volume of approximately 140,000 to 180,000 cubic yards. The topsoil will be stockpiled on the east side of the mine/mill site (Figure 1.3). Some of the topsoil will be used where landscape plantings are to be established. A vegetative cover will be established on the topsoil

stockpile to control erosion. Excess glacial soils from the mine/mill site recovered during initial site grading will be removed to the MWDF for reuse there. There will be no glacial till stockpile at the mine/mill site. Glacial till required for reclamation regrading in the mine/mill site will be returned from the MWDF area at the time of reclamation.

The construction plan in the MWDF area, including the reclaim pond, MRDF and construction support area (CSA), includes the same clearing, grubbing, and topsoil salvage steps described above. For the MWDF and MRDF the clearing, grubbing, and topsoil salvage steps will occur in phases over the Project construction and operation stages. The salvaged topsoils will be stored in one of three locations depending upon the phase of development of the MWDF. The construction plans for the access road, haul road, and railroad spur also include clearing, grubbing, and topsoil salvage steps similar to those for the mine/mill and MWDF areas. Based on the Project area disturbance/reclamation schedule (Table 2.2), annual topsoil storage volumes were estimated for 9 and 12-inch topsoil depths (Table 2.3). Topsoil storage locations are shown on Figure 2.1. These locations include the mine/mill area stockpile, 2 stockpiles for both the access road and railroad, and 3 stockpiles for the MWDF area (only one in use at any time). Topsoils from the haul road will be stored at either the mine/mill site or the MWDF area.

Erosion control procedures will be employed at all the stockpiles. The basic procedure for all the stockpiles, except for the working face of any active stockpile, will include seeding and

TABLE 2.2

AREA DISTURBANCE / RECLAMATION SCHEDULE

ACTIVITY	CONSTR.	OPERATIONS																																RECLAM.				
CONSTRUCTION PHASE	PHASE 1				PHASE 2							PHASE 3							PHASE 4																PHASE 5				
Elapsed Time (Years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Start Construction	▼																																				
Mine/Mill Site	15	(25)	(35)	(10)																														(15)	(15)	(15)	
Access Road	35	(10)																																		(25)	
Railroad Spur & Siding	45	(10)																																	(35)		
Discharge Water Line	15	(15)																																			
Haul Road / Tailings Pipeline	10																																			(10)	
Landfill	5									5	(5)										5	(5)														(5)	
Reclaim Pond	25	(5)		25	(10)																												(35)				
Tailings Pond T1	30	30	(10)					(25)	(25)																												
Tailings Pond T2					95		(20)								(45)																					(30)	
Tailings Pond T3		25										45		(15)								(25)	(30)														
Tailings Pond T4													20						120		(30)														(60)	(50)	
Construction Support Area	25																																		(25)		
Borrow Area																																	40		(40)	
Net Disturbed Area	305	295	250	265	350	350	330	305	280	285	280	325	345	330	285	285	285	285	405	405	380	350	320	320	320	320	320	320	320	320	320	320	285	310	175	0	

NOTES: AREAS IN ACRES (ROUNDED TO NEAREST 5 ACRES)
AREAS IN PARENTHESES INDICATE RECLAMATION

Typical Representations: Refinements May Be Made During Final Engineering

12/16/85

TABLE 2.3

YEARLY TOPSOIL STORAGE VOLUME
(FOR 9 TO 12-INCH DEPTH)

Year	TOPSOIL VOLUME			
	9-inch Depth		12-inch Depth	
	Acre-Feet	Yd^3 x 1000	Acre Feet	Yd^3 x 1000
1	200	323	265	428
2	260	419	345	557
3	200	323	265	428
4	190	307	255	411
5	190	307	255	411
6	265	428	350	565
7	250	403	330	532
8	230	371	305	492
9	210	339	280	452
10	215	347	285	460
11	210	339	280	452
12	210	339	280	452
13	260	419	345	557
14	250	403	330	532
15-19	215	347	285	460
20	305	492	405	653
21	285	460	380	613
22	265	428	350	565
23-32	240	387	320	516
33	215	347	285	460
34	235	379	310	500
35	150	242	200	323
36	0	0	0	0

E 690,000 E 691,000 E 692,000 E 693,000 E 694,000 E 695,000 E 696,000 E 697,000 E 698,000

N 38,000 N 37,000 N 36,000 N 35,000 N 34,000

30' 29' 28'

T35N T34N

TOPSOIL STOCKPILE

TOPSOIL STOCKPILE

TOPSOIL STOCKPILE

ACCESS ROAD

RAILROAD SPUR

MINE/MILL SITE

FUTURE BORROW AREA

RECLAIM POND

CELL A

CELL B

1 2 3

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

MINE WASTE DISPOSAL FACILITY

T1

T2

T3

T4

SOIL & TOPSOIL STOCKPILE AREAS WILL BE RELOCATED WITH DEVELOPMENT OF THE MWDF

SAND LAKE ROAD

S.T.H. 55

CRANDON FORMATION

MWDF ROAD

WATER DISCHARGE PIPELINE

2.0 miles TO DISCHARGE POINT AT SWAMP CREEK

POTABLE WATER WELL

DUCK LAKE

DEEP HOLE LAKE

SCALE IN FEET
0 1000 2000 3000

SCALE IN METERS
0 250 500 1000

REVISED	DATE	BY	DESCRIPTION

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
TOPSOIL STOCKPILE AREAS

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY [illegible]	DATE 11/86		
APPROVED BY	DATE	APPROVED BY [illegible] Schneider	DATE 12-1-86		
APPROVED BY	DATE	EXXON	DATE		
DRAWING NO **FIGURE 2.1**		SHEET 4 OF 36	REVISION NO 0		

DESIGN PRODUCTS CO —

establishment of a vegetative cover. Short-term or temporary erosion control measures, such as silt fences, hay bale barriers, and sediment traps, will be utilized as necessary from the time the stockpiles are established until the surfaces of the stockpiles have stabilized.

2.4.1.1 Peat Humus

Although NR 182.04(50) does not include "peat humus" in the definition of topsoil, it will form a useful material for the generation or sustenance of plant growth. Therefore, where applicable, peat humus will be salvaged during construction activities and utilized during reclamation.

2.4.2 Fertilizer Use

The predominance of Iron River Series subsoils in the Project area, will, of necessity, entail their use in the construction of berms, dams, and dikes. Establishment of indigenous and introduced species for purposes of erosion control may, therefore, require fertilizer applications to achieve a satisfactory vegetative cover. However, data obtained from preliminary evaluations of the vegetation potential of a Crandon Project site soil indicate that higher levels may not always be required (Mine Waste Reclamation Ltd., 1982; Appendix 3.9A). The proposed seed mixtures that will be most commonly used for permanent and temporary erosion control (see subsection 2.4.3) are also composed of species tolerant of low soil fertility.

As major Project facilities are constructed and the areas associated with, or adjacent to, these facilities are graded and ready

for establishment of vegetative cover, soil samples will be taken and analyzed to determine the most appropriate fertilizer application. Each of these areas also will be analyzed (i.e., topography, exposure, drainage and future use) to determine the best seed mixture and practice for seeding. If corrective or maintenance fertilizer applications should be required, soil analyses in conjunction with plant tissue analyses will be performed, when needed, to ensure optimum fertilizer applications.

2.4.3 Plant Species Selection

Species selection for erosion control during construction will be dependent upon timing for erosion control implementation and the duration the vegetation will be in place (i.e., temporary or permanent). Where an area is likely to be exposed for the period May to October only, species which exhibit rapid establishment and growth may be seeded, depending upon specific site conditions. Examples of such species include oats, rye, and annual ryegrass (Table 2.4).

In areas where immediate erosion control or temporary (less than two growing seasons) soil stabilization is the objective, introduced species will be the primary component of the seed mixture. However, a mixture of indigenous and introduced species will be used in areas where the management objective is long-term reestablishment of plants indigenous to the area prior to mining.

Erosion control during the period October to May is equally as important as from May to October. Construction areas having exposed soils that will not be disturbed from October to May will be stabilized

TABLE 2.4

INDIGENOUS AND INTRODUCED HERBACEOUS PLANT SPECIES
FOR USE IN TEMPORARY AND PERMANENT SOIL STABILIZATION

	Plant Species	
	Indigenous	Introduced
Grasses/Sedges		
	Big bluestem	Annual ryegrass
	Bluejoint grass	Barley
	Canada wildrye	Canada bluegrass
	Cord grass	Foxtail millet
	Indiangrass	Japanese millet
	Little bluestem	Oats
	Pennsylvania sedge	Perennial ryegrass
	Reed canary grass	Rye
		Smooth brome
		Timothy
		Winter wheat
Legumes		
	Leadplant	Alsike clover
	Lupine	Birdsfoot trefoil
	Roundheaded bushclover	Red clover
		Wagner flat pea
Forbs	Aster	
	Black-eyed Susan	
	Butterfly weed	
	Dotted mint	
	Evening primrose	
	Flowering spurge	
	Goldenrod	
	Smartweed	
Ferns		
	Bracken fern	
	Sweet fern	

Note: This is a typical list of plants for use in site reclamation and is subject to modification.

in late summer or early autumn with grass-based seed mixtures. These seed mixtures will be supplemented with mulch and/or soil surface stabilizers (see Appendix 2.4A) to ensure establishment of vegetative cover prior to the non-growing season. Vegetative cover will be established as early as possible on these areas so that the soils are stablilized and erosion potential is minimized.

Exposed surfaces requiring surface stabilization for periods longer than those mentioned above will be seeded with a mixture of indigenous and introduced species. The plant species mixture will be selected from those listed in Table 2.4 or other species as determined appropriate in consultation with the DNR.

Where the surface is to form part of a formal landscaped area, a general all-purpose turf grass mixture will be used. Species will include Kentucky bluegrass, red fescue, and perennial ryegrass. Maintenance in these areas will include periodic mowing, fertilizer applications, and weed control programs.

2.4.4 Seeding and Planting Methods

During the construction phases of the Project, the methods of distributing seed will include hydroseeding, broadcasting, and soil contact seeding. Specific site characteristics, but primarily slope, will determine which method is selected.

Trees and shrubs will primarily be hand planted. However, tree planting machines may be used on level to gently sloping portions of the MWDF area.

2.4.5 Timing for Seeding and Planting

The optimum seeding period for legume-based seed mixtures is April to June, whereas the optimum period for grass-based seed mixtures is August and September. Where completion of construction of various facilities does not permit an optimum seeding time, temporary erosion control methods will be utilized (see subsection 2.4.3).

Trees and shrubs will be planted in the spring and autumn when the ground is not frozen. Timing of planting will, in part, be dependent upon when seedlings and larger nursery stock can be obtained from the supplier.

2.4.6 Mulches and Soil Surface Stabilizers

Numerous types of mulches and soil surface stabilizers can be used when hydroseeding. Selection will be dependent upon performance, cost, and availability (Appendix 2.4A).

3.0 RECLAMATION DURING THE CONSTRUCTION, OPERATION, AND CLOSURE PHASES OF THE MINE/MILL SITE, RAILROAD SPUR, ACCESS ROAD, AND OTHER PROJECT FACILITIES

3.1 Introduction

Reclamation of the mine/mill surface and ancillary facilities during construction, operation and closure constitutes one major part of the Reclamation Plan. The other principal segment is associated with the MWDF, MRDF, and reclaim pond addressed in Section 4.0. Intensive reclamation will occur during the approximate 3-year construction period for the mine/mill surface facilities and then will follow a much less intensive period for the operating life of these facilities (approximately 29 years). During operation, reclamation will be primarily limited to maintenance of vegetation established during the construction period. A higher level of reclamation will then occur in the approximate 4-year period following cessation of mining. In contrast, construction and reclamation of the MWDF will occur in five intensive phases of 4 to 6 years each during the 36-year construction, operation and closure period. Therefore, for reasons of simplicity, the descriptions of reclamation procedures for the mine/mill surface facilities and ancillaries and the MWDF and associated facilities have been presented separately.

3.2 Reclamation During Construction, Operation, and Closure

For purposes of reclamation planning and implementation, each of the six major Project facilities (i.e., mine/mill site, railroad spur, access road, haul road and tailings transport system, water discharge pipeline corridor, and reclaim pond/MRDF/MWDF) has been designated as a management unit (Figure 3.1). The management unit area is coincident with the construction zone associated with each facility. These major units are divided into subunits based on the slope of the reclaimed land area (i.e., 0-3 percent, 4-15 percent and >15 percent). Upland and lowland soil phases are included for the 0-3 percent slope subunit.

The discussion of each management unit includes descriptive information on the parameters that define a particular unit. The main components of each management unit and subunit are summarized in Table 3.1. Information on species composition, planting methods, materials, maintenance practices, and implementation schedule are included in Table 3.1. The reclamation concepts and processes to be used from initial land disturbance through closure and annual evaluation are described more fully for each management unit in the following subsections.

A description of expected vertical and horizontal structure, age class of tree species, functional characteristics, and aesthetic qualities of the reclaimed vegetated areas approximately 15 years after final closure is presented in Table 3.2 for each of the management units.

ACCESS ROAD

RAILROAD SPUR

MINE/MILL SITE

HAUL ROAD

CRANDON FORMATION

POTABLE WATER WELL

BORROW AREA

RECLAIM POND
CELL A | CELL B

CSA CELL
1 | 2 | 3
MINE REFUSE DISPOSAL FACILITY

MINE WASTE DISPOSAL FACILITY
T1 | T3
T2 | T4

SEE INSERT

MATCH LINE

WATER DISCHARGE PIPELINE

T 35 N
FOREST CO
LANGLADE CO
T 34 N

INSERT

MOLE LAKE

SWAMP CREEK

WATER DISCHARGE PIPELINE

MATCHLINE

32 | 33 | 34

0 600 1200 1800 SCALE IN METERS

0 1000 2000 3000 SCALE IN FEET

0 250 500 1000 SCALE IN METERS

LEGEND:

(1) MANAGEMENT UNIT

Typical Representations: Refinements May Be Made During Final Engineering

REVISED	DATE	BY	DESCRIPTION
1	8-27-85	DRS	NEW MWDF

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CRANDON PROJECT FACILITIES

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 9/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 10-1-84
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11-85
DRAWING NO			SHEET OF REVISION NO 1

FIGURE 3.1

TABLE 3.1

PLANT SPECIES, PLANTING METHODS, MATERIALS, MAINTENANCE PRACTICES AND SCHEDULE FOR RECLAIMING PROJECT FACILITIES. EACH MAJOR PROJECT FACILITY IS DESIGNATED AS A MANAGEMENT UNIT WITH SUBUNITS BASED ON PERCENT SLOPE OF THE RECLAIMED LAND AREA.

Management Unit/ Slope (%)	Species Composition		Planting Methods[a]		Materials	Maintenance Practices	Implementation Schedule Project Years	
	Grass/Forbs	Trees/Shrubs	Grass/Forbs	Trees/Shrubs			Construction Phase	Final Closure
Access Road								
0 - 3 (Upland soils)	—[b]	Random groups of mixed conifers and hardwoods[c]	Soil contact seeding	Hand plant	Trees - bare root, 3 - 4 ft. Topsoil, fertilizer, mulch	Annual inspections, regrade, reseed and replant as needed.	2	36
(Lowland soils)	—	None	Broadcast, hand plant	N/A[d]	Mulch	Same as above.	2	36
4 - 15	—	None	Soil contact seeding, Hydroseed	N/A	Topsoil, fertilizer, mulch, binding (optional)	Same as above.	2	36
> 15	—	None	Soil contact seeding, Hydroseed	N/A	Same as above	Same as above.	2	36
Railroad Spur								
0 - 3 (Upland soils)	—	None	Soil contact seeding	N/A	Topsoil, fertilizer, mulch	Annual inspections, regrade and reseed as needed.	2	35
(Lowland soils)	—	None	Broadcast, hand plant	N/A	Mulch	Same as above.	2	35
4 - 15	—	None	Soil contact seeding, Hydroseed	N/A	Topsoil, fertilizer, mulch, binding (optional)	Same as above.	2	35
> 15	—	None	Soil contact seeding, Hydroseed	N/A	Same as above	Same as above.	2	35

TABLE 3.1 (continued)

Management Unit/ Slope (%)	Species Composition		Planting Methods[a]		Materials	Maintenance Practices	Implementation Schedule Project Years	
	Grass/Forbs	Trees/Shrubs	Grass/Forbs	Trees/Shrubs			Construction Phase	Final Closure
Mine/Mill Site								
0 - 3 (Upland soils)	—	Selected plantings of hardwoods and conifers[c]	Soil contact seeding	Hand plant	Topsoil, fertilizer, mulch; Trees in maple/basswood type - 10 - 12 feet in height (20 ft. on center); Trees in aspen/birch type - 3 - 4 ft. in height (10 ft. on center)	Annual inspections, regrade, reseed and replant as needed. In maintained areas, mow and fertilize.	1 - 4	34 - 36
(Lowland soils)	—	None	Broadcast, hand plant	N/A	Mulch	Annual inspections, regrade, reseed and replant as needed.	2	36
4 - 15	—	Same as above for upland soils	Soil contact seeding, Hydroseed	Hand plant	Same as above for upland soils	Same as above for upland soils.	1 - 4	34 - 36
> 15	—	N/A	Soil contact seeding, Hydroseed	N/A	Topsoil, fertilizer, mulch, binding (optional)	Annual inspections, regrade and reseed as needed.	1 - 4	34 - 36
Discharge Pipeline Corridor and Discharge Structure								
0 - 3 (Upland soils)	—	None	Broadcast and soil contact seeding	N/A	Mulch, fertilizer	Annual inspections, regrade and reseed as needed.	2 - 3	36
(Lowland soils)	—	None	Broadcast, hand plant	N/A	Mulch	Same as above.	2 - 3	36
4 - 15	—	None	Same as above	N/A	Mulch, fertilizer	Same as above.	2 - 3	36
> 15	—	None	Same as above	N/A	Same as above	Same as above.	2 - 3	36

TABLE 3.1 (continued)

Management Unit/ Slope (%)	Species Composition		Planting Methods[a]		Materials	Maintenance Practices	Implementation Schedule Project Years	
	Grass/Forbs	Trees/Shrubs	Grass/Forbs	Trees/Shrubs			Construction Phase	Final Closure
MWDF Access Road/Tailings Transport Pipeline Corridor								
0 - 3 (Upland soils)	—	None	Broadcast and soil contact seeding	N/A	Fertilizer, mulch	Annual inspections, regrade and reseed as needed; annual mowing of pipeline ROW.	2	36
(Lowland soils)	—	None	Broadcast, hand plant	N/A	Mulch	Annual inspections, regrade, reseed and replant as needed.	2	36
4 - 15	—	None	Same as above	N/A	Fertilizer, mulch	Same as above for upland soils.	2	36
> 15	—	None	Same as above	N/A	Same as above	Same as above for upland soils.	2	36
Reclaim Pond/ MRDF/MWDF								
0 - 3 (Upland soils)	—	Blocks or strips of hardwoods and conifers[c]	Soil contact seeding	Hand plant and mechanical planting at 7 ft. spacing on Pond Tl. Hand plant and direct seeding on other ponds.	Topsoil; fertilizer, mulch, binding (optional) bare root tree seedlings.	Annual inspections, regrade reseed and replant as as needed.	2, 3, 7 - 9, 11, 14 - 16, 21 - 23	33 - 36
(Lowland soils)	—	Random plantings of conifers/hardwoods[c]	Broadcast, hand plant	Hand plant	Fertilizer; mulch, bare root tree seedlings	Same as above.	2, 3, 7 - 9, 11, 14 - 16, 21 - 23	33 - 36
4 - 15	—	Blocks or strips of hardwoods and conifers	Soil contact seeding, Hydroseed	Same as above for upland soils	Same as above	Same as above.	2, 3, 7 - 9, 11, 14 - 16, 21 - 23	33 - 36
> 15	—	Same as above	Soil contact seeding, Hydroseed	Same as above for upland soils	Same as above	Same as above.	2, 3, 7 - 9, 11, 14 - 16, 21 - 23	33 - 36

[a]In addition to the actual seeding/planting methods, the following steps will be taken, as necessary, to ensure a suitable seedbed is prepared for each area being reclaimed: final grading, chiseling, topsoil application, disc/harrowing, and slope scarification. These mechanical operations will be followed by seeding, fertilizer application and mulching.

[b]The herbaceous seed mixtures will consist of the following indigenous and introduced species in proportions suitable for the soil, slope and moisture conditions present at the site being reclaimed:

	Plant Species	
	Indigenous	Introduced
Upland soils		
	Aster	Alsike clover
	Big bluestem	Annual ryegrass
	Black-eyed Susan	Barley
	Bracken fern	Birdsfoot trefoil
	Canada wildrye	Canada bluegrass
	Goldenrod	Millet
	Indiangrass	Oats
	Leadplant	Perennial ryegrass
	Little bluestem	Smooth brome
	Lupine	Timothy
	Pennsylvania sedge	Wagner flat pea
	Reed canary grass	Winter wheat
	Roundheaded bushclover	
Lowland soils		
	Bluejoint grass	Millet
	Bulrush	
	Bur reed	
	Cattail	
	Cord grass	
	Reed canary grass	
	Smartweed	

TABLE 3.1 (continued)

[c]Woody plant species for use in landscaping and reclamation will consist of a mixture of the following indigenous species suitable to meet long-term management objectives for each management unit:

Plant Species	
Trees	Shrubs
Ash	Dogwood
Aspen	Hawthorn
Basswood	Hazel
Black spruce	Highbush cranberry
Hemlock	Viburnum
Red maple	
Red oak	
Red pine	
Sugar maple	
Tamarack	
White spruce	
White birch	
White cedar	
White pine	

[d]Not applicable.

Note: The above lists identify typical plant species that could be used in landscaping/reclamation of Project facilities. These species lists may be modified in consultation with the DNR.

TABLE 3.2

EXPECTED VEGETATION CHARACTERISTICS (STRUCTURE, AGE CLASSES, FUNCTION AND AESTHETICS) OF RECLAIMED PROJECT AREAS 15 YEARS AFTER FINAL CLOSURE[a]

Management Unit/ Final Use	STRUCTURE		AGE CLASSES (Years)[b]		Function	Aesthetics
	Vertical	Horizontal	Planted Stock	Invasion Stock		
Access Road						
Agriculture	Row crops, small grain, hay, or grass.	Monotypic stand of row crops or small grain; mixed pasture grasses.	N/A	N/A	Crop production; pasture	Visual contrast and landscape diversity.
Forestry/Recreation	Groundlayer of indigenous forbs and grasses; clumps of planted conifers/hardwoods; random distribution of pioneer shrubs and trees.	Mixture of forbs and grasses with random distribution of shrubs and trees; occasional clumps of planted trees; irregular edge along original cleared zone.	52	<49 (uneven aged)	Erosion control; wildlife habitat/travel lanes; recreational use.	Visual diversity and enhancement; year-round color.
Railroad Spur						
Agriculture	Row crops, small grain, hay, or grass.	Monotypic stand of row crops or small grain; mixed pasture grasses.	N/A	N/A	Crop production; pasture	Visual contrast and landscape diversity.
Forestry/Recreation	Groundlayer of indigenous forbs and grasses; pioneer shrubs and trees.	Mixture of forbs and grasses with random distribution of shrubs and trees; irregular edge along original cleared zone.	N/A	<49 (uneven aged)	Erosion control; wildlife habitat/travel lanes; recreational use.	Visual diversity and enhancement.
Mine/Mill Site						
Forestry/Recreation	Groundlayer of indigenous forbs and grasses; scattered clumps and strips of planted conifers/hardwoods; random distribution of pioneer shrubs and trees.	Clumps and strips of conifer/hardwood plantings from original landscaping; mixture of forbs and grasses with random distribution of shrubs and trees; irregular edge along original cleared zone.	50 - 52	<49 (uneven aged)	Erosion control; wildlife habitat; recreational use.	Visual diversity and enhancement; year-round color; continuity with undisturbed areas.

TABLE 3.2 (continued)

Management Unit/ Final Use	STRUCTURE		AGE CLASSES (Years)[b]		Function	Aesthetics
	Vertical	Horizontal	Planted Stock	Invasion Stock		
Discharge Pipeline Corridor						
Agriculture	Row crops, small grain, hay or grass.	Monotypic stand of row crops or small grain; mixed pasture grasses.	N/A	N/A	Crop production; pasture	Visual contrast and landscape diversity.
Forestry/Recreation	Groundlayer of indigenous forbs and grasses; mixture of trees and shrubs from invasion.	Mixture of forbs and grasses in uplands; closed canopy in upland forested segments; wetland species in lowland areas.	N/A	<48 (uneven aged)	Erosion control; wildlife habitat/travel lanes; recreational use.	Visual diversity and enhancement.
MWDF Access Road/Tailings Transport Pipeline Corridor						
Forestry/Recreation	Groundlayer of indigenous forbs and grasses; random distribution of pioneer shrubs and trees.	Mixture of forbs and grasses with random distribution of shrubs and trees; irregular edge along original cleared zone.	N/A	<15 (uneven aged)	Erosion control; wildlife habitat/travel lanes; recreational use.	Visual diversity.
Reclaim Pond/MRDF/ MWDF						
Forestry/Recreation	Groundlayer of indigenous forbs and grasses; blocks and strips of uneven aged mixed conifer/hardwood plantings in initial and intermediate stages of development on tailing ponds; random distribution of pioneer shrubs and trees over entire area.	Blocks, clumps and strips of conifer/hardwood plantings from original reclamation installation; mixture of forbs and grasses over entire area with random distribution of early successional shrubs and trees; irregular edge along original cleared zone.	45 - 51 (Pond T1)	<48 (uneven aged)	Erosion control; wildlife habitat/travel lanes; recreational use.	Visual diversity and enhancement; year-round color; continuity with undisturbed areas.
			38 - 47 (Pond T2)	<44 (uneven aged)		
			31 - 40 (Pond T3)	<37 (uneven aged)		
			18 - 33 (Pond T4)	<30 (uneven aged)		

[a] In management units where forestry is the proposed final use, the objective in reclaiming the area is to establish stands of indigenous mixed hardwoods, mixed hardwoods and conifers, or mixed conifers. The reclaimed forested communities will include herb and shrub layers.

[b] Age class of planted stock is based on the age of the plant material at initial planting (assumed to be 3 year old stock) plus the number of years of growth between the date of original planting and a point in time 15 years after final closure. Age class of invasion stock is based on the number of years of growth after initial establishment.

3.2.1 Mine/Mill Surface Facility (Management Unit 1)

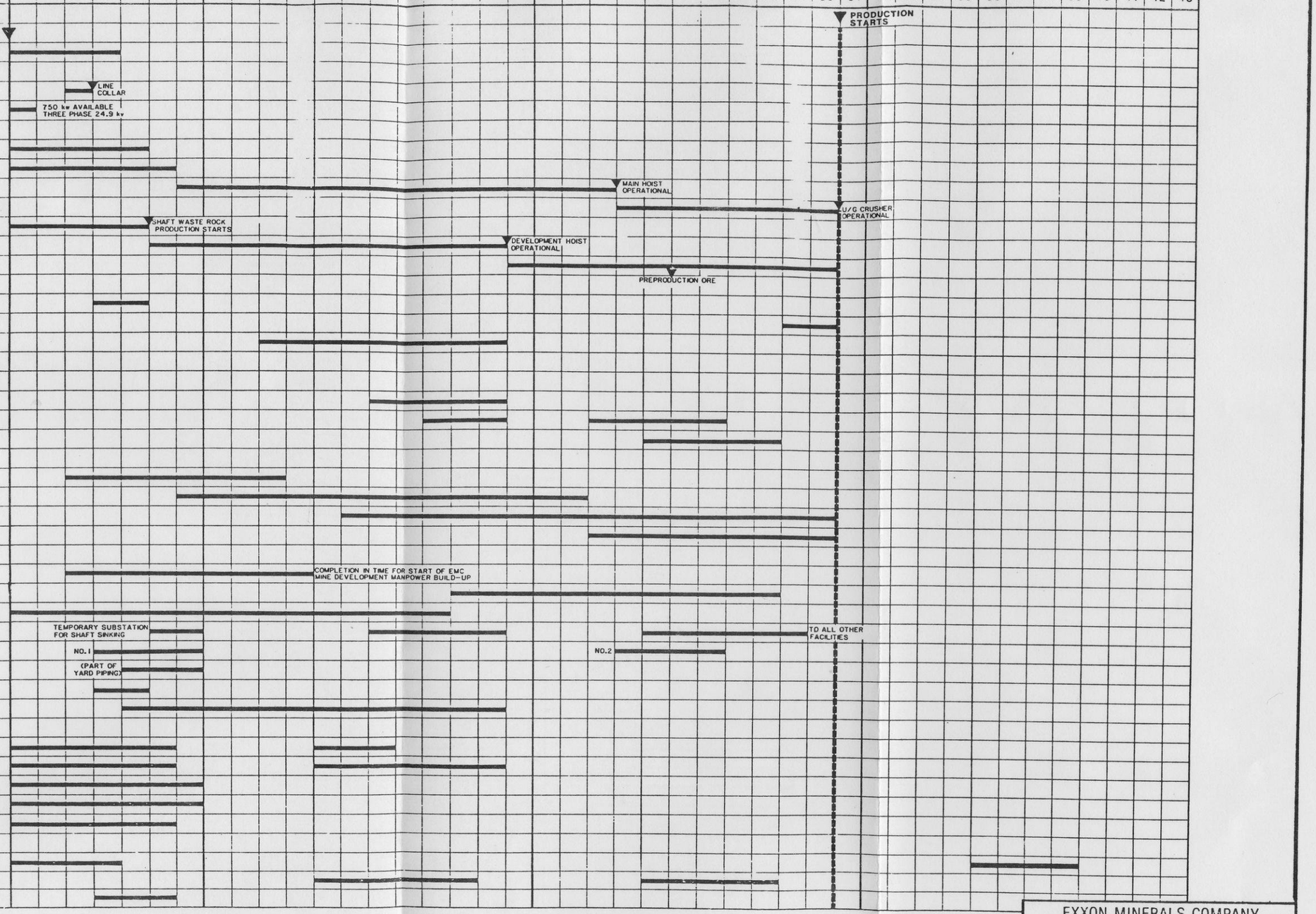
3.2.1.1 Construction Schedule

The duration of the construction phase of the Project is determined by the time required to develop the main shaft and headframe and the east exhaust shaft, and to perform the subsequent preproduction underground mine development activities. Thus, the sequence of key activities consists of site preparation for construction of the main shaft and east exhaust shaft, erection of that portion of the main shaft headframe required to install the sinking hoists, sinking the shaft to the appropriate levels, followed by the necessary underground preproduction development.

The time needed to construct the surface facilities is considerably less than that required to complete the previously described key mine development activities. As a result, the sequence for construction of the surface facilities will initially be governed by the need to provide, in a timely manner, the facilities required to support the shaft sinking and mine development operations. Thus, site preparation, the provision of environmental protection systems such as wastewater treatment and sewage disposal facilities, and installation of temporary power and concrete batching facilities will be the first priorities.

The sequence and duration of the principal construction and associated erosion control activities during the approximate 3-year construction period are described below. The schedule for individual construction activities is shown on Figure 3.2.

ITEM NO.	ACTIVITY	YEAR / MONTHS FROM ACTUAL FIELD START
1		
2	ACTUAL FIELD START	
3	MINE/MILL SITE PREPARATION	
	TEMPORARY FACILITIES	
4	TEMPORARY BATCH PLANT	
5	TEMPORARY POWER EX UTILITY TO TEMP. SITE BLDGS	
	MINE CONSTRUCTION/DEVELOPMENT	
6	MAIN SHAFT COLLAR	
7	MAIN SHAFT HEADFRAME	
8	MAIN SHAFT SINK & EQUIP	
9	ORE BINS/CRUSHER	
10	EAST EXHAUST SHAFT	
11	SINK & EQUIP TO 572 LEVEL	
12	EMC MINE DEVELOPMENT	
13		
14	PREPRODUCTION ORE STORAGE	
15	R.O.M. PRODUCTION	
16	COMPRESSOR STATION	
	SURFACE FACILITIES	
	COARSE ORE STORAGE SYSTEM	
17	EXCAV, FOUNDATIONS, WALLS, SLABS (INC. TRANSFER TOWER)	
18	STRUCTURAL STEEL & FINISH BLDG	
19	EQUIPMENT INSTALLATION	
	CONCENTRATOR	
20	EXCAVATING, FOUNDATIONS, WALLS & SLABS	
21	STRUCTURAL STEEL & FINISH BLDG	
22	EQUIPMENT INSTALLATION	
23	MINE BACKFILL PREPARATION SYSTEM	
	GENERAL FACILITIES	
24	SERVICES BUILDING	
25	PROCESS WATER SYSTEM (PUMPS, PIPING, TANKAGE)	
26	WATER TREATMENT PLANT	
27	PLANT POWER DISTRIBUTION	
28	STANDBY GENERATOR	
29	NATURAL GAS PLANT DISTRIBUTION SYSTEM	
30	SANITARY WASTE TREATMENT PLANT	
31	YARD PIPING	
	OFF - SITES	
32	ACCESS ROAD	
33	RAILROAD	
34	115 kv POWERLINE (UTILITY)	
35	PRIMARY SUBSTATION (EMC)	
36	INCOMING NATURAL GAS LINE & METER STATION	
	MWDF	
37	RECLAIM POND	
38	TAILINGS POND T1	
39	MINE REFUSE DISPOSAL FACILITY	



NOTE: Schedule May Vary Depending Upon The Season Of Year When Construction Is Initiated. Schedule Delays May Occur Because Of Inclement Weather, Labor Problems, Other Force Majeure Items.

Typical Representations Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: **CRANDON PROJECT CONSTRUCTION SCHEDULE**

SCALE NONE | STATE WISCONSIN | COUNTY FOREST

DRAWN BY DR SPRINGBORN | DATE 4/84 | CHECKED BY | DATE

APPROVED BY | DATE | APPROVED BY C.E. Schwedes | DATE 11/13/85

APPROVED BY | DATE | EXXON D.S. Moe | DATE 7/11/86

DRAWING NO **FIGURE 3.2** | SHEET ___ OF ___ | REV NO 6

GBB 8/1001

3.2.1.2 Site Preparation

Site preparation will be performed in two stages:

1) Initially, the mine/mill site will be cleared of shrubs and trees and then rough-graded. Before clearing and grubbing, marketable trees will be cut and removed from the site. Tree stumps, brush and other wood waste will be either burned or mulched with chippers and stockpiled on the east side of the mine/mill site (Figure 3.3) for use in reclamation.

   During rough grading, salvaged topsoil will be stockpiled on the east side of the mine/mill site (Figure 3.3). Based on stripping the topsoils to a depth of 9 to 12 inches in the cleared mine/mill site area, a quantity of 140,000 to 180,000 cubic yards of topsoil will be salvaged. Portions of this stockpile will be reused during construction as areas of the mine/mill site are completed and landscaping/reclamation work is performed. The majority of the topsoil stockpile will be maintained for the entire operating period and reused during final reclamation of the mine/mill site. After all construction has been completed the remaining topsoil stockpile will be stabilized by seeding and establishing a vegetative cover. Additional detail of the topsoil removal and preservation steps is included in subsection 2.4.1.

   Because of the large area being developed, it is not necessary that the steps occur in order, independently. Some areas, including the drainage basins, will be cleared, grubbed, rough graded, and readied for use before other areas are completely cleared and grubbed. This type of refinement does not change the site preparation steps or their sequence, but it does provide development with optimal erosion control potential.

   Subsequently, the mulch and topsoil will be used in revegetation of the mine/mill site. The wood mulch storage area will be used intensively throughout the landscaping efforts during Project construction and to a lesser extent during operations and closure. With this anticipated schedule of use, the mulch storage area will not be stabilized during the construction period. Mulch that is remaining after the 4-year initial intensive period of use will be stabilized with an approved netting securely pegged in place or with anchored brush barriers.

2) Following the above activities, disturbed areas not required in the early phases of construction development will be seeded to control erosion and runoff. Final grading of the seeded areas will be performed as dictated by the requirements of the construction schedule. A storm

E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
E 694 400
E 694 600
E 694 800
E 695 000

N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400

ROAD
ACCESS
EXPLOSIVE STORAGE
SURFACE DRAINAGE BASIN NO. 3
PRE-PRODUCTION ORE STORAGE
SURFACE DRAINAGE BASIN NO. 2
SPUR
RAILROAD
CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR
WATER TREATMENT PLANT
WATER TANKS
PUMP HOUSE
PUMP CHAMBER
TAILINGS THICKENER
TRACK SCALE
DISCHARGE LAGOONS
FUEL STATION
REAGENT BULK STORAGE
CEMENT SILOS
MARCONAFLO'S
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
COVERED STORAGE
TIMBER & STEEL STORAGE
SANITARY WASTE TREATMENT PLANT
HAUL
SUBSTATION
NATURAL GAS METER STATION
SERVICES BLDG.
COLLAR HOUSE
HEADFRAME
MINE FRESH AIR INTAKE & HEATER
CORE PROCESSING & STORAGE
HOIST HOUSE COMP. STATION
TOPSOIL STORAGE AREA
TRUCK SCALE
GATE HOUSE
COMP. COOLER
ELEC. ROOM
MULCH STORAGE AREA
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO. 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
EAST EXHAUST RAISE
WEST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY

0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

LOCATION OF TOPSOIL STOCKPILE IN MINE/MILL SITE AREA

SCALE: SHOWN | STATE: WISCONSIN | COUNTY: FOREST
DRAWN BY: DR SPRINGBORN | DATE: 8/85
APPROVED BY | DATE | CHECKED BY: [signature] 7/16/86
APPROVED BY | DATE | ENGR: [signature] 7-17-86
DRAWING NO | REVISION NO | SHEET NO

FIGURE 3.3

water drainage system will be extended to each construction zone before any other work is initiated in that area. In the mine/mill site these storm water drainage systems will direct surface water flow to one of the three main surface drainage basins (Figure 3.3). The proposed phasing plan for establishment of permanent vegetative cover in the mine/mill site will be implemented as construction activities are completed (see subsection 3.2.1.3).

Erosion could occur in the following areas: mine/mill site, haul road/tailings transport corridor, water discharge line corridor, access road corridor, railroad spur corridor, and the MWDF. The greatest potential for erosion is expected to occur within the confines of the mine/mill site. Exposure of bare soils during the grading phase in Year 1 will temporarily encompass approximately 115 acres.

The primary source of effluents during construction will be storm water drainage which will be controlled to prevent increased levels of suspended solids in nearby water bodies. Most construction activities will occur prior to mill operations. During construction, the primary source of potentially contaminated water will be from the developing mine. Other sources of potentially contaminated water will include surface water runoff from a 5-acre equipment laydown area near the main shaft and an 8-acre preproduction ore storage pad located on the north side of the mine/mill area.

As described above, the entire mine/mill site will be cleared, grubbed, and rough graded as necessary as one of the initial activities in the construction schedule. Since there is no phasing to this work, there will be no interim conditions for any length of time.

Erosion control will be developed as necessary with the rough grading. To the extent possible, the surface drainage basins will be used for runoff control. The basin areas will be excavated first with grading work generally progressing outward from the basins. Where portions of the storm drainage system are not installed concurrently with the rough grading, separate provisions for runoff and erosion control will be made. These provisions will consist of temporary siltation basins or hay or straw bale ditch retention checks.

Graded areas not scheduled for immediate development will be revegetated with a temporary groundcover following the grading work to reduce siltation from runoff erosion. As an area is subsequently developed, any portions of the final storm drainage system not installed with the initial site work would first be installed for the area before beginning other construction. At that point, runoff would be controlled by the final system, although some hay or straw bale ditch checks may still be used to prevent downstream siltation of the system. Development of the site in this manner will reduce the need for short-term temporary erosion control measures. The long-term control will be through the final surface water drainage system. Through application of these procedures the major effects of construction activity will be contained within the construction area boundaries (Figure 3.4).

The relationship between annual construction activities, and physical and vegetative erosion control procedures is described in subsection 3.2.1.3. At the end of Year 3 when major above ground construction on the mine/mill site will have been completed, a complex

E 693 200
E 693 400
E 693 600
E 693 800
E 694 000
E 694 200
E 694 400
E 694 600
E 694 800
E 695 000

N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400

ACCESS ROAD

EXPLOSIVE STORAGE

SURFACE DRAINAGE BASIN NO. 3

PRE-PRODUCTION ORE STORAGE

SURFACE DRAINAGE BASIN NO. 2

RAIL ROAD SPUR

CONCENTRATE THICKENERS
ZINC
COPPER
LEAD
CONCENTRATOR
WATER TREATMENT PLANT
WATER TANKS
PUMP HOUSE
PUMP CHAMBER
TAILINGS THICKENER
TRACK SCALE
DISCHARGE LAGOONS
FUEL STATION
REAGENT BULK STORAGE
CEMENT SILOS
MARCONAFLOS
BALL STORAGE
LUBE STORAGE
COLD STORAGE
COVERED COARSE ORE STORAGE
FINE BACKFILL BIN
BACKFILL CRUSHER
WASTE ROCK STORAGE BIN
COVERED STORAGE
TIMBER & STEEL STORAGE
SANITARY WASTE TREATMENT PLANT
HAUL ROAD
SUBSTATION
NATURAL GAS METER STATION
SERVICES BLDG.
COLLAR HOUSE
HEADFRAME
MINE FRESH AIR INTAKE & HEATER
CORE PROCESSING & STORAGE
TOPSOIL STORAGE AREA
TRUCK SCALE
GATE HOUSE
COMP. COOLER
HOIST HOUSE COMP. STATION
ELEC. ROOM
MULCH STORAGE AREA
BULK FUEL STORAGE
BACKFILL HOLE NO. 1
PARKING
BACKFILL HOLE NO. 2
FUEL TANKS
SURFACE DRAINAGE BASIN NO. 1
WEST EXHAUST RAISE
EAST EXHAUST RAISE
TO MINE WASTE DISPOSAL FACILITY

0 50 100 150
SCALE IN METERS
0 100 200 300 400 500
SCALE IN FEET

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

CONSTRUCTION ZONE FOR MINE/MILL SURFACE FACILITIES

SCALE: SHOWN | STATE: WISCONSIN | COUNTY: FOREST
DRAWN BY: DR SPRINGBORN | DATE: 8/85
APPROVED BY | DATE | APPROVED BY | DATE
APPROVED BY | DATE | BASELINE | DATE
REVISED | DATE | BY | DESCRIPTION

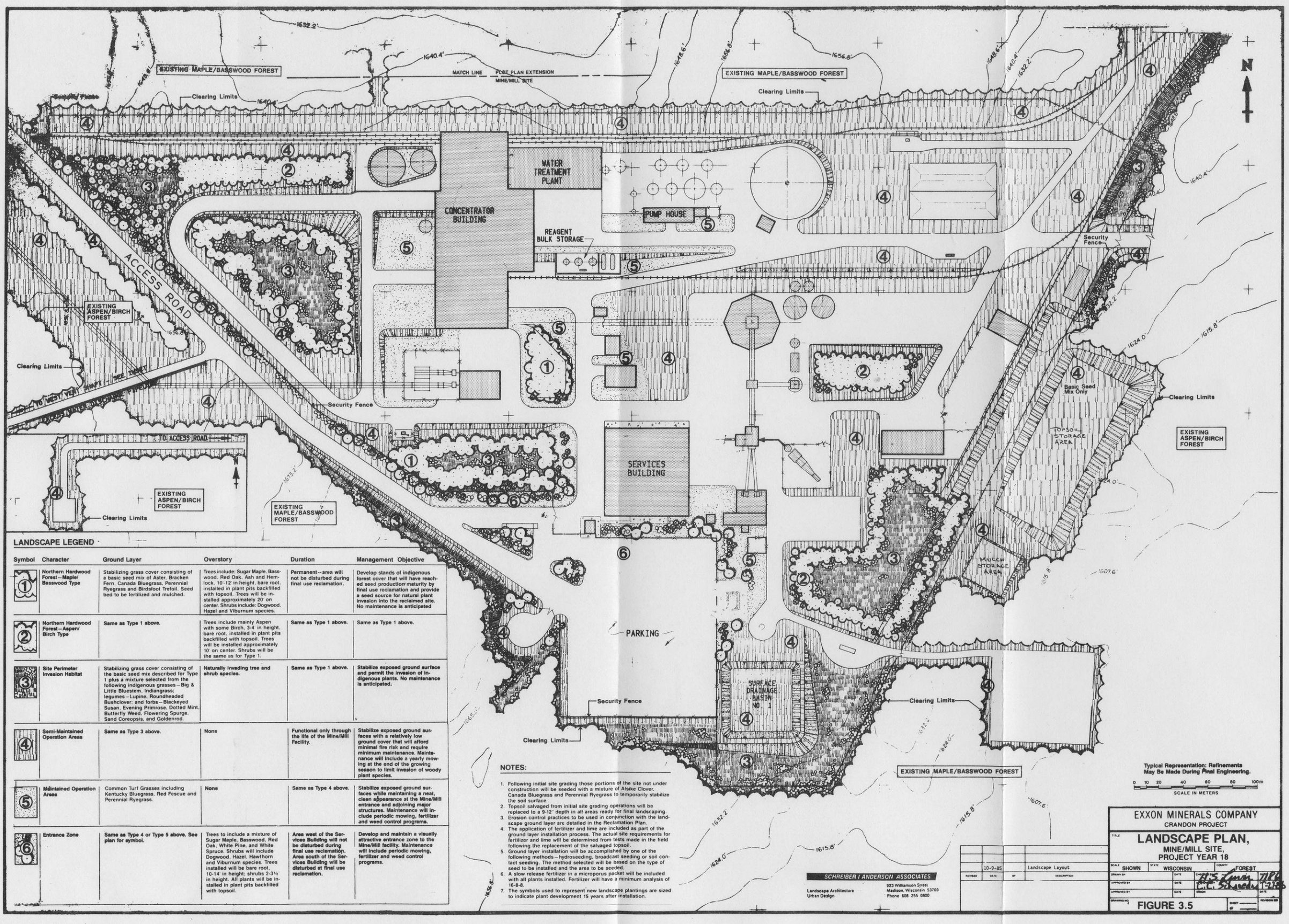
FIGURE 3.4

of physical and vegetative erosion control structures will encompass the site.

3.2.1.3 Landscape/Reclamation Phasing Plan

Site landscaping will occur throughout the construction period and will be primarily concentrated in the mine/mill site. The purpose of the landscape plan is to revegetate the mine/mill site in a manner compatible with the functional, aesthetic, and environmental character of the surrounding landscape (Figures 3.5 and 3.6). Indigenous plant species will be used to maintain site character and to aid in long-term reclamation of the mine/mill site to a natural state (Table 2.4).

Phasing of the landscaping activities will follow the schedule for construction of surface facilities as described in subsection 3.2.1.1. A conceptual phased implementation plan for landscaping the mine/mill site is shown on Figures 3.7 and 3.8 and as fully completed on Figures 3.5 and 3.6. These figures illustrate in conceptual form plant development approximately 15 years after installation. It was assumed that all mine/mill site planting would be completed by Project Year 4 and, accordingly, the scale dimensions of the trees on the plan depict the size of the planted stock after approximately 15 years of growth. Plant species that will be used in mine/mill site landscape/reclamation activities are described in the legend on the figures and in Table 3.1. The management objective, maintenance requirements, and the planned duration of each planted and seeded area are also summarized in the legend.



LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
①	Northern Hardwood Forest—Maple/ Basswood Type	Stabilizing grass cover consisting of a basic seed mix of Aster, Bracken Fern, Canada Bluegrass, Perennial Ryegrass and Birdsfoot Trefoil. Seed bed to be fertilized and mulched.	Trees include: Sugar Maple, Basswood, Red Oak, Ash and Hemlock. 10'-12' in height, bare root, installed in plant pits backfilled with topsoil. Trees will be installed approximately 20' on center. Shrubs include: Dogwood, Hazel and Viburnum species.	Permanent—area will not be disturbed during final use reclamation.	Develop stands of indigenous forest cover that will have reached seed production maturity by final use reclamation and provide a seed source for natural plant invasion into the reclaimed site. No maintenance is anticipated
②	Northern Hardwood Forest—Aspen/ Birch Type	Same as Type 1 above.	Trees include mainly Aspen with some Birch, 3-4' in height, bare root, installed in plant pits backfilled with topsoil. Trees will be installed approximately 10' on center. Shrubs will be the same as for Type 1.	Same as Type 1 above.	Same as Type 1 above.
③	Site Perimeter Invasion Habitat	Stabilizing grass cover consisting of the basic seed mix described for Type 1 plus a mixture selected from the following indigenous grasses—Big & Little Bluestem, Indiangrass; legumes—Lupine, Roundheaded Bushclover; and forbs—Blackeyed Susan, Evening Primrose, Dotted Mint, Butterfly Weed, Flowering Spurge, Sand Coreopsis, and Goldenrod.	Naturally invading tree and shrub species.	Same as Type 1 above.	Stabilize exposed ground surface and permit the invasion of indigenous plants. No maintenance is anticipated.
④	Semi-Maintained Operation Areas	Same as Type 3 above.	None	Functional only through the life of the Mine/Mill Facility.	Stabilize exposed ground surfaces with a relatively low ground cover that will afford minimal fire risk and require minimum maintenance. Maintenance will include a yearly mowing at the end of the growing season to limit invasion of woody plant species.
⑤	Maintained Operation Areas	Common Turf Grasses including Kentucky Bluegrass, Red Fescue and Perennial Ryegrass.	None	Same as Type 4 above.	Stabilize exposed ground surfaces while maintaining a neat, clean appearance at the Mine/Mill entrance and adjoining major structures. Maintenance will include periodic mowing, fertilizer and weed control programs.
⑥	Entrance Zone	Same as Type 4 or Type 5 above. See plan for symbol.	Trees to include a mixture of Sugar Maple, Basswood, Red Oak, White Pine, and White Spruce. Shrubs will include Dogwood, Hazel, Hawthorn and Viburnum species. Trees installed will be bare root, 10-14' in height; shrubs 2-3½' in height. All plants will be installed in plant pits backfilled with topsoil.	Area west of the Services Building will not be disturbed during final use reclamation. Area south of the Services Building will be disturbed at final use reclamation.	Develop and maintain a visually attractive entrance zone to the Mine/Mill facility. Maintenance will include periodic mowing, fertilizer and weed control programs.

NOTES:

1. Following initial site grading those portions of the site not under construction will be seeded with a mixture of Alsike Clover, Canada Bluegrass and Perennial Ryegrass to temporarily stabilize the soil surface.
2. Topsoil salvaged from initial site grading operations will be replaced to a 9-12" depth in all areas ready for final landscaping.
3. Erosion control practices to be used in conjunction with the landscape ground layer are detailed in the Reclamation Plan.
4. The application of fertilizer and lime are included as part of the ground layer installation process. The actual site requirements for fertilizer and lime will be determined from tests made in the field following the replacement of the salvaged topsoil.
5. Ground layer installation will be accomplished by one of the following methods—hydroseeding, broadcast seeding or soil contact seeding. The method selected will be based on the type of seed to be installed and the area to be seeded.
6. A slow release fertilizer in a microporus packet will be included with all plants installed. Fertilizer will have a minimum analysis of 16-8-8.
7. The symbols used to represent new landscape plantings are sized to indicate plant development 15 years after installation.

Typical Representation: Refinements May Be Made During Final Engineering.

0 10 20 40 60 80 100m
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION
	10-9-85		Landscape Layout

SCHREIBER / ANDERSON ASSOCIATES
Landscape Architecture
Urban Design
923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE: LANDSCAPE PLAN, MINE/MILL SITE, PROJECT YEAR 18

SCALE: SHOWN | STATE: WISCONSIN | COUNTY: FOREST

DRAWN BY | DATE | CHECKED BY | DATE
APPROVED BY | DATE | ERDM | DATE
APPROVED BY | DATE
DRAWING NO. | SHEET OF | REVISION NO.

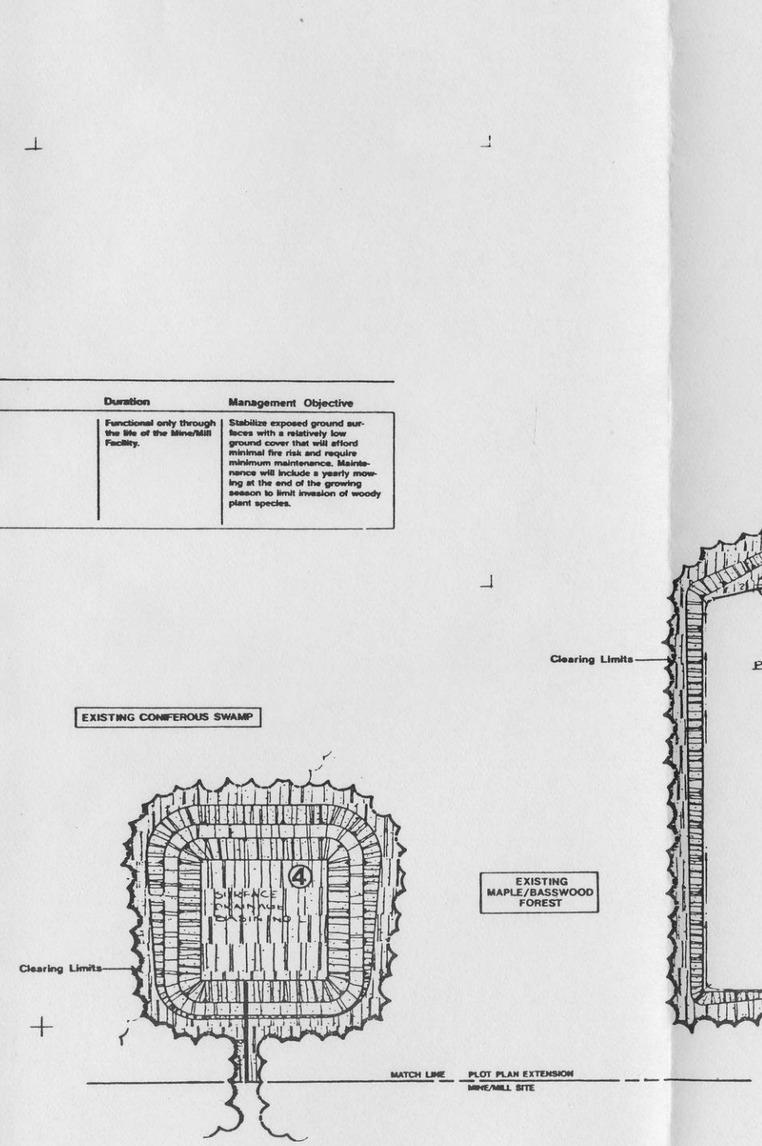
FIGURE 3.5

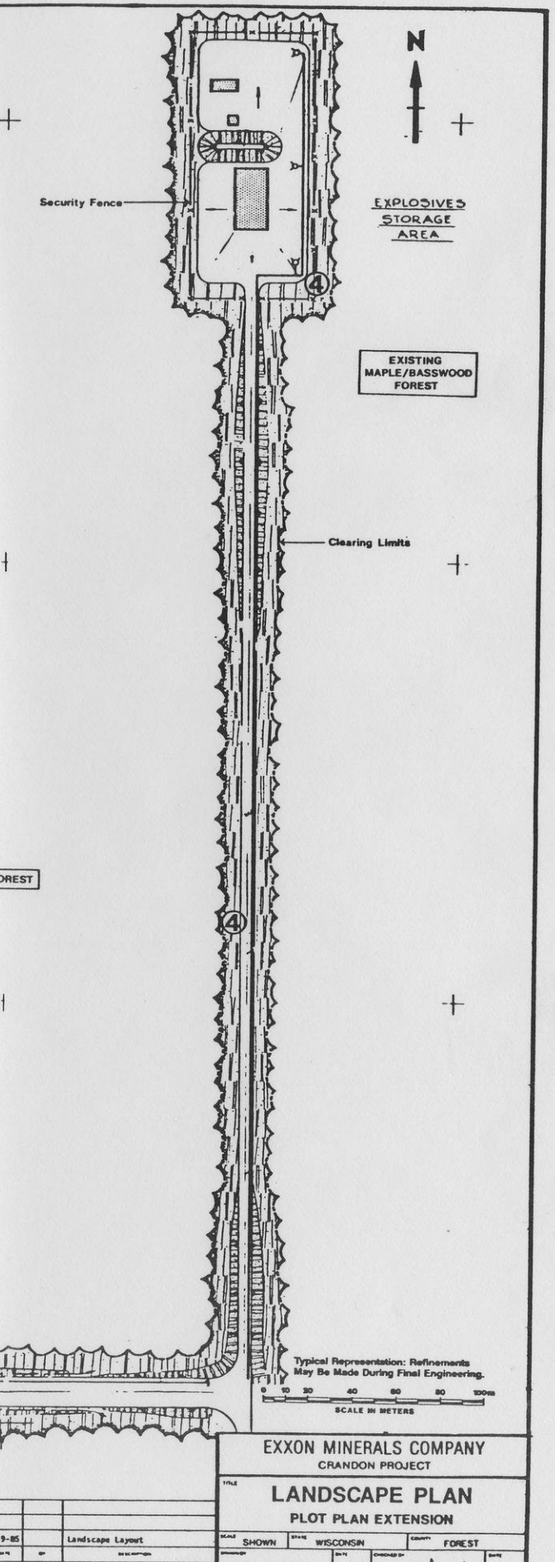
LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
④	Semi-Maintained Operation Areas	Stabilizing grass cover consisting of the basic seed mix described above, plus a mixture selected from the following indigenous grasses – Blue stem, Indian Grass; legumes – Lupine, Roundheaded Bushclover; and forbs – Blackeyed Susan, Evening Primrose, Dotted Mint, Butterfly Weed, Flowering Spurge, Sand Coreopsis, Stiff Goldenrod.	None	Functional only through the life of the Mine/Mill Facility.	Stabilize exposed ground surfaces with a relatively low ground cover that will afford minimal fire risk and require minimum maintenance. Maintenance will include a yearly mowing at the end of the growing season to limit invasion of woody plant species.

NOTES:

1. See Landscape Plan – Mine/Mill Site for applicable notes.





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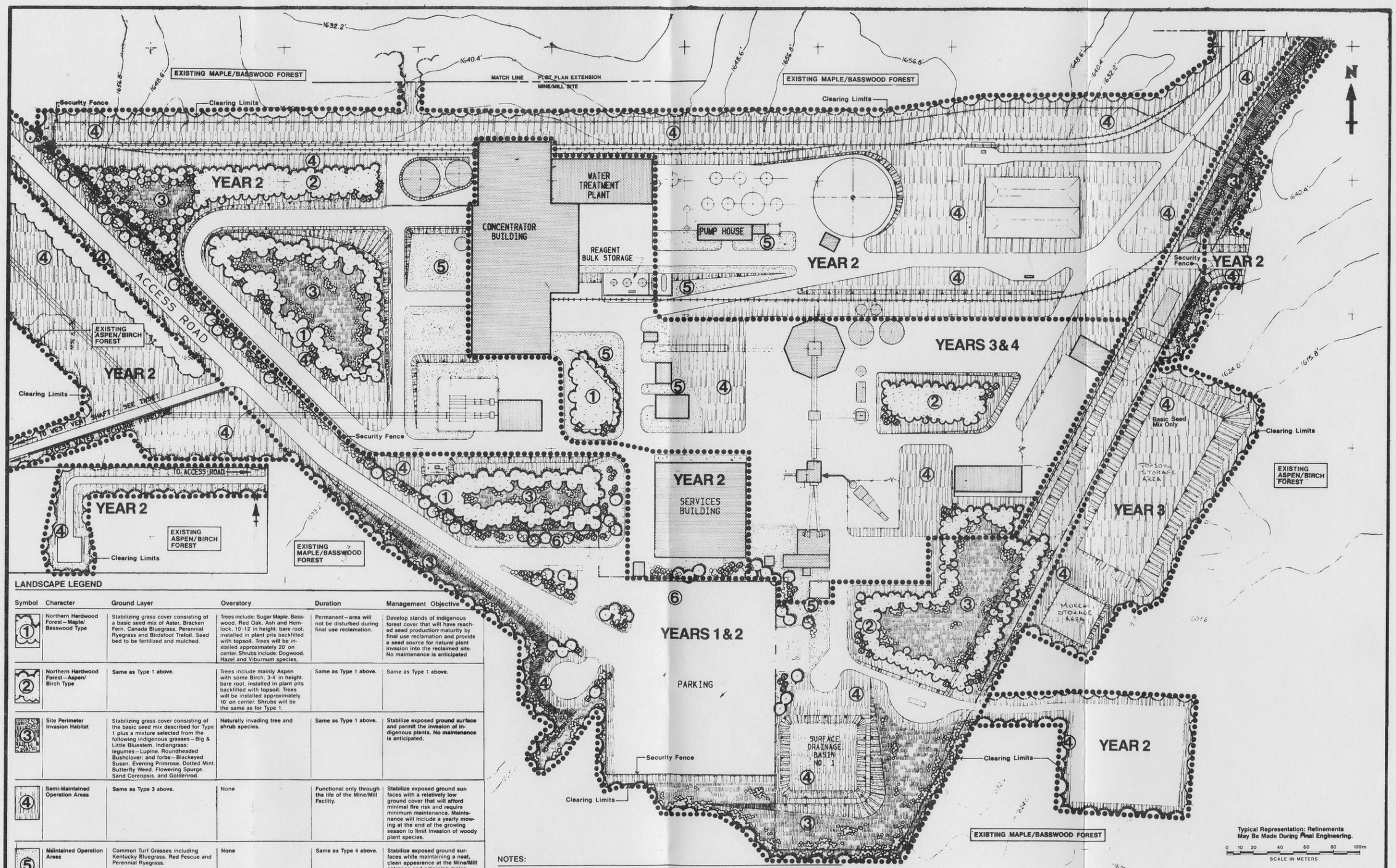
	10-9-85		Landscape Layout
REVISIONS	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
LANDSCAPE PLAN
PLOT PLAN EXTENSION

SCALE SHOWN	STATE WISCONSIN	COUNTY FOREST	
APPROVED BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	DRAWN BY D.T. Mat	DATE 11/85
APPROVED BY	DATE		DRAWING NO. 11/85

FIGURE 3.6



LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
①	Northern Hardwood Forest—Maple/ Basswood Type	Stabilizing grass cover consisting of a basic seed mix of Aster, Bracken Fern, Canada Bluegrass, Perennial Ryegrass and Birdsfoot Trefoil. Seed bed to be fertilized and mulched.	Trees include: Sugar Maple, Basswood, Red Oak, Ash and Hemlock, 10-12' in height, bare root, installed in plant pits backfilled with topsoil. Trees will be installed approximately 20' on center. Shrubs include: Dogwood, Hazel and Viburnum species.	Permanent—area will not be disturbed during final use reclamation.	Develop stands of indigenous forest cover that will have reached seed production maturity by final use reclamation and provide a seed source for natural plant invasion into the reclaimed site. No maintenance is anticipated
②	Northern Hardwood Forest—Aspen/ Birch Type	Same as Type 1 above.	Trees include mainly Aspen with some Birch, 3-4 in height, bare root, installed in plant pits backfilled with topsoil. Trees will be installed approximately 10' on center. Shrubs will be the same as for Type 1.	Same as Type 1 above.	Same as Type 1 above.
③	Site Perimeter Invasion Habitat	Stabilizing grass cover consisting of the basic seed mix described for Type 1 plus a mixture selected from the following indigenous grasses—Big & Little Bluestem, Indiangrass; legumes—Lupine, Roundheaded Bushclover; and forbs—Blackeyed Susan, Evening Primrose, Dotted Mint, Butterfly Weed, Flowering Spurge, Sand Coreopsis, and Goldenrod.	Naturally invading tree and shrub species.	Same as Type 1 above.	Stabilize exposed ground surface and permit the invasion of indigenous plants. No maintenance is anticipated.
④	Semi-Maintained Operation Areas	Same as Type 3 above.	None	Functional only through the life of the Mine/Mill Facility.	Stabilize exposed ground surfaces with a relatively low ground cover that will afford minimal fire risk and require minimum maintenance. Maintenance will include a yearly mowing at the end of the growing season to limit invasion of woody plant species.
⑤	Maintained Operation Areas	Common Turf Grasses including Kentucky Bluegrass, Red Fescue and Perennial Ryegrass.	None	Same as Type 4 above.	Stabilize exposed ground surfaces while maintaining a neat, clean appearance at the Mine/Mill entrance and adjoining major structures. Maintenance will include periodic mowing, fertilizer and weed control programs.
⑥	Entrance Zone	Same as Type 4 or Type 5 above. See plan for symbol.	Trees to include a mixture of Sugar Maple, Basswood, Red Oak, White Pine, and White Spruce. Shrubs will include Dogwood, Hazel, Hawthorn and Viburnum species. Trees installed will be bare root, 10-14' in height; shrubs 2-3½ in height. All plants will be installed in plant pits backfilled with topsoil.	Area west of the Services Building will not be disturbed during final use reclamation. Area south of the Services Building will be disturbed at final use reclamation.	Develop and maintain a visually attractive entrance zone to the Mine/Mill facility. Maintenance will include periodic mowing, fertilizer and weed control programs.

NOTES:

1. The Landscape Phasing Plan identifies the construction year(s) when the permanent landscape will be installed in the Mine Mill site. Facilities scheduled for completion early in the construction phase (eg. vehicular, rail and utility corridors and drainage basins) are generally located on the Mine Mill site perimeter and will be landscaped in Years 1 and 2. Facilities related to the mine production shaft and ore processing will require longer construction periods and are grouped at the center of the site. These facilities will be completed in Year 3 and landscaping will be initiated in Year 3 and extended into Year 4.
2. The Landscape Phasing Plan is based on the assumption that landscape construction will only occur during the months of May thru October. Seasonal weather conditions at the end of the growing season may necessitate the carryover of some landscaping work into the following construction year. In areas designated for permanent or temporary landscape cover, seeding planting programs will be implemented within approximately 30 days after grading to minimize the exposure time for uncovered areas.
3. The permanent landscape type to be installed in each construction year is identified by number and is described in the Landscape Legend.
4. Following completion of major earthwork and grading in Year 1, all areas not scheduled for permanent landscaping will be temporarily seeded with a grass mixture such as Alsike Clover, Canada Bluegrass and Perennial Ryegrass. The temporary landscape cover will be replaced by permanent seeding/plantings when construction activities have been completed in these areas.
5. Application of salvaged topsoil will only occur at the time of permanent landscaping.

Typical Representation: Refinements May Be Made During Final Engineering.

0 10 20 40 60 80 100m
SCALE IN METERS

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	10-9-85	Landscape Phasing Plan	

EXXON MINERALS COMPANY
CRANDON PROJECT

LANDSCAPE PHASING PLAN,
MINE/MILL SITE

SHOWN WISCONSIN FOREST

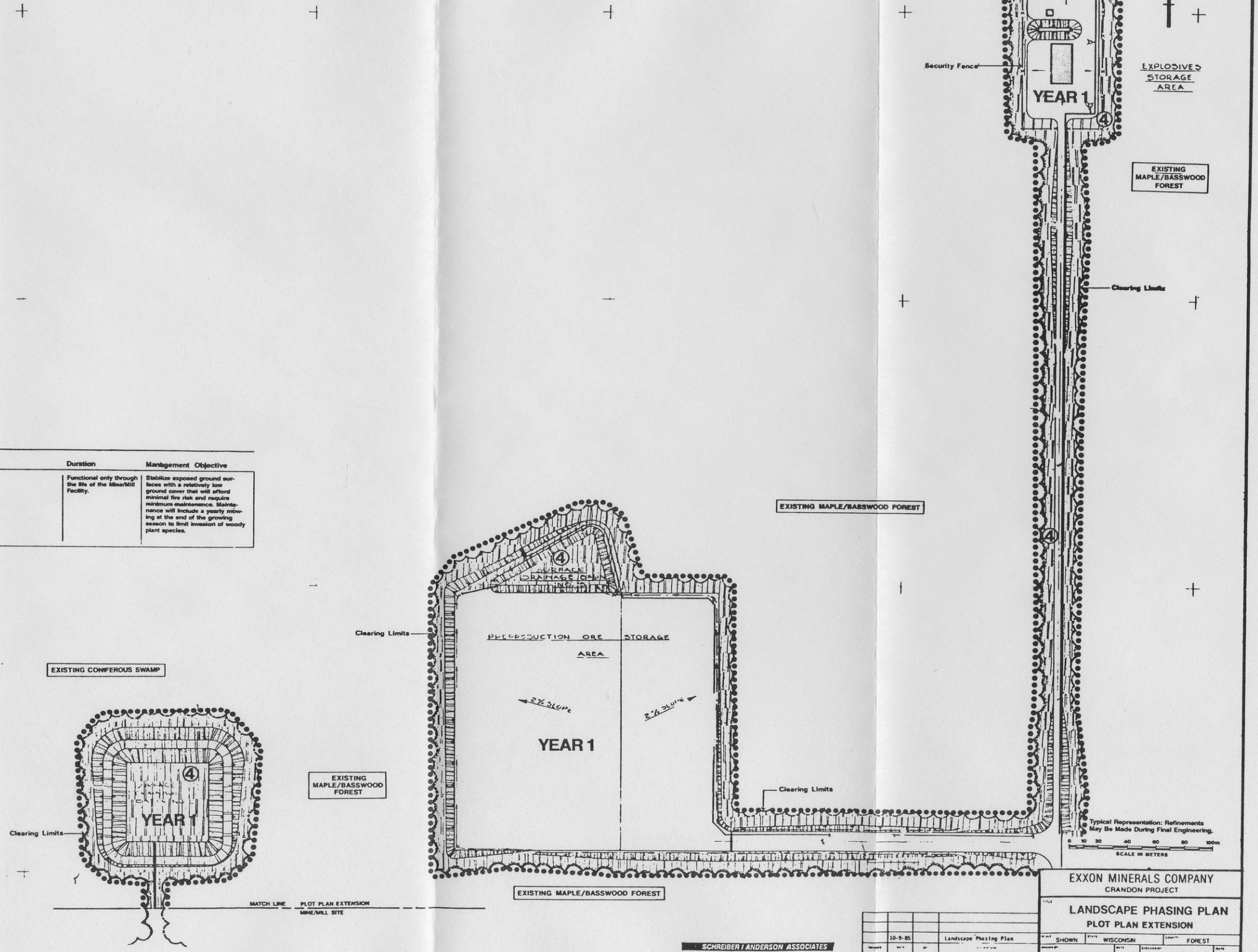
FIGURE 3.7

LANDSCAPE LEGEND

Symbol	Character	Ground Layer	Overstory	Duration	Management Objective
④	Semi-Maintained Operation Areas	Stabilizing grass cover consisting of the basic seed mix described above, plus a mixture selected from the following indigenous grasses – Blue stem, Indian Grass; legumes – Lupine, Roundheaded Bushclover; and forbs – Blackeyed Susan, Evening Primrose, Dotted Mint, Butterfly Weed, Flowering Spurge, Sand Coreopsis, Stiff Goldenrod.	None	Functional only through the life of the Mine/Mill Facility.	Stabilize exposed ground surfaces with a relatively low ground cover that will afford minimal fire risk and require minimum maintenance. Maintenance will include a yearly mowing at the end of the growing season to limit invasion of woody plant species.

NOTES:

1. See Landscape Phasing Plan — Mine/Mill Site for applicable notes.



EXXON MINERALS COMPANY
CRANDON PROJECT

LANDSCAPE PHASING PLAN
PLOT PLAN EXTENSION

SHOWN | WISCONSIN | FOREST

10-9-85 Landscape Phasing Plan

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FIGURE 3.8

Landscape implementation activities will follow a sequence which involves (1) site preparation, including clearing, grubbing, erosion control, topsoil removal, earthwork and maintenance of a permanent salvaged topsoil stockpile for reclamation operations; (2) final grading, reapplication of topsoils and seedbed preparation; (3) seeding of landscape groundcover and planting of trees and shrubs which initiates reclamation of perimeter areas and then progresses to the interior of the site as facilities are completed; (4) fertilizer application; (5) mulching; and (6) short and long-term maintenance operations.

The landscape phasing plan (Figures 3.7 and 3.8) illustrates landscape implementation zones based upon the sequence and duration of the principal construction activities during the 3-year construction period. Landscape ground layer and tree plantings contained within an implementation zone labeled by construction year(s) are to be installed during that time period. Final landscaping of the mine/mill site will be completed in Year 4.

3.2.1.3.1 Landscape Implementation

Site preparation operations (subsection 3.2.1.2), species selection (subsection 2.4.3), and methods of establishment (subsection 2.4.4) have been described for those areas where construction activities occur immediately and for those where construction activities occur in Years 2 and 3. In addition, site perimeter areas which are to remain undisturbed for the operational period of the Project and those which are to permanently remain after abandonment will be vegetated following final grading.

Site preparation will occur during Years 1 and 2 of construction. The perimeter zone and entrance zone will be finish graded during this period and permanent landscape ground layer and overstory plantings installed. All main powerline and circulation corridors within the mine/mill site will be constructed during Years 1 and 2 along with the site's main drainage channels and surface drainage basins. A mixture of indigenous and introduced plant species will be established in these areas as soon as they are completed. Indigenous forbs with a complete seasonal flowering sequence will be included in the seed mixtures (Table 2.4).

Typical species that could be used in the powerline corridor and in the retention basins are listed in Table 2.4. Within the powerline corridor from State Highway 55 to the mine/mill site the only areas proposed to be seeded are those that are entirely cleared of vegetation and where soils are disturbed, e.g., around transmission towers and the access road used during construction.

Seed suppliers within the State of Wisconsin, such as Wild Life Nurseries, Oshkosh; Prairie Nursery, Westfield; Sperka's Woodland Acres Nursery, Crivitz; and Strand Nursery, Osceola, will be the source of native plant seeds. Agricultural plant seeds will be obtained from local commercial suppliers. Most bulk seed requirements will be obtained on a competitive bid basis.

In Year 2 of mine/mill construction the services building, water treatment plant, and most of the site infrastructure 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, permanent groundcover seeding and planting of trees and shrubs will occur. All necessary erosion control structures and techniques will be employed as needed to ensure site stabilization.

During Year 3, construction of all facilities will have been completed, including the concentrator, coarse ore storage building and the remaining ancillary facilities. Following finish grading in Years 3 and 4, the permanent ground layer 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 landscape maintenance practices for the site will be initiated.

3.2.1.4 Revegetation

Installation of landscape plantings will begin as soon as portions of the site are brought to final grade and a suitable seedbed has been prepared. No landscape plants will be installed in temporarily disturbed or unfinished areas of the site. The seeding and planting methods and materials to be used in the mine/mill site are presented in Table 3.1.

3.2.1.4.1 Seedbed Preparation

After final grading, steps will be taken to provide a satisfactory seedbed for the establishment of herbaceous cover and tree and shrub species. The seedbed will be prepared by some mechanical

method of tilling or scarifying the soil surface. One of the initial steps in preparing the seedbed will be application of topsoil to a depth of 9 to 12 inches. Measures will be taken to minimize the amount of compaction during grading and leveling of the topsoil. If necessary, compaction of the topsoil will be reduced by the utilization of a disc-harrow before seeding. If it is necessary to relieve compaction of the final graded surface prior to topsoil application, equipment such as a ripper or chisel will be used on the subgrade.

Scarification may be required to prepare an acceptable seedbed on slopes. A tracked vehicle, such as a bulldozer, could be used for "tracking-in" numerous small depressions that will collect water and favor seed germination and seedling establishment.

3.2.1.4.2 Plant Materials

If it is cost effective and suitable stock is available, some specimens for use in landscaping the mine/mill site will be taken from property owned by Exxon Minerals Company immediately around the mine/mill site or in those areas designated for future Project facilities, such as the tailing ponds in the MWDF area. Prior to transplanting, all stock selected in the Project area will be marked and inspected by a qualified horticulturalist to ensure the specimens are disease free, structurally acceptable and suitable for landscaping purposes. Nursery grown stock will also be used in landscaping. Commercially grown plants will be obtained from local and regional nurseries and will conform to the requirements of the American Standard for Nursery Stock and the Wisconsin Administrative Code, Agriculture 21.

Examples of such nurseries include: Evergreen Nursery, Sturgeon Bay; Silver Creek Nursery, Manitowoc; and Bruce Company, Middleton.

High quality seed that has been properly tested and tagged will be used to establish herbaceous cover. Depending upon availability, seed with known purity and germination percentages will be used. Pure live seed (PLS) expresses seed quality and is the percent of pure, viable seed in a particular lot of seed. Seed based on PLS will be used. Seed of agronomic species will be certified.

Specific seed mixtures, adapted to detailed site conditions, will be selected from the species listed in Tables 2.4 and 3.1. Final seed mixtures will be selected in consultation with the DNR at the time of annual permit reviews. The seed mixtures will contain a variety of species adaptable to the microclimatic conditions present at the site being revegetated. This approach of selecting specific seed mixtures for different climatic conditions will accelerate the successional process and result in more rapid development of a stable community.

3.2.1.4.3 Seeding and Plant Installation

Seeding methods for use in establishing indigenous and introduced plant materials in the mine/mill site will include broadcast and soil contact seeding and hydroseeding (Table 3.1). The method to be used in each area will depend upon slope conditions, amount of area to be seeded, and the type of seed to be installed. The seeding rate will be based on the size of the seeds being sown, type of equipment being used to distribute the seed, and the aspect of the site being seeded.

During the construction phase, seed will be sown in Years 1 through 4 (Table 3.1).

Trees in the maple/basswood group will be 10 to 12 feet in height, bare root and will be installed in plant pits backfilled with topsoil and compost. Trees will be installed approximately 20 feet on center.

Trees in the aspen/birch group will consist of 3 to 4-foot bare root stock. These trees will be hand planted in plant pits and backfilled with topsoil. The trees will be installed approximately 10 feet on center.

A conceptual illustration in cross-section view of the distribution and growth forms of reestablished vegetation in relation to mine/mill surface facilities and adjacent undisturbed vegetation is presented on Figure 3.9. The scale dimensions of the vegetation on the figure depict plant development after approximately 5 years of growth (Project Year 9). Figures 3.5 and 3.6 illustrate in plan view the distribution and growth form of plants in the mine/mill site 15 years after installation (Project Year 18).

Plant installation will occur throughout the spring, summer, and fall seasons in Years 2 through 4 (Table 3.1). Normally, balled and burlapped and bare root stock will be planted until June 1 and again after October 1. In general, container grown stock will be planted throughout the spring, summer, and fall. All plant materials will be installed following standard landscape practices (Sanborn Group, Inc., 1983).

EXISTING MAPLE/BASSWOOD FOREST

Main Entrance Road

PLANTED NORTHERN HARDWOOD FOREST – MAPLE/BASSWOOD

PLANTED MAPLE/BASSWOOD FOREST (MIDDLEGROUND)

Plant Road to concentrator

EXISTING GRADE

FACILITY GRADE

EXISTING MAPLE/BASSWOOD FOREST (BACKGROUND)

MATCH LINE

10′

1640′

ENTRANCE ROAD EL. 1666.24′

CONCENTRATOR BUILDING & ELECTRICAL SUBSTATION (FOREGROUND) EL. 1679.36′

SECTION THROUGH SERVICES BUILDING EL. 1662.96′

COLLAR HOUSE & HEADFRAME EL. 1662.96′
COARSE ORE STORAGE (BACKGROUND) EL. 1666.24′

MATCH LINE

PLANTED NORTHERN HARDWOOD FOREST – ASPEN/BIRCH

Railroad Corridor

EXISTING GRADE

FACILITY GRADE

EXISTING MAPLE/BASSWOOD FOREST (BACKGROUND)

EXISTING ASPEN/BIRCH FOREST

Haul Road

1640′

10′

COLLAR HOUSE & HEADFRAME EL. 1662.96′
COARSE ORE STORAGE (BACKGROUND) EL. 1666.24′

MINE AIR HEATER EL. 1658.37′
WASTE ROCK BIN EL. 1666.24′
MARCONAFLO BACKFILL STORAGE EL. 1666.24′

CORE PROCESSING STORAGE EL. 1659.68′

COVERED STORAGE BUILDING EL. 1659.68′

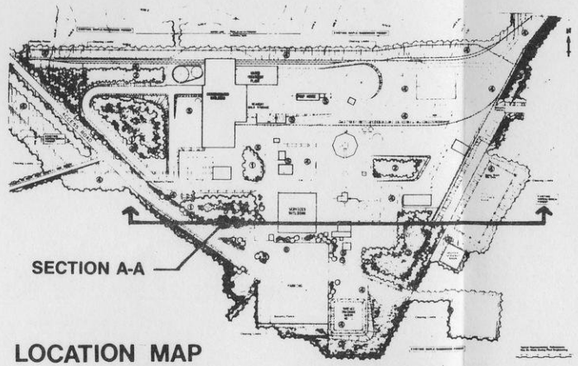
TOPSOIL STORAGE EL. 1636.72′

HAUL ROAD EL. 1613.76′

SECTION A-A

NOTES:

1. Landscape plantings are sized to indicate plant development 5 years after mine/mill construction.



LOCATION MAP

0 50 100 200

SCALE IN FEET

SCHREIBER / ANDERSON ASSOCIATES

Landscape Architecture
Urban Design

923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **CONCEPTUAL LANDSCAPE PLAN SECTION – MINE/MILL SITE, PROJECT YEAR 9**

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST
DRAWN BY	DATE 1-86	CHECKED BY D. S. Fuson DATE 1/86
APPROVED BY	DATE	APPROVED BY C.C. Schroeder DATE 1-27-86
APPROVED BY	DATE	EXXON DATE

DRAWING NO **FIGURE 3.9** SHEET OF REVISION NO

3.2.1.4.4 Mulching

Organic mulches will be used, as needed, to reduce erosion, provide a source of organic matter, and conserve soil moisture, thereby enhancing the establishment of vegetation. Mulching of seeded areas will be most important on south facing slopes and slopes subject to erosion. If required, chemical binders will be used to hold organic mulches in place. Typical mulches that will be used include straw, hay, wood chips, wood fiber, and bark. Application rates will be determined in conjunction with the DNR.

Mulches will also be applied around the base of planted trees in the entrance zone.

3.2.1.5 Landscape Maintenance

3.2.1.5.1 Short-Term Maintenance Requirements

The objective of short-term maintenance operations is the establishment of the permanent landscape. Short-term operations will be in effect for the first two growing seasons following installation of trees, shrubs, and herbaceous plantings. These operations will include erosion control and weed and disease control. A higher level of maintenance activity will occur in the entrance zone to the mine/mill site to maintain the desired aesthetic appearance. Maintenance of landscape plants at the perimeter of the operations zone will focus on periodic control of grass and weeds until the plants are established.

3.2.1.5.2 Long-Term Maintenance Requirements

The objective of long-term maintenance is to ensure the continued growth and vigor of the site landscape for aesthetic and functional considerations and future reclamation purposes. Operations will include mowing, fertilization, and disease control for maintained turf areas in the entrance zone (Figure 3.5). Periodic mowings around surface facilities and in semi-maintained and maintained operation areas will also occur to facilitate operations and maintain fire breaks (Figures 3.5 and 3.6). In the entrance zone, landscape plants in close public view will be monitored for continued growth, disease control, and general aesthetic appearance. Proposed maintenance practices in the mine/mill site over the life of the Project are summarized in Table 3.1.

As part of the long-term maintenance program during Project operations, clear zones will be maintained around the perimeter fence surrounding the mine/mill, reclaim pond, MRDF, and MWDF facilities and in the rights-of-way for the access road, railroad spur, and haul road/tailings transport pipeline corridor. These areas will be maintained in herbaceous vegetation and/or low growing woody species to minimize the potential for fires. Growth of woody species within these clear areas will be controlled by mowing and selective application of EPA approved herbicides.

3.2.1.6 Reclamation Upon Completion of Mining

Final reclamation of the mine/mill site and ancillary facilities will begin approximately 32 years after the start of Project

construction, if no acceptable alternative use is found for the facilities. Final reclamation will be performed in the following sequence: (1) demolition of major structures, followed by site regrading and erosion control; (2) an approximate 4-year revegetation program; (3) removal, after 2 years, of the water treatment plant and associated structures required for treatment of water from the MWDF; and (4) long-term monitoring of the completed reclamation.

An outline of final reclamation objectives for the Project area is depicted in Table 3.3. Reclamation procedures during the closure period for the mine/mill site, railroad spur, access road, and haul road/tailings transport system are described under each management unit. Of the four final reclamation steps listed above for the mine/mill site, steps 1, 2, and 3 are described below; step 4 is described in Section 5.0, Monitoring and Long-Term Maintenance Plan.

3.2.1.6.1 Removal of Facilities

Mine/mill and other designated site structures will be dismantled and removed if no alternative use can be made of the facilities. Facilities for which no use can be made will be removed within approximately 2 years after operations cease. Within the mine/mill site, the sequence is planned to start with the concentrator and adjacent buildings (which have the largest assemblage of machinery and equipment) and end with the services building (Figure 1.3). Because of their necessary function, the water treatment and fire protection systems will be maintained until late in the removal phase. Underground

TABLE 3.3

SUMMARY OF PROJECT AREA FINAL RECLAMATION

FACILITY	PROPOSED ACTION*	PROPOSED END STATUS
Mine/Mill Site	Dismantle and regrade.	Return to premining vegetative conditions through use of short-term vegetation, enrichment with indigenous species, and invasion of herbaceous and woody species.
Railroad Spur	Remove rails, ties, ballast and subballast. Replace topsoil and final grade.	Return to premining vegetative conditions through use of short-term vegetation, enrichment with indigenous species, and invasion of herbaceous and woody species.
Access Road	Remove pavement and base. Replace topsoil and final grade.	Return to premining vegetative conditions through use of short-term vegetation, enrichment with indigenous species, and invasion of herbaceous and woody species.
Haul Road and Tailings Transport Corridor	Cover base with soil layer. Plug pipe ends and leave pipelines in place.	Return to premining vegetative conditions through use of short-term vegetation, enrichment with indigenous species, and invasion of herbaceous and woody species.
Water Discharge System	Remove discharge structure at Swamp Creek, plug pipe ends, and leave pipeline in place.	Revegetation established with initial construction to remain.
MWDF and MRDF	Remain in place, covered and capped.	Revegetation with short-term vegetation, enrichment with indigenous herbaceous species and tree and shrub plantings, and invasion of herbaceous and woody species.
Reclaim Pond	Remove liner system and embankments. Replace topsoil and final grade.	Return to premining vegetative conditions through use of short-term vegetation, enrichment with indigenous species, and invasion of herbaceous and woody species.

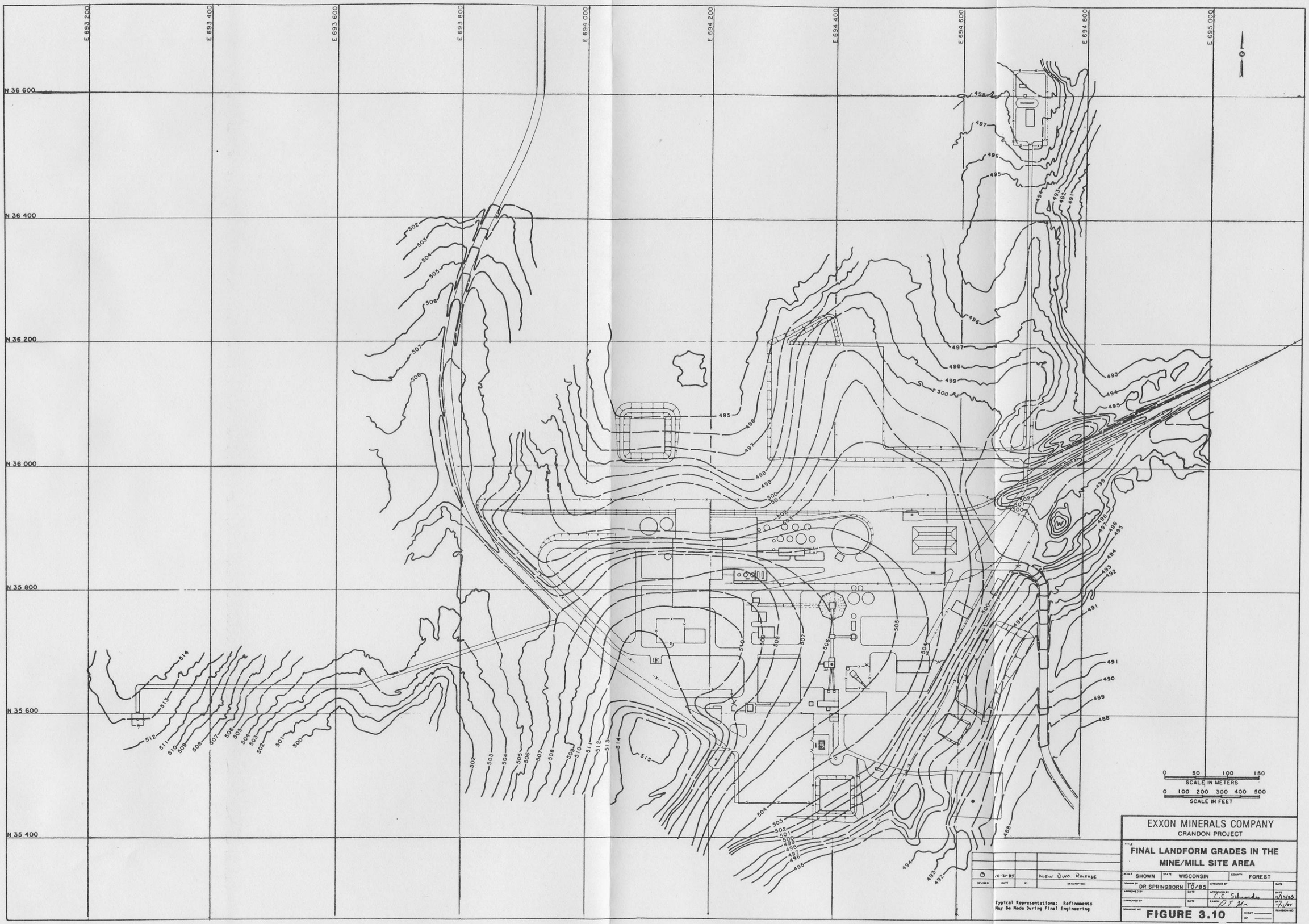
*Action will be taken if no other acceptable use or requirement exists for the facility.

pipelines, which will be at least 2 feet below the planned final grade, will be plugged and left in place.

The mine/mill area roads and railroad tracks will be some of the last items to be removed as they are required for movement of reclamation equipment, material and personnel. The access road, necessary in-plant roads and the haul road/tailings transport corridor will remain in place for approximately 2 years, or until pumping and treatment of tailing pond water are complete.

For the mine/mill site, broken concrete will be placed into the low areas to assist in establishing desired contours for final site reclamation. The broken concrete used to fill in low areas in the mine/mill site will be mixed and covered with borrowed earth, obtained either from high areas within the mine/mill site or the MWDF area. Typically, most broken concrete will be 12 inches or less in size. The broken concrete will be placed in layers and the voids will be filled with soil followed by compaction of the layer. This procedure ensures a competent total fill and minimizes the possibility of any subsidence due to void areas. Following removal of buildings and service structures, grading will be performed to establish the desired landform which will be similar to the overall final reclamation grading plan shown on Figure 3.10.

Any required borrow to develop the final reclamation grades at the mine/mill site will primarily be obtained from materials maintained at the MWDF. The final reclamation grades have been planned so that the original drainage patterns are reestablished, to the extent possible, and also to minimize required earthwork.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N 36 600
N 36 400
N 36 200
N 36 000
N 35 800
N 35 600
N 35 400
SCALE IN METERS
0 50 100 150
SCALE IN FEET
0 100 200 300 400 500
EXXON MINERALS COMPANY
CRANDON PROJECT
FINAL LANDFORM GRADES IN THE MINE/MILL SITE AREA
SCALE SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY DR SPRINGBORN
DATE 10/8/85
CHECKED BY
APPROVED BY C.C. Silvander
DATE 11/14/85
APPROVED BY
DATE
DRAWING NO.
0 10-24-85 NEW DWG RELEASE
REVISED DATE BY DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering
FIGURE 3.10

When pumping and treatment of tailing pond water are complete, approximately 2 years after reclamation of tailing pond T4, all remaining facilities in the mine/mill site and haul road/tailings transport corridor will be dismantled and the area graded and revegetated. Access to both of these areas will be maintained for inspection and monitoring purposes. At this time an access road to the MWDF (to be used during the long-term monitoring and care period) will be constructed from the existing town road to the southeast side of tailing pond T4.

Access to the mine/mill site will be provided from Sand Lake Road through one of the existing access ways. Access to long-term monitoring locations in the mine/mill site will be provided by a network of roads. The mine/mill site related roads and the MWDF monitoring road system, including the road around the perimeter of the facility, the access road from the town road, and a road to the monitoring locations on the reclamation cap will all be similar. Dirt roads, similar to the existing network of logging roads in the site area, will be maintained for this use during operation and post-operation monitoring periods. These roads will have an approximate 10-foot wide travelling area with a few additional feet of clearing on both sides in most areas. Maintenance requirements are expected to be minimal with only occasional regrading and gravel placement. These roads will not be reclaimed at the conclusion of the 30-year long-term care period since access to the area will enhance its long-term use for forestry and recreation.

When mine production operations cease, underground reclamation activities will begin with the salvage of all equipment with potential

resale value. This will typically include mobile mining vehicles, the underground crusher, ventilation fans, and ultimately the mine hoists. All equipment, installations, and supplies containing potentially toxic materials (e.g., mine fueling station gear and electrical transformers) also will be removed. Normal mine water pumping operations will continue through this mine salvage and clean-up period.

Following the removal of salvageable equipment and potentially toxic materials, the mine will be allowed to flood. Preparations for mine inundation will include cement grouting of the mine backfill delivery boreholes and the diesel fuel supply pipeline. Some of the mine pumping equipment may be salvaged. Reinforced concrete isolation barriers may be placed in vertical openings at selected locations on the uppermost mine levels. Complete flooding of the mine will occur within 2 to 3 years after inundation preparations are complete and mine drainage pumping ceases.

The final aspect of underground mine reclamation activities will be the abandonment of the three shafts leading to the surface (Figure 3.3):

1) Main production and hoisting shaft;

2) East exhaust shaft; and

3) West exhaust shaft.

Surface mine air heating equipment and/or main exhaust fans will be removed from the shaft collars. Only the main production and hoisting shaft will contain in-shaft salvageable equipment, namely the conveyances which will be dismantled in conjunction with demolition of the main shaft concrete tower headframe.

Final closure procedures for each of the three concrete lined shaft collars extending through the overburden to bedrock will include:

1) Placement of a reinforced concrete ground water isolation plug, connected to the shaft lining, at the bedrock subcrop elevation.

2) Removal of all shaft steel, service pipelines, and utilities above the ground water isolation plugs.

3) Overburden backfilling of the shafts above the ground water isolation plugs to within 10 feet of the final reclaimed surface grade.

4) Demolition of the near surface concrete shaft lining and collars, subsequently combined with the final grade fill prior to site revegetation.

5) Placement of identification and security structures for any reclaimed shaft sites containing provisions for ground water monitoring.

The gate house and the security fence will be the last structures to be removed. Refencing the main substation and water treatment plant may be required to secure these areas during the period allotted for tailings water treatment.

3.2.1.6.2 Prevention of Surface Subsidence During and After Mining

An evaluation of underground mining activities as they could affect surface land subsidence was undertaken by Mitchell et al. (1982). It was concluded that the proposed mining practices would cause negligible surface subsidence. Surface subsidence at the mine/mill site is not, therefore, being considered an item under NR 132.08(2)(e) in the Reclamation Plan.

3.2.1.6.3 Reclamation Grading and Soil Placement

If all facilities in the mine/mill site are removed, approximately 115 acres will be subject to regrading. Site material or borrow fill from the MWDF area will be used to cover disposed rubble to a minimum 24-inch depth and will be placed to approximately the landform grades depicted schematically on Figure 3.10.

Topsoil Salvage - Topsoil within the reclamation plan grading limits will be salvaged and stockpiled at the beginning of earthwork regrading operations. Revegetating the topsoil stockpile for wind and water erosion control is not planned since the material will be used early in the regrading operation. Topsoil will be replaced in the areas disturbed by reclamation as described in subsection 2.4.1. While regrading operations may proceed on a longer basis, finished grading, i.e., placement of topsoil for plant growth media, will be primarily restricted to May through October.

Preservation of Existing Vegetation - Regrading will be designed to minimize disturbance of existing forest and landscape plantings although turf and ground layer vegetation adjacent to buildings and road corridors will be disturbed. Some trees near the services building and surface drainage basin No. 1 located in the southcentral portion of the site will be removed for excavation of borrow fill.

Erosion Control - During reclamation grading, erosion control measures will be implemented. Generally, new opportunities for erosion will not be created in the reclamation process. Existing slopes will be

reduced in grade for purposes of acquiring borrow fill, reducing visual impact and improving surface drainage. Surface drainage patterns will be reestablished according to the final grading plan shown on Figure 3.10. The slopes of newly constructed swales and other disturbed areas will receive salvage topsoil to promote revegetation and subsequent site stabilization. Revegetation of exposed soil surfaces will commence as final grading operations are completed. Portions of the site that are regraded will be seeded with a mixture of indigenous and introduced species. Where necessary, organic mulches will be applied to slopes. Drainage swales will be protected, where appropriate, through the use of erosion control fabrics.

The same temporary erosion control techniques described in Section 2.0 and used in the initial construction will be reemployed during reclamation. Wherever soils are redisturbed for reclamation, temporary erosion control techniques will be used until the final reclaimed surfaces have stablized and vegetative cover has been established.

The surface drainage basins in the mine/mill site will also be used for erosion control during final reclamation. To the extent possible, surface runoff from the final reclaimed areas will be directed to the basins until the surface soils have stabilized and the final vegetative cover is established. Any areas that cannot be drained through the surface basins will be protected with temporary erosion control devices as described in Section 2.0. The final reclamation step will consist of removing and reclaiming the surface basins and any temporary structures.

3.2.1.6.4 Revegetation and Maintenance

Upon completion of facility dismantling in the mine/mill site, if required, and site regrading, several open areas will remain. These will be delineated by major landscape plantings and surrounding undisturbed forest. The two largest open areas will extend along an east-west axis and occupy the northern and southern halves, respectively, of the former mine/mill site. Linear clearings will occur along former mine/mill roads and the railroad spur corridor. When final grading has been completed, the above open areas will be seeded with a mixture of indigenous and introduced plant species (Table 3.1).

Reclamation procedures during the closure phase will be similar to those described in subsection 3.2.1.4 for seedbed preparation, selection of plant materials, seeding and planting methods and mulching (Table 3.1). Herbaceous groundcover will be established in all regraded areas. Seed mixtures will be selected from the indigenous and introduced plant species listed in Tables 2.4 and 3.1. The area will be revegetated over a 3-year period from Years 34 through 36 (Table 3.1). Final seed mixtures will be determined in conjunction with the DNR at the time of annual permit reviews.

Irregular clumps and strips of indigenous trees and shrubs will also be planted over a portion of the regraded area. These plantings will accelerate the successional process and will be located to promote blending with the remaining landscape plantings and the adjacent undisturbed vegetation around the perimeter of the mine/mill site. Whips or seedlings approximately 3 years old will be planted.

The woody plants to be used will be selected from the list of indigenous species presented in Table 3.1.

Annual inspections of the reclaimed areas will be performed and regrading, reseeding and/or replanting will be completed as required. Further information on the vegetation inspection, monitoring and long-term maintenance programs is presented in Section 5.0.

During operation of the Project, landscape communities planted in the mine/mill site during construction will mature. At the completion of mine operations, those communities will consist of shrubs, saplings, and mature tree species. Reclamation of exploration drilling sites in the Project area has demonstrated that cleared areas surrounded by undisturbed forests are rapidly colonized by native shrub and tree species, provided herbaceous cover has been established on the disturbed areas (Appendix 3.3A). The results of studies by the DNR (McCaffery et al., 1981) of constructed forest openings in the North Central District also demonstrated that native ground layer and woody plant species readily invade such areas. The trees and shrubs planted during the closure period in conjunction with the pioneer woody plants that invade the area will promote forest development in the reclaimed mine/mill site.

Figure 3.11 illustrates a conceptual cross-section view of the mine/mill site showing the development of revegetated areas 15 years after final closure. Undisturbed vegetation around the perimeter of the site and landscaped areas established during the construction phase are also illustrated.

EXISTING MAPLE/BASSWOOD FOREST

INVADING INDIGENOUS PLANTS

LANDSCAPING INSTALLED YEAR 2 OF OPERATIONS PERIOD (MAPLE/BASSWOOD TYPE)

LANDSCAPING INSTALLED YEARS 3 & 4 OF OPERATIONS PERIOD (MAPLE/BASSWOOD TYPE)

INVADING INDIGENOUS PLANTS

EXISTING MAPLE/BASSWOOD FOREST (BACKGROUND)

MATCH LINE

10′

1640′

EXISTING GRADE

FINAL RECLAMATION GRADE

INVADING INDIGENOUS PLANTS

MATCH LINE

LANDSCAPING INSTALLED YEARS 3 & 4 OF OPERATIONS PERIOD (ASPEN/BIRCH TYPE)

INVADING INDIGENOUS PLANTS

EXISTING MAPLE/BASSWOOD FOREST (BACKGROUND)

EXISTING ASPEN/BIRCH FOREST

INVADING INDIGENOUS PLANTS

EXISTING ASPEN/ BIRCH FOREST

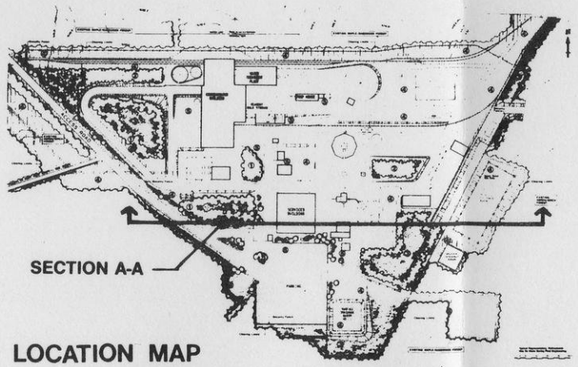
1640′

10′

EXISTING GRADE

FINAL RECLAMATION GRADE

SECTION A-A



LOCATION MAP

0 50 100 200

SCALE IN FEET

SCHREIBER / ANDERSON ASSOCIATES

Landscape Architecture
Urban Design

923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **CONCEPTUAL LANDSCAPE PLAN SECTION - MINE/MILL SITE, YEAR 15 OF LONG-TERM CARE PERIOD**

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY	DATE 1-86	CHECKED BY H. S. Knox	DATE 1/86
APPROVED BY	DATE	APPROVED BY C.C. Schneider	DATE 1-27-86
APPROVED BY	DATE	EXXON	DATE
DRAWING NO		SHEET OF	REVISION NO

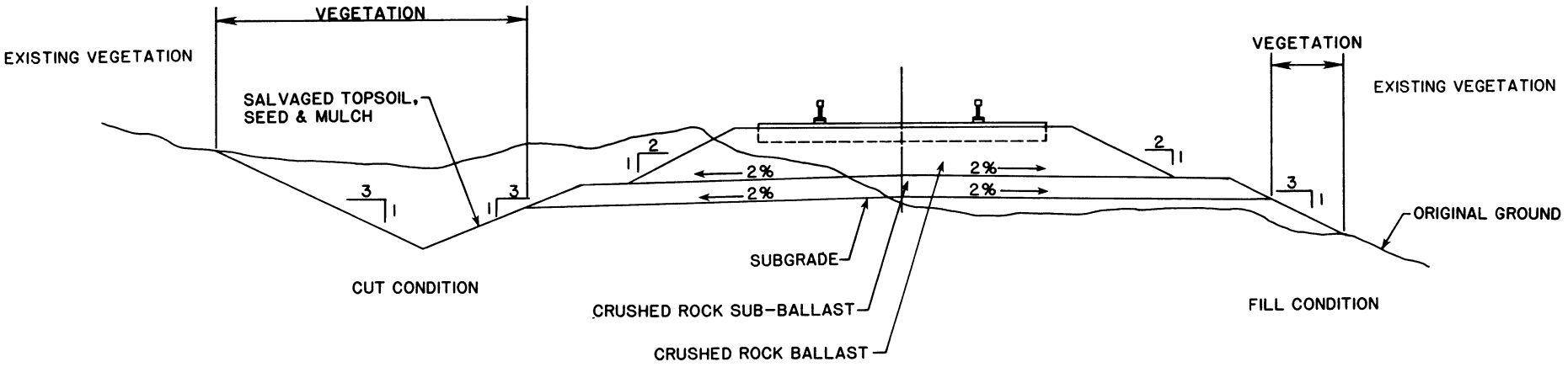
FIGURE 3.11

3.2.2 Railroad Spur (Management Unit 2)

The requirements for a railroad spur to serve the mine/mill site have been outlined in Section 1.3; the proposed route from the Soo Line Railroad main track line to the mine/mill site is shown on Figure 1.2.

3.2.2.1 Construction Procedures and Erosion Control

The railroad spur will be constructed during Years 1 and 2 of the Project (Figure 3.2). A typical section of single track showing general construction form and the areas to be vegetated is presented on Figure 3.12. The figure illustrates how the revegetated portion of the railroad spur corridor will blend with the adjacent undisturbed vegetation. Activities during construction will consist of the following: (1) clearing and grubbing, (2) installation of 5 miles of railroad spur track and siding track, including culverts, grading, bridge structure, and crushed aggregate ballast; and (3) application of topsoil, fertilizer, seed, and mulch. Topsoil will be salvaged according to the guidelines presented in subsection 2.4.1. Most topsoil will be replaced during construction in those portions of the typical section that will be revegetated (Figure 3.12). A portion of the topsoil will be maintained in long-term stockpiles for use in final reclamation after removal of the rails, ties, and ballast. Evaluation of the various auger sample descriptions (Foth & Van Dyke, 1982a) indicates that no subsoil material deleterious to plant growth (forage type species) exists along the proposed alignment and that suitable fertilizer, species, and establishment practices can be selected.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE

RAILROAD SPUR
TYPICAL SECTION

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
D.R.SPRINGBORN	9/82	C Schroeder	10/82
APPROVED BY	DATE	APPROVED BY	DATE
		A E Kunz	01/16
APPROVED BY	DATE	EXXON	DATE

DRAWING NO

FIGURE 3.12

SHEET 1 OF 1

REVISION NO. 0

Clearing, grubbing, and material disposal for the railroad spur will be performed in the same manner as that planned for mine/mill site preparation. Earthwork operations will follow as closely behind the grubbing operation as is practical. Erosion and runoff control, as described in Section 2.0, will be used with permanent culverts and a system of retention basins built into ditch bottoms to eliminate the unrestricted flow of runoff. Riprap, filter fabric and hay matting in conjunction with settling basins, built as an integral part of the ditch system, will eliminate sediment flow into adjacent wetland areas.

As part of the engineering study for the railroad spur (Foth & Van Dyke, 1982a), plan and profile drawings were prepared depicting the entire alignment from the Soo Railroad mainline to the mine/mill interface point. Drainage structure locations, typical sections showing revegetation (as shown on Figure 3.12), and settling basin details are included in the Foth and Van Dyke report. The design study has also determined the approximate slope intercept lines along the entire route, showing the limits of revegetation after construction. This slope intercept location is illustrated on the typical section on Figure 3.10 as the interface between the edge of the existing vegetation and the reestablished vegetation included with the railroad construction.

Locations of the temporary erosion control facilities to be utilized during construction, such as the straw bale and filter fabric silt traps and the sheet piling at the area of the Swamp Creek crossing structure, will be determined during final engineering and detailed construction planning for the railroad. Once construction is complete

and vegetation has been reestabished in the disturbed areas, the temporary erosion control facilities will be removed.

Wetland material not suitable for roadbed construction will be excavated and organic peat and muck material will be replaced with select material from on-site excavation. The excavated peat and muck soils will be temporarily stockpiled near the excavation area and later reused as top dressing on the railroad section embankment slopes. Placement of sub-ballast and ballast on the subgrade will complete the railroad bed before ties and rails are installed. Guidelines for acceptable construction practices in the wetlands are presented in Foth & Van Dyke (1982a).

The bridge at Swamp Creek will be provided with concrete abutments and wingwalls and the stream banks will be protected by rip-rap to prevent erosion and resulting runoff of sediments into the stream. Prior to construction of bridge abutments and approaches, temporary sheet piling will be installed to contain and prevent any loosened soil materials from spilling into the stream. The sheet piling will be removed after the banks are fully stabilized. All construction practices adjacent to Swamp Creek will be performed in accordance with the Chapter 30/31 permit approval.

3.2.2.2 Revegetation

Revegetation of the railroad spur corridor will be initiated following final grading and seedbed preparation. Herbaceous plant species will be established to ensure development of a stable plant community that is self-perpetuating and requires minimal maintenance.

The seeding methods and materials to be used in the railroad spur corridor are presented in Table 3.1.

3.2.2.2.1 Seedbed Preparation

The same procedures described in subsection 3.2.1.4.1 will be used to prepare the seedbed in the railroad spur corridor.

3.2.2.2.2 Plant Materials

The same type of herbaceous plant materials described in subsection 3.2.1.4.2 will be used in revegetating the railroad spur corridor. Seed mixtures consisting of indigenous and introduced species (Tables 2.4 and 3.1) will be selected that are adaptable to microclimatic conditions present at the site being revegetated.

3.2.2.2.3 Seeding and Plant Installation

The methods of establishing plant materials in the railroad spur corridor will include broadcast and soil contact seeding and hydroseeding (Table 3.1). In lowland soil situations, roots of some of the wetland species will be planted by hand. During the construction phase, seed will be established in Year 2 (Table 3.1).

3.2.2.2.4 Mulching

Organic mulches will be applied, as needed, on the reseeded segments of the corridor. Typical mulches that will be used are described in subsection 3.2.1.4.4.

3.2.2.3 Erosion and Vegetation Maintenance Practices

During the operation of the railroad spur, standard erosion control and vegetation maintenance procedures will be utilized. These procedures will include fertilization, mowing, brush control, and regrading and reseeding of areas disturbed during railroad maintenance, as required. The general maintenance practices to be followed in the railroad spur corridor over the life of the Project are summarized in Table 3.1.

Only EPA approved herbicides will be used to selectively treat undesirable woody plant species that encroach within the railroad spur right-of-way.

3.2.2.4 Reclamation Upon Completion of Mining

Final reclamation of the railroad spur will be initiated in Year 35 (Table 3.1) if no alternative use is found for the facility. The proposed final reclamation objective of the railroad spur corridor is presented in Table 3.3.

3.2.2.4.1 Removal of Facilities

Unless an alternative use is found, the railroad corridor will be reclaimed to a natural state and will have minimal reclamation consisting mainly of removing the rails and ties, ballast, and base materials followed by topsoil replacement, regrading, and revegetation of the disturbed area. The bridge over Swamp Creek will be dismantled and removed.

3.2.2.4.2 Reclamation Grading and Soil Placement

Grading within the corridor will be kept to a minimum to preserve as much of the corridor as possible. However, in areas where agriculture was the premining land use, the corridor will be regraded to approximately the same elevation(s) as the adjacent undisturbed agricultural land. Topsoil will be replaced in the area disturbed by removal of the ballast and base materials.

3.2.2.4.3 Revegetation and Maintenance

After removal of the rails, ties, and ballast and final grading, herbaceous vegetation will be established in the disturbed area. Seedbed preparation, selection of plant materials, seeding methods, and mulching will be completed in accordance with the procedures described in subsection 3.2.1.4. Indigenous and introduced herbaceous species will be included in the seed mixture(s); species will be selected from those listed in Table 2.4 and 3.1. Seeding of the corridor will occur in Year 35. The expected characteristics of vegetation in the reclaimed corridor 15 years after final closure are described in Table 3.2.

Inspection and maintenance practices in the corridor will be the same as those described in subsection 3.2.1.6.4 for the mine/mill site.

3.2.3 Access Road (Management Unit 3)

The requirements for a new access road to service the mine site are briefly described in Section 1.3; the proposed route from State Highway 55 to the mine/mill site is depicted on Figure 1.2.

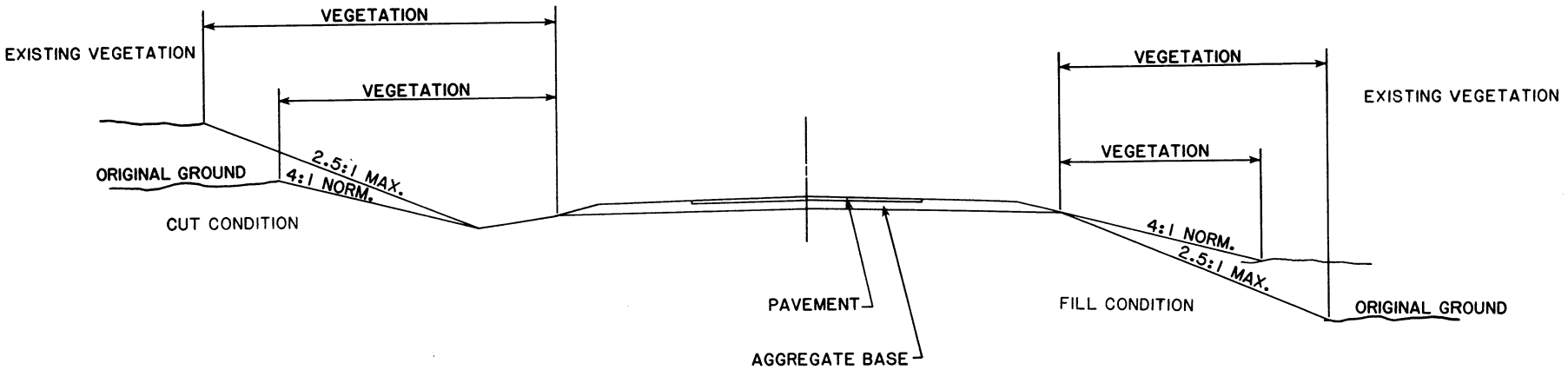
3.2.3.1 Construction Procedures and Erosion Control

Access road construction is scheduled to begin in Year 1 and be completed in Year 2 (Figure 3.2). A typical section of the access road showing general construction form and areas to be revegetated is shown on Figure 3.13. The figure illustrates how the revegetated portion of the access road corridor will blend with the adjacent undisturbed vegetation. The right-of-way corridor for the access road will be cleared and grubbed prior to rough grading. Before clearing and grubbing, marketable trees will be cut and ultimately hauled off-site. Tree stumps and brush will be burned or mulched with chippers and stockpiled for use in reclamation.

Implementation of runoff and erosion control methods will be completed concurrently with the earthwork activities. These methods include salvaged topsoil placement and seeding of herbaceous cover (see subsection 2.4.1) following final grading to reduce the exposure of bare ground.

Wetland crossings will include temporary berms at the edge of the fill slopes or the equivalent to contain runoff and divert it outside of the wetland for sediment removal before the water enters the wetland. Organic peat removed from wetlands will be replaced with selected cut materials from locations within the road alignment. Materials excavated from wetlands will be utilized as surface cover (Foth & Van Dyke, 1982b).

The bridge at the Swamp Creek crossing will be provided with concrete abutments with wingwalls and the stream banks on the bridge approaches will be protected by rip-rap to minimize erosion and sediment



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
ACCESS ROAD TYPICAL SECTION

SCALE NONE	STATE WISCONSIN		COUNTY FOREST
DRAWN BY D.R.SPRINGBORN	DATE 9/82	CHECKED BY C.Schroeder	DATE 10/82
APPROVED BY	DATE	APPROVED BY H. E. Kunn	DATE 11/86
APPROVED BY	DATE	EXXON	DATE
DRAWING NO. **FIGURE 3.13**		SHEET 1 OF 1	REVISION NO.

runoff into the stream. Prior to construction of bridge abutments and approaches, sheet piling will be driven into the ground parallel with the stream banks. Grading will be performed behind the piling and loose material will be contained and prevented from spilling into the stream. The sheet piling will be removed after the banks are fully stabilized. All construction practices adjacent to Swamp Creek will be performed in accordance with the Chapter 30/31 Permit approval.

The access road will be built up using select cut material from within the road alignment. A pavement base of gravel material will then be placed and compacted. The base material probably will be obtained from an established commercial source.

3.2.3.2 Revegetation

The access road corridor will be revegetated following final grading and seedbed preparation. Herbaceous groundcover and random groups of mixed conifers and hardwoods will be established in the corridor. The seeding and planting methods and materials to be used in establishing the vegetative cover are presented in Table 3.1.

3.2.3.2.1 Seedbed Preparation

The same procedures described in subsection 3.2.1.4.1 will be used to prepare the seedbed in the access road corridor.

3.2.3.2.2 Plant Materials

The same type of herbaceous plant materials and nursery stock described in subsection 3.2.1.4.2 will be used to revegetate the access

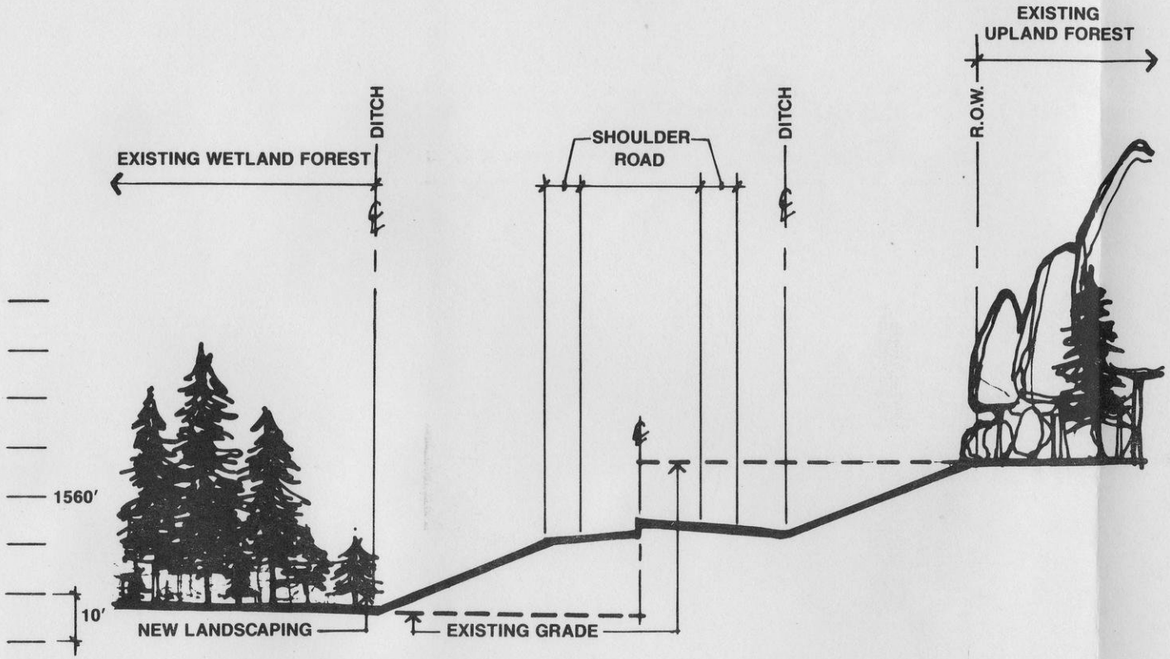
road corridor and reestablish an indigenous community. Seed mixtures will be selected from the species presented in Tables 2.4 and 3.1. Species will be selected to achieve a permanent vegetative cover of the same seasonal composition represented in the area.

3.2.3.2.3 Seeding and Plant Installation

The methods of distributing seed in the access road corridor will include broadcast and soil contact seeding and hydroseeding (Table 3.1). Roots of herbaceous wetland species will be planted by hand. During the construction phase, seed will be established in Year 2.

Clumps of mixed conifer and hardwood seedlings and shrubs will be established in selected segments of the access road corridor. Plantings will be located near the intersection with State Highway 55, in the entrance zone to the mine/mill site, and on the stream banks adjacent to Swamp Creek. The plant stock will consist of bare root trees, 3 to 4 feet in height. The woody plants to be used will be selected from the list of indigenous species presented in Table 3.1. Planting of woody species will occur during Year 2 of construction.

Figure 3.14 illustrates conceptual plan and cross-section views of vegetation development in the access road corridor in relation to the road surface and the undisturbed vegetation at the edge of the corridor. This figure illustrates the reestablished vegetation in lowland and upland situations at two periods during Project development, approximately 5 years after installation (Project Year 7) and 15 years after final reclamation.



SECTION A-A
PROJECT YEAR 7

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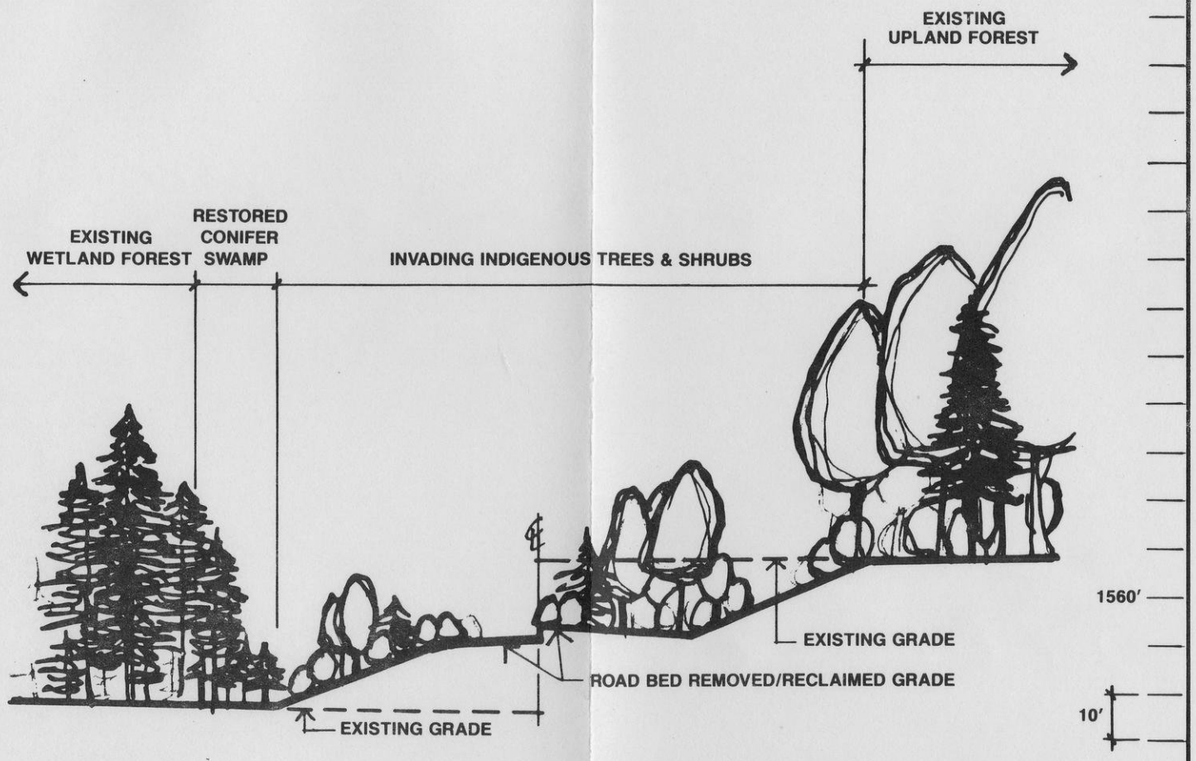
SCALE IN FEET



SECTION A-A
YEAR 15 OF THE LONG-TERM CARE PERIOD

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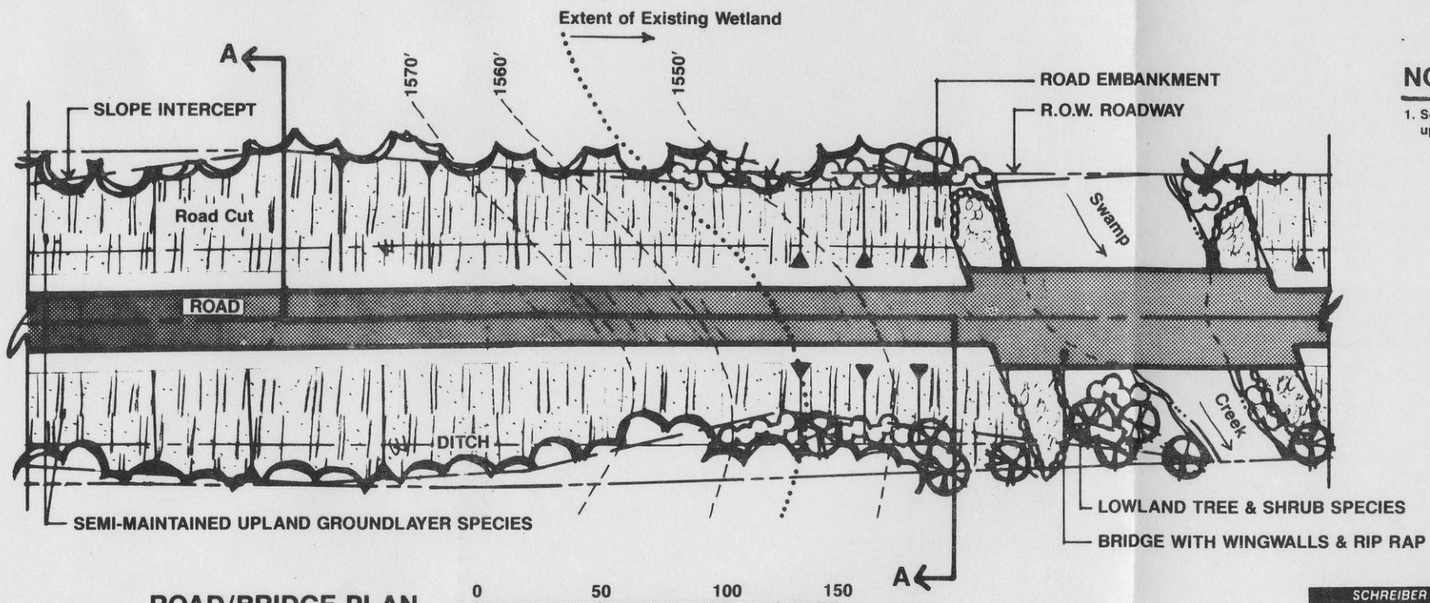
SCALE IN FEET

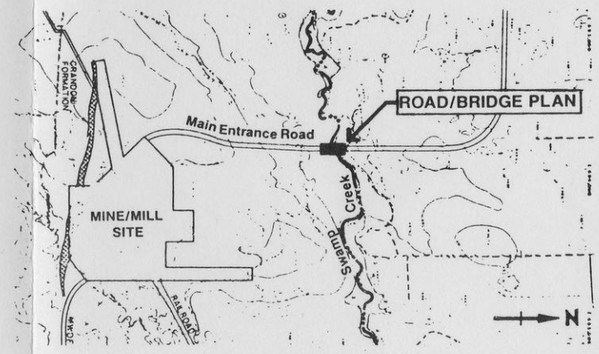


ROAD/BRIDGE PLAN
PROJECT YEAR 7

0 50 100 150
SCALE IN FEET

NOTES:

1. See Table 3.1 for listing of lowland species and upland plant species.



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REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **CONCEPTUAL LANDSCAPE PLAN AND SECTIONS–PROJECT YEAR 7 & YEAR 15 OF LONG-TERM CARE PERIOD**

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST
DRAWN BY	DATE 1-86	CHECKED BY D. S. Lemke 1/86
APPROVED BY	DATE	APPROVED BY R. C. Schroeder 1-7-86
APPROVED BY	DATE	EXXON DATE
DRAWING NO		SHEET OF REVISION NO

FIGURE 3.14

3.2.3.2.4 Mulching

Organic mulches, as needed, will be applied on the revegetated segments of the corridor. Typical mulches that will be used are described in subsection 3.2.1.4.4.

3.2.3.3 Erosion and Vegetation Maintenance Practices

During use of the access road, standard erosion control and vegetation maintenance procedures will be utilized. These procedures will include fertilization and mowing of shoulders, brush control along the right-of-way, maintenance of permanent surface water drainage structures and reseeding of areas disturbed during highway maintenance, as appropriate. The general maintenance practices to be followed in the access road corridor over the life of the Project are summarized in Table 3.1.

3.2.3.4 Reclamation Upon Completion of Mining

The access road corridor will be reclaimed in Year 36 (Table 3.1) if no alternative use is found for the facility. Table 3.3 identifies the proposed final reclamation status of the corridor.

3.2.3.4.1 Removal of Facilities

The access road will be reclaimed if no alternative use can be found, or requirement exists, for this facility. The pavement and stone base will be removed and minor grading will be performed prior to topsoil replacement and revegetation of the disturbed areas. The bridge across Swamp Creek also will be dismantled and removed.

3.2.3.4.2 Reclamation Grading and Soil Placement

Grading will be performed in the corridor following removal of the stone base. The amount of grading will be minimal in order to preserve as much of the corridor as possible. However, in areas where agriculture was the premining land use, the corridor will be regraded to approximately the same elevation(s) as the adjacent undisturbed agricultural land. Topsoil will be replaced in the area disturbed by removal of the stone base.

3.2.3.4.3 Revegetation and Maintenance

The access road corridor will be revegetated after removal of the pavement and stone base and regrading and application of topsoil. The same procedures described in subsection 3.2.1.4 will be followed in preparing the seedbed, selecting the plant materials, application of seed, and mulching. Herbaceous cover, consisting of indigenous and introduced species, will be established. Final grading and seeding of the corridor will be completed in Year 36. Anticipated vegetation characteristics in the reclaimed corridor 15 years after final closure are described in Table 3.2.

Inspection and maintenance practices in the corridor will be the same as those described in subsection 3.2.1.6.4 for the mine/mill site.

3.2.4 Haul Road/Tailings Transport System (Management Unit 4)

The haul road and tailings transport system share a common corridor from the mine/mill site to the MWDF. The haul road is a

rock/stone surfaced road with a width of 30 feet provided for transport of waste rock to the MWDF and for other travel between the two locations.

The tailings transport system will carry the tailings from the mine/mill site to the MWDF area (Figure 1.2). The tailings will be transported by buried pipeline in a slurry form. Additional water streams from the mine/mill site to the waste disposal area are also included so that the entire transport system consists of the following streams, all transported by buried pipeline:

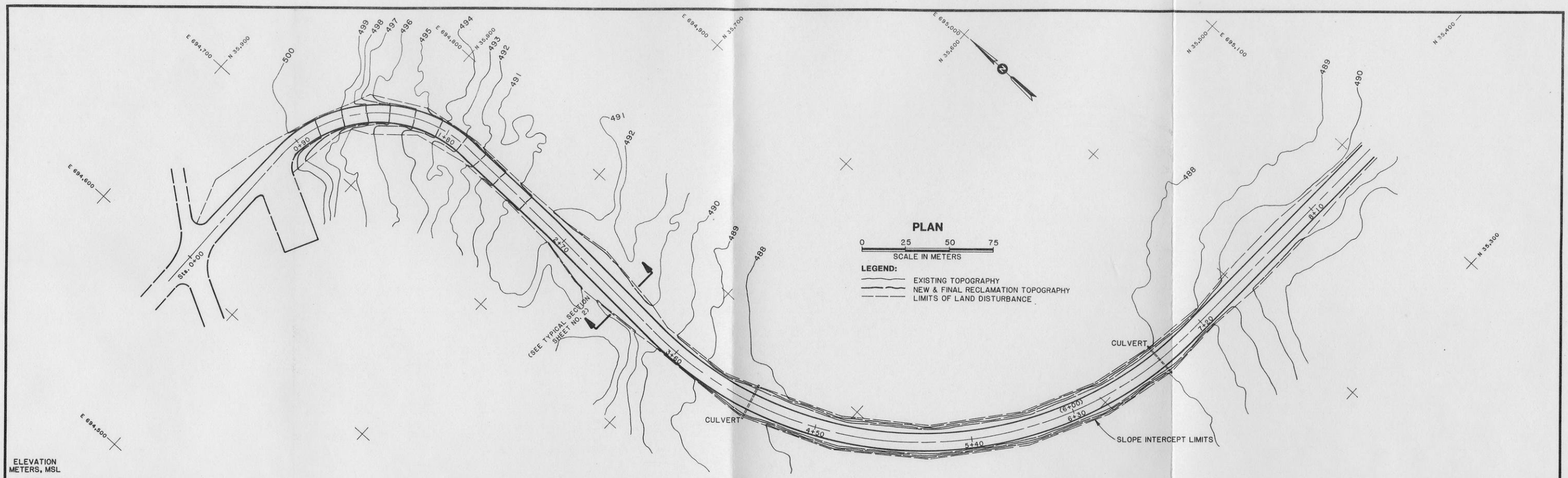
1) Tailings from the tailings thickener underflow at the mine/mill site site to the tailings pond;

2) Water from the tailings thickener overflow to reclaim pond cell B. This stream also includes some surface water input and a mine water input in the mine/mill site; and

3) Reclaim water from reclaim pond cell A to the reclaim water supply tank at the mine/mill site.

3.2.4.1 Construction Procedures and Erosion Control

Figures 3.15 and 3.16 depict the preliminary plan and profile for the haul road and tailings transport pipeline corridor. Drainage structure locations, approximate limits of land disturbance and revegetation (noted on the figures as the slope intercept limits) and the typical cross-section are included. Temporary erosion control techniques to be used during construction and until the new vegetation has been established are described in Section 2.0. Specific details and locations of the temporary erosion control measures used during construction (straw or hay bale silt traps, filter fabric fences or similar measures) will be determined during final engineering and detailed construction planning.



PROFILE

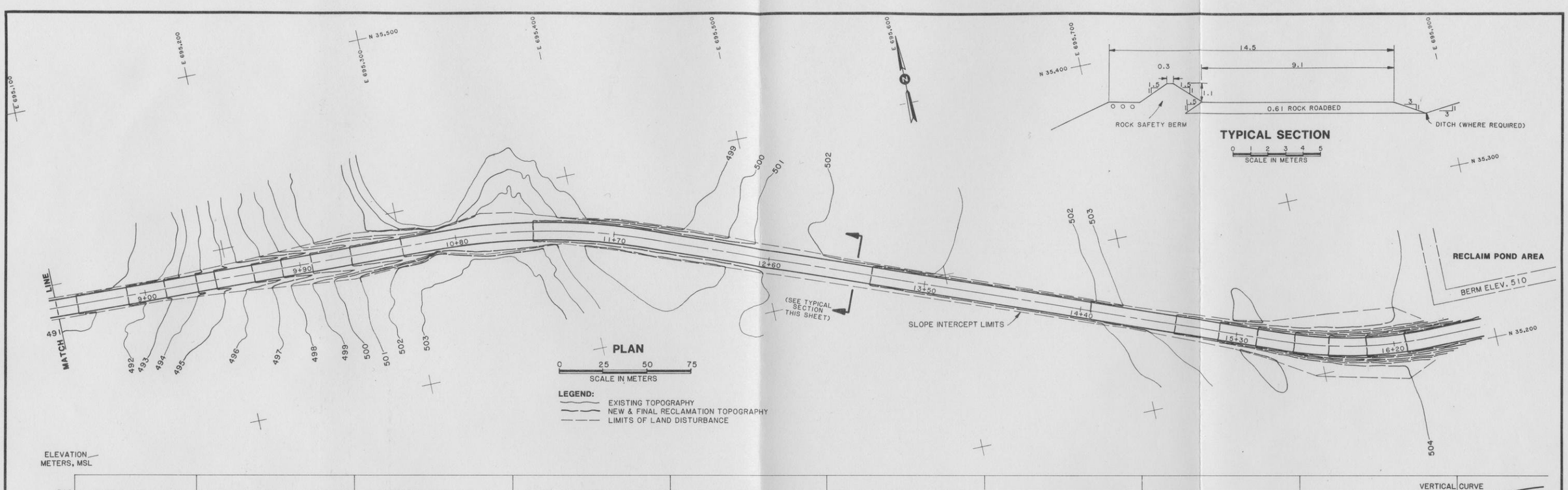
REVISED	DATE	BY	DESCRIPTION

Typical Representation: Refinements May Be Made During Final Design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MWDF ACCESS ROAD PLAN & PROFILE

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 12/85	CHECKED BY H. S. Town	DATE 1/9/86		
APPROVED BY	DATE	APPROVED BY O. C. Schroeder	DATE 1/9/86		
APPROVED BY	DATE	EXXON	DATE		
DRAWING NO **FIGURE 3.15**		SHEET 1 OF 2	REVISION NO		



Typical Representation: Refinements May Be Made During Final Design.

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MWDF ACCESS ROAD
PLAN, PROFILE & SECTION

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY DR SPRINGBORN	DATE 12/85	CHECKED BY H S Ravin		DATE 1/9/86	
APPROVED BY	DATE	APPROVED BY C.C. Schroeder		DATE 1/9/86	
APPROVED BY	DATE	EXXON		DATE	
DRAWING NO **FIGURE 3.16**		SHEET 2 OF 2		REVISION NO	

3.2.4.2 Revegetation

The haul road/tailings transport pipeline corridor will be revegetated following final grading and seedbed preparation. Herbaceous groundcover consisting of indigenous and introduced plant species will be established in the corridor. The seeding methods and materials to be used in establishing the groundcover are presented in Table 3.1.

3.2.4.2.1 Seedbed Preparation

The same procedures described in subsection 3.2.1.4.1 will be used to prepare the seedbed in the haul road/tailings transport pipeline corridor.

3.2.4.2.2 Plant Materials

The type of herbaceous plant materials to be used in establishing groundcover in the haul road/tailings transport pipeline corridor is described in subsection 3.2.1.4.2. A mixture of indigenous and introduced species will be used to establish a stable plant community. The mixture(s) will be selected from the species listed in Tables 2.4 and 3.1.

3.2.4.2.3 Seeding and Plant Installation

Seeding will be accomplished by broadcasting and soil contact methods and hydroseeding (Table 3.1). In areas of the corridor containing lowland soils, roots of some wetland species will be planted by hand. During the construction phase, seed will be established in Year 2 (Table 3.1).

3.2.4.2.4 Mulching

Organic mulches will be applied, as needed, on the reseeded portions of the corridor. Typical mulches that will be used are described in subsection 3.2.1.4.4

3.2.4.3 Erosion and Vegetation Maintenance Practices

During Project operation, landscape maintenance practices will be used to minimize invasion of shrubs and trees which could interrupt normal operating and line maintenance/repair procedures. The shoulders of the haul road and the pipeline corridor will be mowed annually.

A general summary of the maintenance practices to be followed in the haul road/tailings transport pipeline corridor is presented in Table 3.1.

3.2.4.4 Reclamation Upon Completion of Mining

Final reclamation of the haul road/tailings transport system will be initiated in Year 36 (Table 3.1) if no alternative use is found for the facilities. The proposed final reclamation status of the road and pipeline system is summarized in Table 3.3.

3.2.4.4.1 Removal of Facilities

The haul road/tailings transport corridor will be reclaimed to a natural state. The road base will be left in place and covered with a topsoil layer sufficient to allow vegetation to establish. Tailings and water reclaim pipelines will be plugged and left in place.

3.2.4.4.2 Reclamation Grading and Soil Placement

Regrading of the corridor will be limited. Topsoil will be placed over the road base and graded to a relatively even depth over the entire road surface.

3.2.4.4.3 Revegetation and Maintenance

The corridor for the haul road/tailings transport system will be seeded following minor grading and topsoil application over the road base. Procedures for seedbed preparation, selection of plant material, seeding, and mulching will be the same as those described in subsection 3.2.1.4. A mixture of indigenous and introduced plant species will be used to establish vegetation in the corridor (Tables 2.4 and 3.1). Final reclamation of the corridor will occur in Year 36. A description of vegetation characteristics in the reclaimed corridor 15 years after final closure is presented in Table 3.2.

Inspection and maintenance practices in the reclaimed corridor will be the same as those described in subsection 3.2.1.6.4 for the mine/mill site.

3.2.5 Water Discharge Pipeline Corridor and Discharge Structure (Management Unit 5)

The water discharge system will consist of an underground pipe approximately 14 inches in diameter, running from the mine/mill site to a discharge point on Swamp Creek downstream from County Trunk Highway M and a discharge structure. The overall route length is approximately 6 miles.

3.2.5.1 Construction Procedures and Erosion Control

Installation procedures for the water discharge pipeline will be similar to those used for pipeline installations in the mine/mill site and for the tailings transport system. Vegetation will be reestablished in areas disrupted by construction.

The water discharge pipeline corridor is shown on Figure 1.2. The corridor has a nominal width of 50 feet. The area disturbed during pipeline installation was estimated based on a 20-foot width which results in a total estimated disturbed area of 15 acres. Approximately 75 percent of the route length is across high ground which will present no special construction difficulties. Trench excavation, pipe laying, and backfilling will be completed in segments to avoid having long lengths of open trenches for extended periods.

Installation of pipe through the wetland areas will require additional precautions. Muck and organic soil conditions as well as season of the year will determine the most effective equipment to use. To the extent possible, the wetland soils will be kept separate from the subsoils as they are excavated and placed along the trench. The soils will be backfilled later in the approximate original sequence, i.e., subsoils will be backfilled before the peat and muck soils. In areas where there is potential for erosion, the materials will be contained with silt fences (geotextiles) or other appropriate methods. Because of the nature of wetland soils, wider disturbed areas will result in the wetlands. Lighter equipment and swamp mats will probably be used unless a winter time construction schedule is determined to be beneficial.

Temporary erosion control facilities will be used during construction of the discharge structure adjacent to Swamp Creek. Straw bale and filter fabric silt traps and sheet piling will be installed parallel to the stream bank to minimize erosion and sediment runoff into the stream.

3.2.5.2 Revegetation

The water discharge pipeline corridor will be revegetated following backfilling of the trench, final leveling, and seedbed preparation. A vegetative cover of indigenous and introduced plant species will be established in the corridor. The seeding methods and materials to be used in establishing the vegetative cover are presented in Table 3.1.

3.2.5.2.1 Seedbed Preparation

The soils will be backfilled in the trench in the sequence in which they were removed. These soils will serve as the seedbed after leveling and final grading of the backfilled trench and any adjacent disturbed areas.

3.2.5.2.2 Plant Materials

Herbaceous plant materials for use in establishing vegetative cover in the water discharge pipeline corridor are described in subsection 3.2.1.4.2. Suitable seed mixes for upland and lowland areas will be selected from the species listed in Tables 2.4 and 3.1.

3.2.5.2.3 Seeding and Plant Installation

Methods that will be used in seeding the corridor and in the disturbed area around the discharge structure include broadcasting and soil contact seeding (Table 3.1). In lowland soil situations, roots of wetland plants will be planted by hand. Revegetation of the water discharge pipeline corridor and the area around the discharge structure is scheduled for Year 2 of the construction phase (Table 3.1).

3.2.5.2.4 Mulching

Organic mulches will be applied, as needed, on the reseeded portions of the corridor. Typical mulches that will be used are described in subsection 3.2.1.4.4.

3.2.5.3 Erosion and Vegetation Maintenance Practices

The water discharge pipeline corridor and the revegetated area around the discharge structure will be inspected annually. Areas will be regraded and/or reseeded as necessary to ensure that a stable plant community is established. Woody plant species will be allowed to invade the corridor and no measures will be taken to maintain the corridor in herbaceous cover. The maintenance practices to be followed in the corridor are summarized in Table 3.1.

3.2.5.4 Reclamation Upon Completion of Mining

The discharge structure adjacent to Swamp Creek is the only facility associated with the water discharge pipeline system that will be removed during final reclamation. The area where the discharge

structure is to be located will be reclaimed in Year 36. The proposed final reclamation status of the water discharge pipeline system is presented in Table 3.3.

3.2.5.4.1 Removal of Facilities

During the closure period, the ends of the water discharge pipeline will be plugged and the pipeline will be left in place. The discharge structure adjacent to Swamp Creek will be removed.

3.2.5.4.2 Reclamation Grading and Soil Placement

The area disturbed during removal of the discharge structure will be regraded during final reclamation. Fill material covered by topsoil will be placed in the disturbed area and the land surface will be recontoured to conform with the elevation of adjacent undisturbed land.

3.2.5.4.3 Revegetation and Maintenance

The vegetation established in the pipeline corridor during the construction phase will not be disturbed with the exception of the area leading to and surrounding the discharge structure adjacent to Swamp Creek. After the discharge structure is removed, the disturbed area will be graded and seeded with a mixture of indigenous and introduced plant species. The procedures described in subsection 3.2.1.4 will be followed in preparing the seedbed, selecting the plant materials, seeding the area, and applying mulch. Expected vegetation

characteristics in the reclaimed corridor 15 years after final closure are described in Table 3.2.

Inspection and maintenance practices in the reclaimed area will be the same as those described in subsection 3.2.1.6.4 for the mine/mill site.

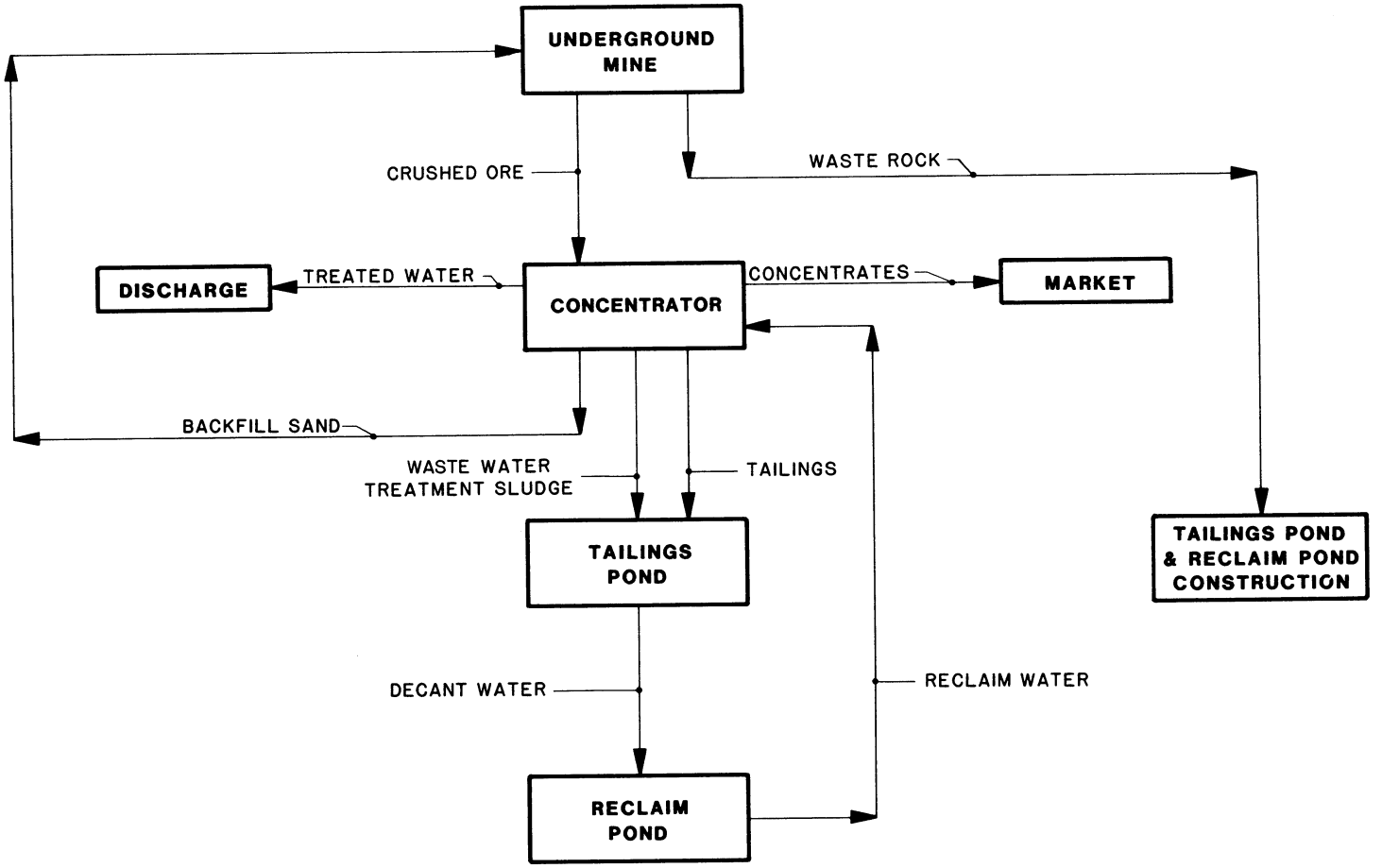
4.0 RECLAMATION DURING CONSTRUCTION, OPERATION, AND CLOSURE OF THE MINE WASTE DISPOSAL FACILITY, RECLAIM POND AND MINE REFUSE DISPOSAL FACILITY (MANAGEMENT UNIT 6)

4.1 General System Operation

The mine waste disposal facility (MWDF) for the Crandon Project will provide for surface disposal of materials generated directly by mining and milling ore and the sludge from water treatment. The waste products from mining and milling are essentially crushed or ground rock of varying grain size. The water treatment sludge will include ground rock and precipitates from the treatment process. The disposal system will also serve as a water retention and recycle system. The materials to be stored or disposed in the MWDF are: tailings, reclaim water, and water treatment sludge. A small volume of waste rock will be used in construction of the MWDF and reclaim pond as slope protection. A schematic flow diagram of the system is shown on Figure 4.1.

The tailings remaining after extraction of the concentrates will be separated by size with the coarser fraction being returned to the underground mine as backfill.

The finer fraction of the tailings is primarily silt sized and will be pumped as a slurry to the tailing ponds. The tailings solids will settle in the tailing ponds, and clarified water will be decanted to the reclaim water pond for reuse in the mill as process water. Additional information on waste characterization and the MWDF is provided in the MWDF Feasibility Report.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MATERIAL FLOW SYSTEM DIAGRAM

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY S. J. Harvey	DATE 9/8/82	CHECKED BY C. Schroeder	DATE 10/82
APPROVED BY	DATE	APPROVED BY H. E. Kann	DATE 1/26
APPROVED BY	DATE	EXXON	DATE
DRAWING NO		SHEET 1 OF 1	REVISION NO. 0

FIGURE 4.1

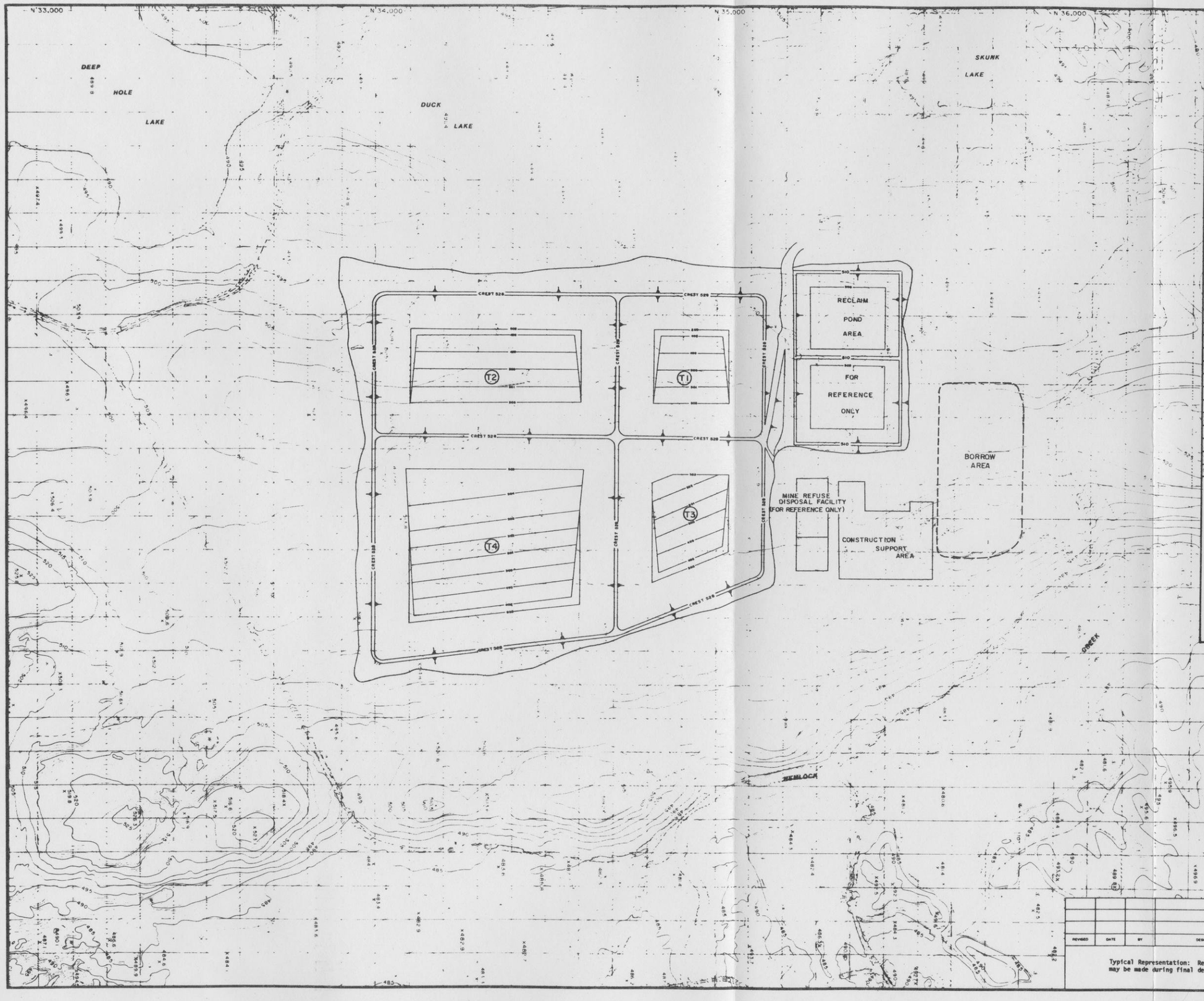
The mine refuse disposal facility (MRDF) will be used for disposal of non-hazardous waste, refuse and garbage other than the tailings, water treatment sludges, and waste rock. The MRDF will be operated over the entire Project life following standard landfill operating practices. Additional detail for the design and operation of the MRDF is provided in the MRDF Feasibility Report.

4.2 Design and Construction

4.2.1 General Criteria

The MWDF and reclaim pond system and the MRDF are depicted on Figure 4.2. The MWDF will be developed to provide permanent storage of mine/mill waste materials that would be generated from a 67.4 million ton orebody. The MWDF and reclaim pond system is designed to utilize waste rock generated both before and during the production of ore as embankment slope protection. The embankments of the MWDF and the cover material over the tailings at reclamation will be composed of glacial till materials excavated from within the tailing ponds' areas. A total land area of approximately 390 acres is required for the MWDF and water reclaim pond. Seepage control liners will be included in the tailing ponds and reclaim pond; an underdrain system will also be installed above the tailing ponds' liners. Two cells will be utilized for reclaim water; the primary purpose of the reclaim pond is to provide storage and retention of water for reuse in the various ore concentrating operations. Water recovered from the waste disposal ponds through the underdrain and decant systems will be transferred to the reclaim pond for reuse in the mine/mill operations. General details pertaining to the MWDF and reclaim pond system are summarized in Table 4.1.

The MRDF will be considerably smaller than the MWDF or reclaim pond and will require an area of only approximately 10 acres over the Project life. Three cells, each approximately 3 acres in size and 30 feet deep, will be developed, operated and reclaimed in phases over the life of the Project. The seepage control system and reclamation procedures will generally be the same as those for the MWDF.



WASTE DISPOSAL SYSTEM AND RECLAIM POND DATA

Tailings and Reclaim Pond Area (ac) (1)	390	Abandonment Cover Seal Thickness(in)	8
Tailings Pond Abandonment Area (ac.) (2)	360	Minimum Abandonment Cover Thickness (ft)	5
Wetlands Covered (ac.) (3)	46	Underdrain Drain Layer Thickness (in)	6-12
Pond Excavation ($\times 10^6 yd^3$)	14.99	Minimum Underdrain Filter Layer Thickness (in)	12
Till Embankment Fill ($\times 10^6 yd^3$)	7.95	Minimum Rock Slope Protection Thickness (ft)	3.0
Minimum Crest Width (ft) (5)	16.00	Reclaim Pond Synthetic Liner Thickness (in)	0.036
Tailings Pond Reclamation Cap Synthetic Membrane Thickness (in)	0.040	Reclaim Pond Till/Bentonite Liner Thickness (in)	8
Tailings Slope (%)	0.5	Sand Cushion Above Synthetic Liner ($\times 10^6 yd^3$)	0.09
Abandonment Cover Slope (%) (Varies)	1-2	Sand Cushion/Drain Layer Below Synthetic Liner Thickness (in)	12
Till/Bentonite Tailings Pond Liner Thickness (in)	8	Protective Cushion Above Synthetic Liner Thickness (in)	18
Abandonment Cover Drain Layer Thickness (in)	8	Transition Below Reclaim Pond Rock Slope Protection Thickness (in)	12

POND NUMBER / POND DATA	RECLAIM POND DATA FOR REFERENCE ONLY						
	CELL A	CELL B	T1	T2	T3	T4	Σ
Period of Use (yrs.) (4)	2-32	3-32	3-7	7-14	14-21	21-32	—
Area Inside Crest (ac)	18	18	43	71	50	107	307
Bottom Area (ac)	10.5	10.5	9	22	12	39	103
Lined Slope Area (ac)	6.5	6.5	35	50	39	70	207
Maximum Interior Depth (ft)	33	33	99	99	99	99	—
Maximum Exterior Fill Height (ft)	35	—	110	107	36	77	—
Crest Elevation (ft)	1673	1673	1732	1732	1732	1732	—
Lowest Bottom Elevation (ft)	1640	1640	1633	1633	1633	1633	—
Struck Storage Volume ($\times 10^6 yd^3$)	0.83	0.83	3.56	6.59	4.25	10.46	24.86
Design Storage Volume ($\times 10^6 yd^3$)	—	—	3.1	5.7	3.7	9.1	21.6
Till Excavation ($\times 10^6 yd^3$)	3.82		1.21	2.35	2.44	5.17	14.99
Till Embankment ($\times 10^6 yd^3$)	0.36		2.25	2.81	0.69	1.84	7.95
Synthetic Liner/Reclamation Seal Area (ac.)	36		43	71	50	107	307
Till/Bentonite Liner Volume ($\times 10^6 yd$)	0.040		0.047	0.077	0.055	0.117	0.336
Underdrain Drain Material Volume ($\times 10^6 yd$)	0.040		0.039	0.067	0.046	0.104	0.296
Underdrain Filter Material Volume ($\times 10^6 yd^3$)	—	—	0.071	0.116	0.082	0.176	0.445
Rock Slope Protection Volume ($\times 10^6 yd^3$)	0.053		0.047	0.093	0.053	0.094	0.340
Abandonment Cover Volume($\times 10^6 yd^3$) (6)	—	—	1.03	1.64	0.90	2.03	5.60
Till/Bentonite Abandonment Cover Seal ($\times 10^6 yd^3$)	—	—	0.046	0.076	0.054	0.115	0.291
Abandonment Cover Drain Layer ($\times 10^6 yd^3$)	—	—	0.046	0.076	0.054	0.115	0.291
Underdrain Collector Pipe Length (ft)			590	1500	660	1510	4260

Notes:

1. Measured to outside toe of slope.
2. Includes tailings ponds only.
3. Represents wetland areas within toe of facility.
4. Start of construction for Crandon Project of beginning of year one. Schedule includes 30 months construction, 29 years operation and 4 years reclamation.
5. Crest width varies from 16 feet to 23 feet depending on number of pipelines along crest.
6. Includes material for grading below top seal and 5 feet of till cover over top seal.

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET
0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

Typical Representation: Refinements may be made during final design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MINE WASTE DISPOSAL FACILITY AREA
SITE 41-114C

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY J.J.T.	DATE 9-27-85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY D.R. Wallace	DATE 10-7-85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 12-16-85
DRAWING NO		SHEET 5 OF 36	REVISION NO 0

FIGURE 4.2

Additional system data for the MRDF, similar to that in Table 4.1 for the MWDF, are provided in the MRDF Feasibility Report.

4.2.2 Construction Scheduling

Construction of the MWDF will be staged to correspond with tailings production from the mine. Earthwork operations, including closure, will be divided into five phases over an approximate 36-year period, including an initial 3-year construction period, a 29-year operating period, and a 4-year final reclamation period. The length of construction in each phase will generally vary from 4 to 5 years, with periods of up to several years between some phases in which no major earthwork operations are conducted. Table 4.2 and Figure 4.3 outline the five primary construction phases and activities. Additional detail of the estimated scheduling for these phases and activities is included in the EIR.

4.2.3 Earthwork and Staged Construction

Embankments for the MWDF, reclaim pond and MRDF will be constructed of glacial till from within the pond areas. Glacial till from within the system area will also be used as reclamation cover, and processed for liner material, underdrain material, and sand cushion/underdrain material for the reclaim pond liner.

Construction in the MWDF area will begin with preparation of the construction support area (CSA) and installation of a construction well (WS-2) adjacent to the area. The first phase of construction will cover Project Years 1-5 and will include construction of reclaim pond cells A and B, MRDF cell 1, and tailing pond T1.

TABLE 4.1

SUMMARY OF MINE WASTE DISPOSAL FACILITY AND RECLAIM POND FEATURES

Feature	System Data
Number of reclaim pond cells	2
Number of tailing ponds	4
Minimum distance from lakes, feet	1,000
Wetlands covered, acres	46
Total land area, acres[a]	390
Total area inside crests, acres	307
Area inside crests, by pond (acres):	
Tailing pond 1	43
Tailing pond 2	71
Tailing pond 3	50
Tailing pond 4	107
Reclaim pond cell A	18
Reclaim pond cell B	18
Final reclaimed surface area, acres[b]	360
Minimum height from tailing pond bottom to ground water, feet	39
Height crest elevation, feet MSL	1,732
Maximum pond depth, feet	99
Maximum exterior fill height, feet	110
Approximate earthwork, 10^6 cubic yards	15.0

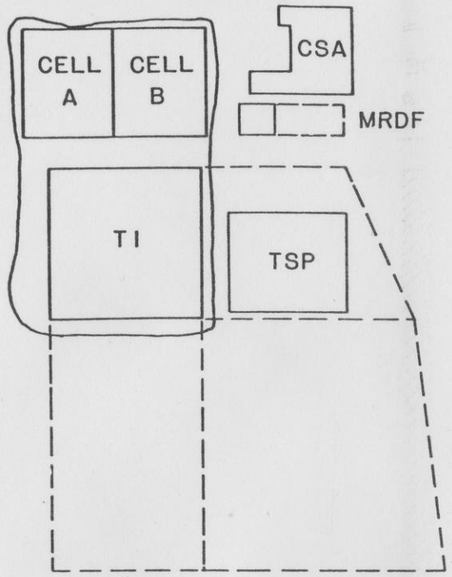
[a]Measured to outside toe of slope.
[b]Includes tailing ponds only.

TABLE 4.2

ESTIMATED PHASES OF EARTHWORK CONSTRUCTION AND RECLAMATION OF THE MINE WASTE DISPOSAL FACILITY, RECLAIM POND AND MINE REFUSE DISPOSAL FACILITY AND ASSOCIATED FACILITIES

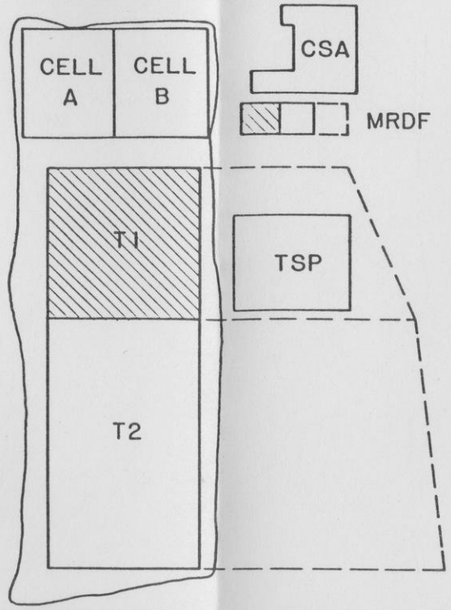
PHASE	YEAR	CONSTRUCTION ACTIVITIES
1	1-5	Construct Construction Support Area (CSA) Construct Reclaim Pond Cell A Construct Tailing Pond T1 Construct Reclaim Pond Cell B Construct MRDF Cell 1
2	6-11	Construct Tailing Pond T2 Tailing Pond T1 Reclamation Construct MRDF Cell 2 MRDF Cell 1 Reclamation
3	13-16	Construct Tailing Pond T3 Tailing Pond T2 Reclamation (Partial)
4	19-23	Construct Tailing Pond T4 Tailing Pond T3 Reclamation Construct MRDF Cell 3 MRDF Cell 2 Reclamation
5	33-36	Borrow Area Development, Use and Reclamation Tailing Pond T4 Reclamation Tailing Pond T2 Reclamation Reclaim Pond Cell A and B MRDF Cell 3 Reclamation CSA Reclamation

PHASE 1 - YEARS 1-4



CONSTRUCTION OF TAILING POND T1, WATER RECLAIM POND, MRDF CELL 1 & CSA

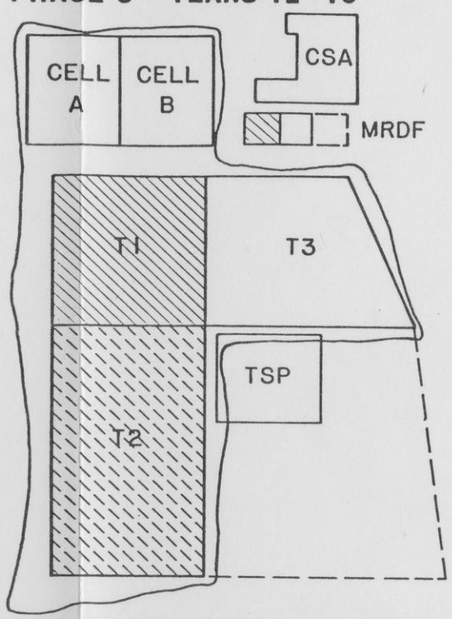
PHASE 2 - YEARS 5-11



CONSTRUCTION OF TAILING POND T2 & MRDF CELL 2

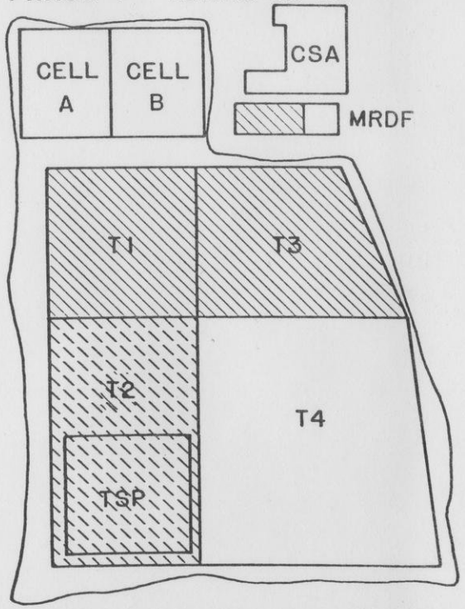
RECLAMATION OF TAILING POND T1 & MRDF CELL 1

PHASE 3 - YEARS 12-16



CONSTRUCTION OF TAILING POND T3
PARTIAL RECLAMATION OF TAILING POND T2

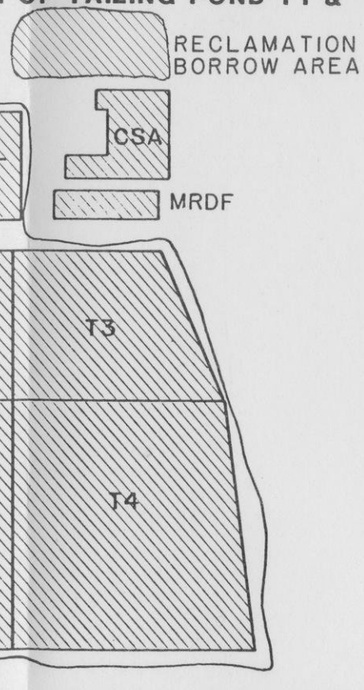
PHASE 4 - YEARS 19-23



CONSTRUCTION OF TAILING POND T4 & MRDF CELL 3

RECLAMATION OF TAILING POND T3 & MRDF CELL 2

PHASE 5 - YEARS 33-36



RECLAMATION OF TAILING POND T2 & T4, WATER RECLAIM POND, MRDF CELL 3 & CSA

LEGEND:

CSA – CONSTRUCTION SUPPORT AREA
TSP – TILL STOCKPILE
MRDF – MINE REFUSE DISPOSAL FACILITY

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL AREA FACILITIES CONSTRUCTION & RECLAMATION PHASES

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/19/85
DRAWING NO **FIGURE 4.3**	SHEET OF		REVISION NO

The following phases, 2, 3 and 4, each coincide with construction of tailing ponds T2, T3 and T4 and reclamation of the previous tailing pond. The length of each construction phase is long enough to cover construction of the current pond and continue through reclamation of the previous pond. In phases 2 and 4 construction and reclamation activity also is scheduled at the MRDF. In each of the first four phases there is some reclamation associated directly with the construction. As the outside embankments are completed for each pond, they will be revegetated as the initial reclamation step for the pond. Phase 5, the final phase, will include final reclamation of all facilities in the MWDF area.

Soil stockpile areas are planned with each phase of construction as shown on Figure 4.3. The stockpile area will contain salvaged topsoil and excess excavation volumes. During phase 4, the final stockpile area will be located on pond T2. This will avoid having to disturb areas outside the footprint of the MWDF for stockpile area. The procedures described in subsection 2.4.1 for topsoil salvage and preservation will be followed in the MWDF area. The MWDF area facilities design will achieve a nearly balanced earthwork (cut equal to fill) condition. The current MWDF design projects an approximate 0.2 M cubic yard fill deficit out of approximately 15.0 M cubic yards of earthwork. To provide for this imbalance, a 0.5 M cubic yard borrow area has been included in the MWDF planning. The 0.5 M cubic yard borrow area will cover the anticipated deficit and any inaccuracies in earthwork estimates or unanticipated MWDF changes where an approximately balanced earthwork condition might not be possible.

4.2.3.1 Site Preparation

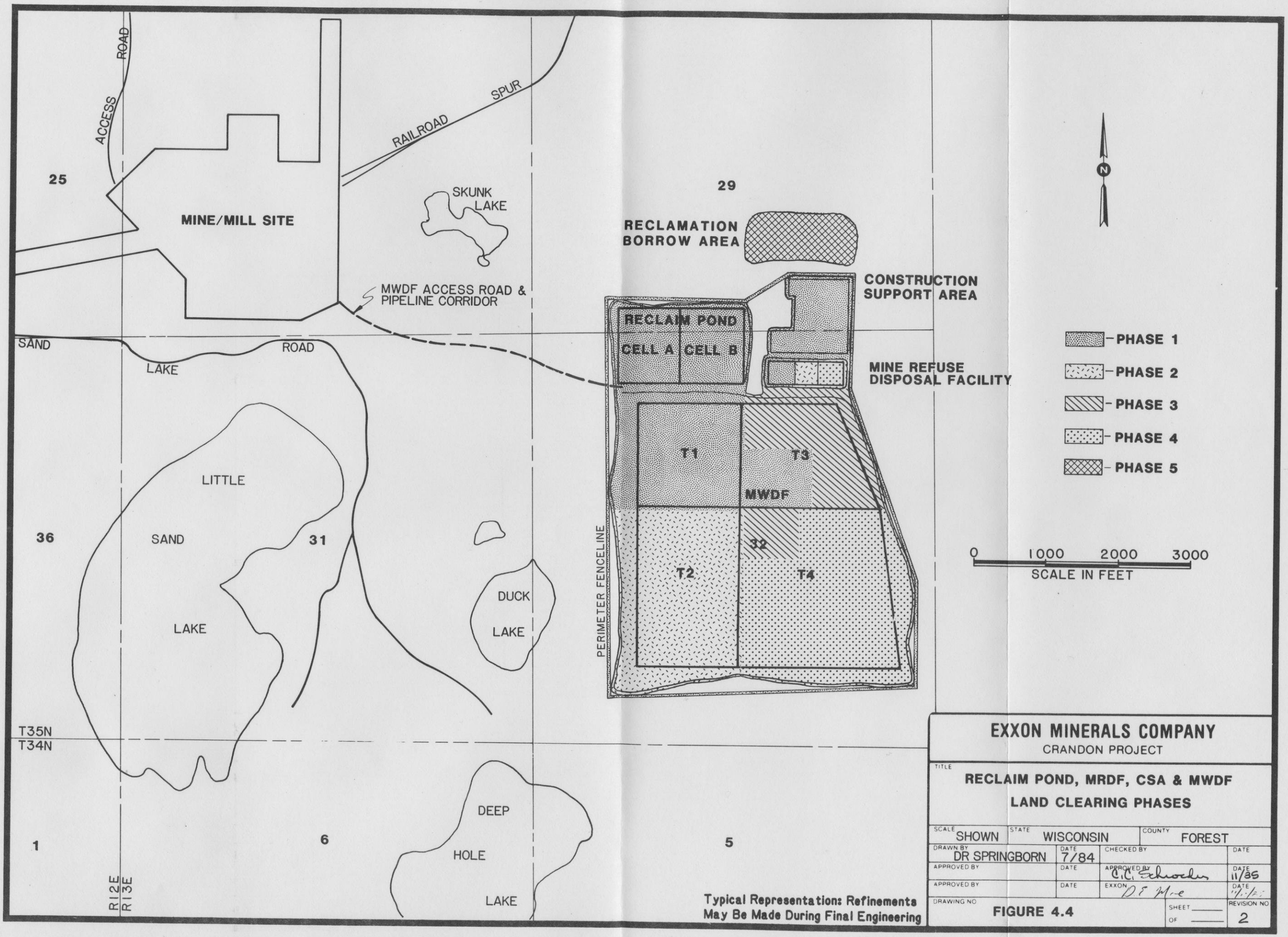
Site preparation is required in the first four phases of the MWDF construction. Clearing and grubbing also will be done in phases so that only the area actually required for the earthwork operations or the stockpile areas in a particular phase is cleared and grubbed. The remainder of the site will be disturbed as little as possible. Figure 4.4 outlines the areas to be cleared and grubbed for each phase.

Marketable timber will be cut and hauled off-site. Some stumps, brush, and slash will be windrowed, piled, and burned; portions will also be chipped and stored. Any waste ash will be buried.

Before clearing and grubbing activities are initiated, erosion control facilities will be installed in the area to be developed. Detail of these activities is included in subsection 4.2.3.5.

After the area is cleared and grubbed, topsoil will be salvaged and stockpiled for future use. The guidelines presented in subsection 2.4.1 for topsoil removal and preservation will be followed.

In Phase 1, additional site preparation is required to perform the following activities: (1) construct the haul road from the mine/mill site to the tailing ponds; (2) install a fence around the perimeter of the site; (3) construct a contractor's construction support area near the tailing ponds. The fence will be located so as to provide a corridor approximately 50 feet wide between the toe of all future embankments and the site perimeter. An access road for embankment inspection purposes will be constructed around the tailing ponds.



Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
RECLAIM POND, MRDF, CSA & MWDF LAND CLEARING PHASES

SCALE: SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 7/84	CHECKED BY:	DATE:
APPROVED BY:	DATE:	APPROVED BY: C.C. Schroeder	DATE: 11/85
APPROVED BY:	DATE:	EXXON: D E Moe	DATE: 11/15
DRAWING NO: **FIGURE 4.4**		SHEET ___ OF ___	REVISION NO: 2

In phases 2 through 4 required site preparation is generally limited to clearing and grubbing. In phase 5 no major site preparation work is required.

4.2.3.2 Waste Rock Utilization

Waste rock will be produced throughout the life of the mine. Most of the waste rock will be reused in the mine, either directly for fill in mined areas or mine road building or reintroduced to the mine as backfill after crushing.

A small portion of the waste rock will be utilized for embankment slope protection in the tailing ponds and reclaim pond. In all cases the waste rock will be placed above the pond seepage control systems. Figure 4.5 illustrates the use of the waste rock for slope protection.

4.2.3.3 Access Roads

Access roads will be provided along the pond crests and toe of exterior embankment slopes for use in inspecting and maintaining the waste disposal system facilities. All access roads will be surfaced with rock or granular material as necessary to maintain travel.

4.2.3.4 Construction Support Area

The construction support area will be an earthfill pad approximately 25 acres in size. The pad will be sloped to drain and the runoff will be diverted into a retention pond. The retention pond will also be used in conjunction with the material processing activities for

N 33,000 N 34,000 N 35,000 N 36,000

E 696,000

E 697,000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

RECLAIM

POND (FOR REFERENCE ONLY)

T1 T2 T3 T4

CREST 520

CREST 500

CREST 480

ROAD

LEGEND

- ROCK SLOPE PROTECTION
- (T2) POND NUMBER
- EMBANKMENT SLOPE

NOTE:

1) ROCK SLOPE PROTECTION DETAILS SHOWN ON PLAN SHEETS 22 & 23.

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.
4. CONTOURS SHOWN WITHIN THE POND CONFINES ARE FINISHED GRADE / TOP OF FILTER LAYER UNLESS OTHERWISE INDICATED.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

Typical Representation: Refinements may be made during final design.

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
ROCK SLOPE PROTECTION PLAN

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY J.J.T.	DATE 10-4-85	CHECKED BY E. Schroeder	DATE 12/4/85
APPROVED BY	DATE	APPROVED BY R.W. Walker	DATE 12/4/85
APPROVED BY	DATE	EXXON D.F. Mac	DATE 12/4/85
DRAWING NO.		SHEET 24 OF 36	REVISION NO.

FIGURE 4.5

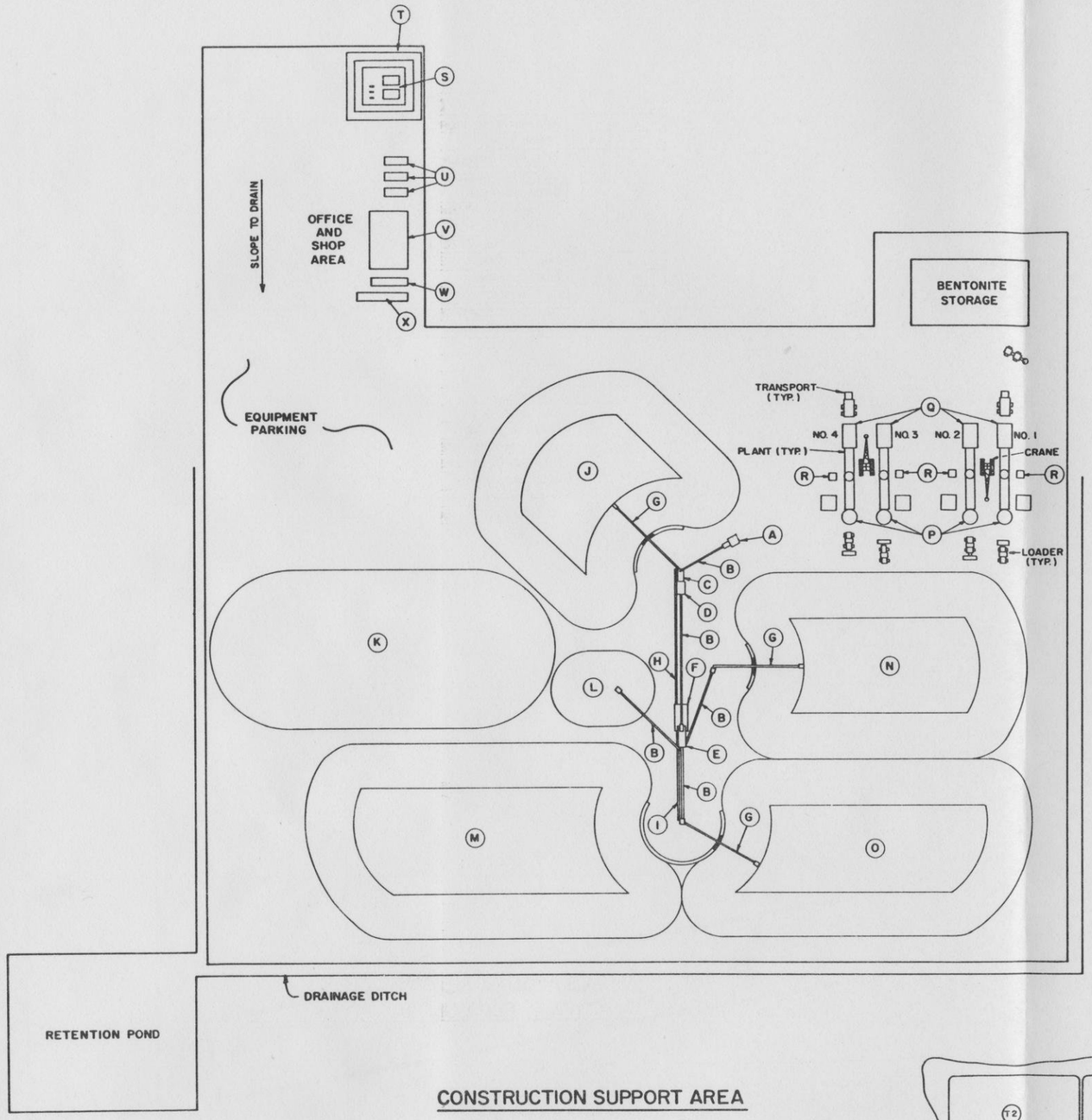
underdrain material preparation. The surface of the support area will consist of natural glacial till - no gravel will be placed.

Figure 4.6 presents a plan of the proposed construction support area. The retention pond will be sized for the process water requirements and drainage from the construction support area. The majority of the construction support area will be used; however, any open spaces will be revegetated to reduce erosion.

4.2.3.5 Erosion Control During Construction

During each phase of construction, control of surface water runoff will be accomplished by constructing a series of ditches, dikes, and retention ponds, and use of temporary vegetation, soil stabilizers and mulches (see Appendices 2.1A and 2.4A). Figures 4.7 through 4.11 detail the drainage patterns and location of required control features for each of the five phases of construction. Surface runoff with the potential for high suspended solids content will be diverted through sedimentation ponds with overflow weirs before being discharged into the natural drainage system of the surrounding area. These sedimentation ponds will allow settling of the suspended solids. As each construction phase is completed, temporary and final vegetative cover will be established where appropriate (see Section 4.4).

The sedimentation ponds proposed for use during construction and phasing of the MWDF are temporary basins, installed prior to a construction phase and removed after vegetation has been established and erosion control is no longer required. Later, however, when a phase of

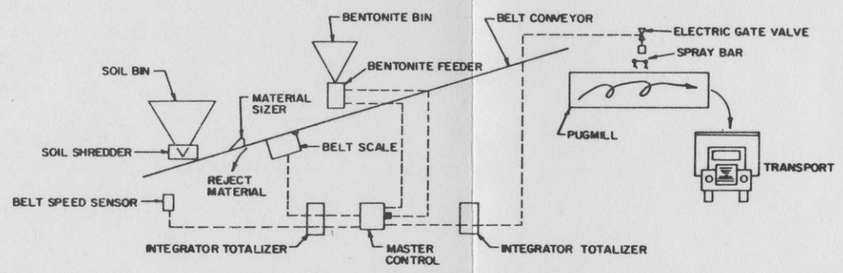


CONSTRUCTION SUPPORT AREA

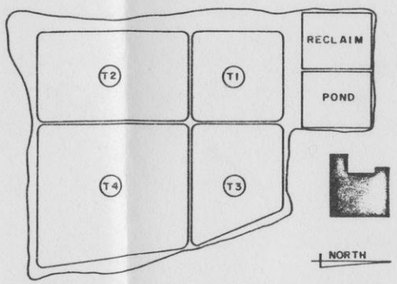
30 0 30

SCALE IN METERS

ITEM		DESCRIPTION
A		HOPPER WITH VIBRATING FEEDER
B		CONVEYOR
C		SCALPING SCREEN
D		CRUSHING PLANT
E		DECK SCREEN
F		CLASSIFYING TANK
G		RADIAL STACKER
H		SINGLE FINE MATERIAL SCREW
I		DOUBLE FINE MATERIAL SCREW
J		SAND CUSHION
K		FILTER MATERIAL
L		TRANSITION MATERIAL
M		DRAIN MATERIAL
N		LINER MATERIAL
O		SAND CUSHION
P		SOIL BINS
Q		PUG MILL
R		BENTONITE BINS
S		FUEL STORAGE
T		CONTAINMENT DIKE
U		STORAGE TRAILERS
V		PORTABLE SHOP
W		QUALITY CONTROL TRAILER
X		CONTRACTOR'S TRAILER



LINER MATERIAL PROCESSING PLANT
(TYPICAL FLOW DIAGRAM)



PROJECT LOCATION

REVISED	DATE	BY	DESCRIPTION

Typical Representation: Refinements may be made during final design.

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
CONSTRUCTION SUPPORT AREA GENERAL PLAN

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY J.J.T.	DATE 10-31-85	CHECKED BY [illegible]	DATE 11/1/85
APPROVED BY	DATE	APPROVED BY [illegible]	DATE 11/1/85
APPROVED BY	DATE	FOR OF Mine	DATE 11/7/85
DRAWING NO.		SHEET 36 OF 36	REVISION NO.

FIGURE 4.6

N 33.000 N 34.000 N 35.000 N 36.000

E 696.000 E 697.000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

HEMLOCK CREEK

El. 495.0
Q_{100}= 4.1 cms
SP-A

El. 500.2
Q_{100}= 1.4 cms
SP-B

El. 517.1
Q_{100}= 1.0 cms
SP-C

El. 514.0
Q_{100}= 1.6 cms
SP-D

HBF-M El. 518.0
Q_{100}= 1.0 cms

Reclaim Pond

Reclaim Pond

Toe Of Embankment Slope

Toe Of Embankment Slope

Temporary Stockpile Area

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

T1 T2 T3 T4

1 2 3 4 5

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

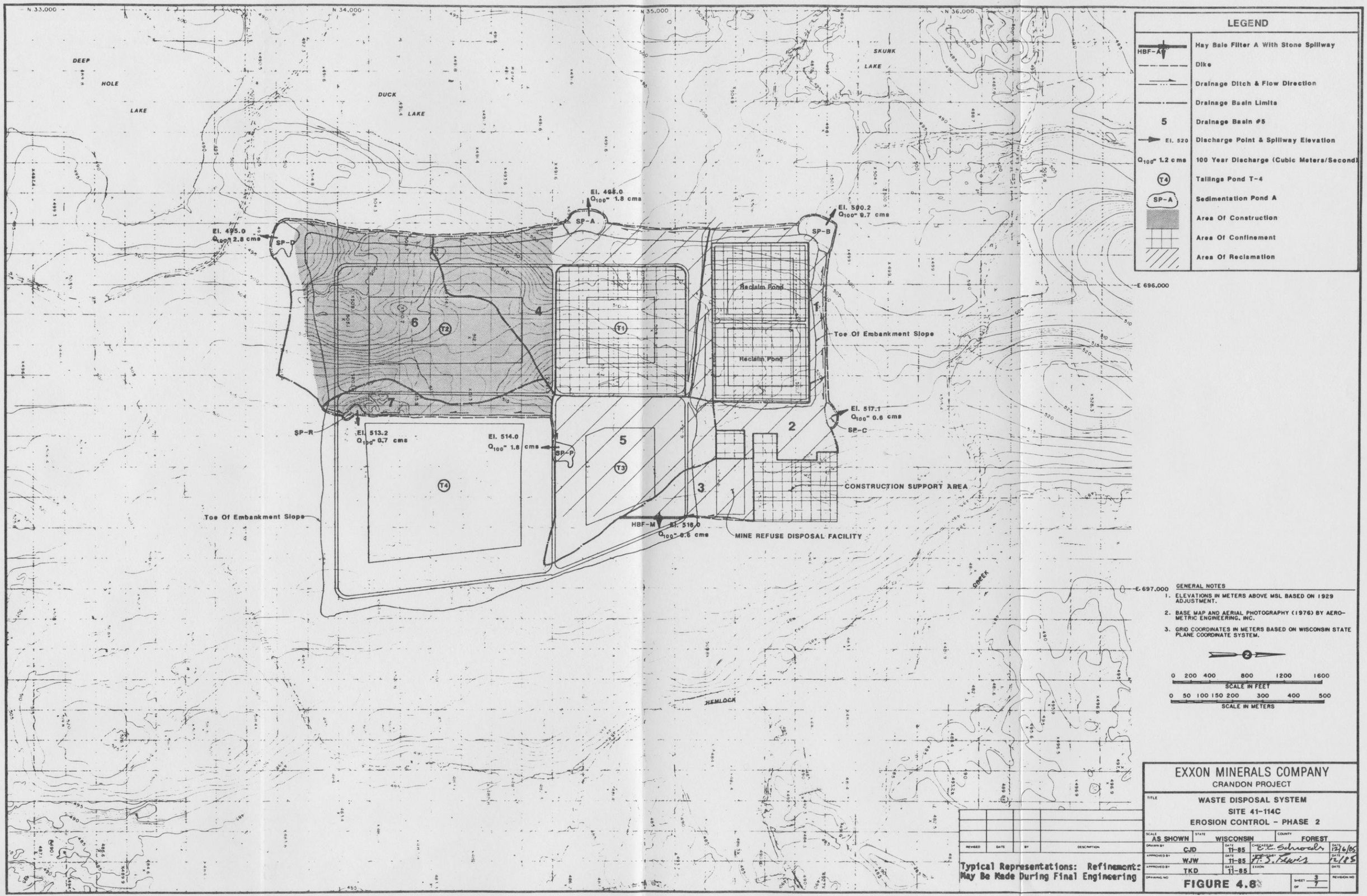
Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 1

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY CJD	DATE 11-85	DESIGNED BY C. Schuzler	DATE 12/6/85
APPROVED BY WJW	DATE 11-85	REVIEWED BY W. J. Weis	DATE 12/6/85
APPROVED BY TKD	DATE 11-85	EXXON	DATE
DRAWING NO		SHEET 2 OF 7	REVISION NO

FIGURE 4.7



LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

Typical Representations: Refinement: May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 2

SCALE: AS SHOWN	STATE: WISCONSIN		COUNTY: FOREST
DRAWN BY: CJD	DATE: 11-85	CHECKED BY: C.J. Schroeder	DATE: 12/6/85
APPROVED BY: WJW	DATE: 11-85	APPROVED BY: T. S. Harris	DATE: 12/85
APPROVED BY: TKD	DATE: 11-85	EXXON	DATE
DRAWING NO.			REVISION NO.

FIGURE 4.8

SHEET 3 OF 7

DESIGN PRODUCTS CO.

N 33.000 N 34.000 N 35.000 N 36.000

E 696.000

E 697.000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

HEMLOCK CREEK

El. 495.0
Q_{100}= 3.1 cms
SP-A

El. 500.2
Q_{100}= 0.7 cms
SP-B

El. 485.0
Q_{100}= 1.3 cms
SP-D

Toe Of Embankment Slope

Reclaim Pond

Reclaim Pond

Toe Of Embankment Slope

El. 517.1
Q_{100}= 0.9 cms
SP-C

SP-B

El. 513.2
Q_{100}= 0.8 cms

El. 513.6
Q_{100}= 2.3 cms
HBF-Q

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

SP-L

El. 517.6
Q_{100}= 0.9 cms

El. 521.2
Q_{100}= 0.1 cms
HBF-S

T1 T2 T3 T4

1 2 3 4 5 6 7

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

N

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

Typical Representations: Refinements May Be Made During Final Engineering

REVISED | DATE | BY | DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 3

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY CJD	DATE 11-85	CHECKED BY C.J. Schroeder	DATE 11/6/85
APPROVED BY WJW	DATE 11-85	EXXON BY H.S. Lewis	DATE 12/85
APPROVED BY TKD	DATE 11-85	EXXON	DATE
DRAWING NO			REVISION NO

FIGURE 4.9

SHEET 4 OF 7

N 33.000 N 34.000 N 35.000 N 36.000

E 696.000

E 697.000

DEEP HOLE LAKE

DUCK LAKE

SKUNK LAKE

HEMLOCK CREEK

El. 495.0
Q_{100}= 1.6 cms

El. 495.0
Q_{100}= 2.7 cms

El. 500.2
Q_{100}= 0.7 cms

Reclaim Pond

Reclaim Pond

Toe Of Embankment Slope

El. 517.1
Q_{100}= 0.9 cms

SP-C

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

El. 512.3
Q_{100}= 3.3 cms

SP-F

Toe Of Embankment Slope

SP-L

El. 517.0
Q_{100}= 0.9 cms

SP-G

SP-H

El. 511.5
Q_{100}= 0.3 cms

El. 504.5
Q_{100}= 1.8 cms

LEGEND

HBF-A	Hay Bale Filter A With Stone Spillway
	Dike
	Drainage Ditch & Flow Direction
	Drainage Basin Limits
5	Drainage Basin #5
El. 520	Discharge Point & Spillway Elevation
Q_{100}= 1.2 cms	100 Year Discharge (Cubic Meters/Second)
T4	Tailings Pond T-4
SP-A	Sedimentation Pond A
	Area Of Construction
	Area Of Confinement
	Area Of Reclamation

GENERAL NOTES

1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.

0 200 400 800 1200 1600
SCALE IN FEET

0 50 100 150 200 300 400 500
SCALE IN METERS

REVISED	DATE	BY	DESCRIPTION

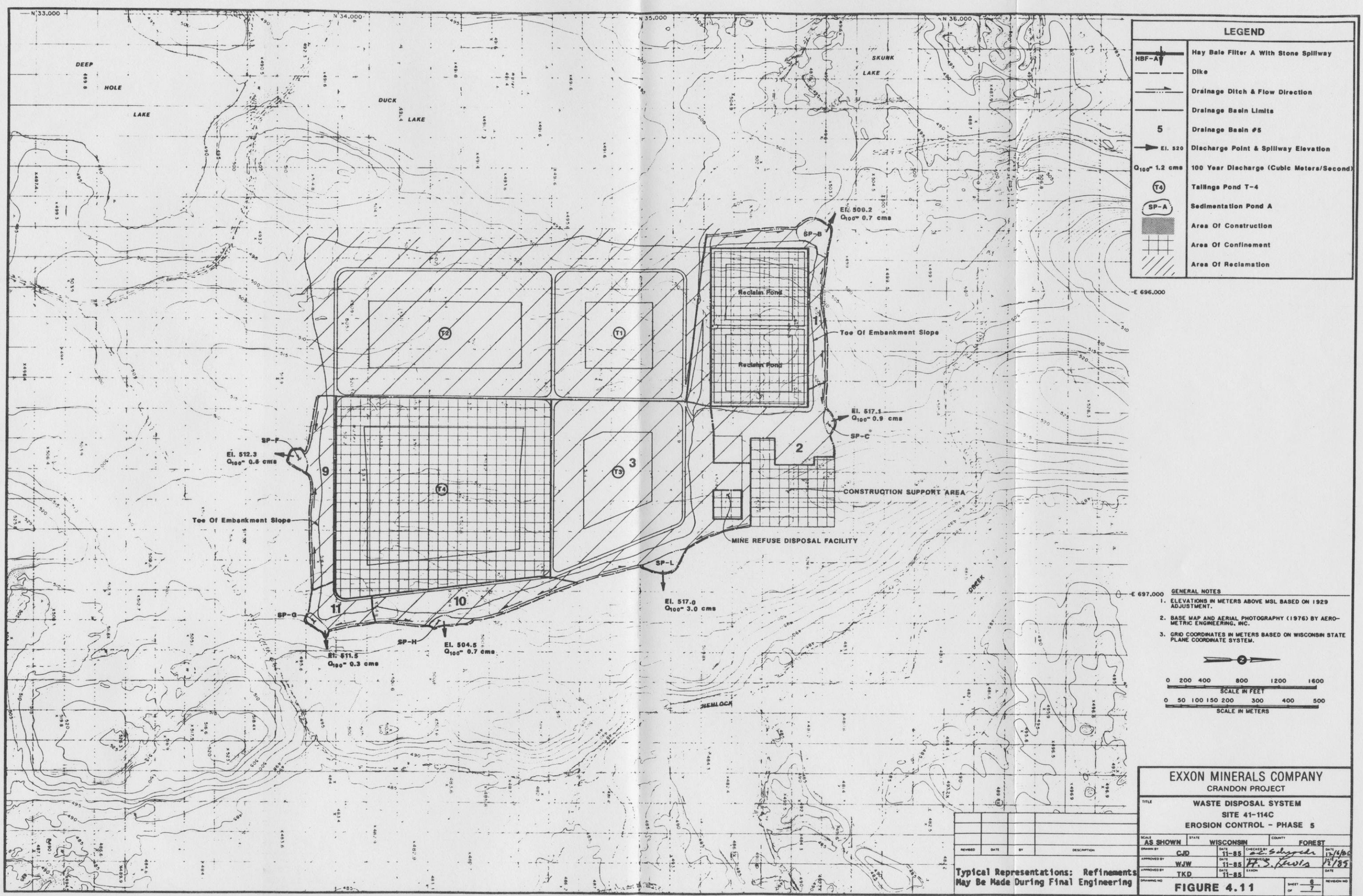
Typical Representations; Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 4

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY CJD	DATE 11-85	CHECKED BY C.C. Schroeder	DATE 12/6/85		
APPROVED BY WJW	DATE 11-85	EXXON T. S. Lewis	DATE 12/15/85		
APPROVED BY TKD	DATE 11-85	EXXON	DATE		
DRAWING NO	FIGURE 4.10	SHEET 5 OF 7	REVISION NO		

DESIGN PRODUCTS CO —


N 33.000
N 34.000
N 35.000
N 36.000
E 696.000
E 697.000
DEEP HOLE LAKE
DUCK LAKE
SKUNK LAKE
HEMLOCK CREEK
LEGEND
HBF-A
Hay Bale Filter A With Stone Spillway
Dike
Drainage Ditch & Flow Direction
Drainage Basin Limits
5
Drainage Basin #5
El. 520
Discharge Point & Spillway Elevation
Q100= 1.2 cms
100 Year Discharge (Cubic Meters/Second)
T4
Tailings Pond T-4
SP-A
Sedimentation Pond A
Area Of Construction
Area Of Confinement
Area Of Reclamation
T2
T1
T3
T4
Reclaim Pond
Reclaim Pond
1
2
3
9
10
11
SP-B
El. 508.2
Q100= 0.7 cms
Toe Of Embankment Slope
El. 517.1
Q100= 0.9 cms
SP-C
CONSTRUCTION SUPPORT AREA
MINE REFUSE DISPOSAL FACILITY
SP-L
El. 517.0
Q100= 3.0 cms
SP-F
El. 512.3
Q100= 0.8 cms
Toe Of Embankment Slope
SP-G
El. 511.5
Q100= 0.3 cms
SP-H
El. 504.5
Q100= 0.7 cms
GENERAL NOTES
1. ELEVATIONS IN METERS ABOVE MSL BASED ON 1929 ADJUSTMENT.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.
N
0 200 400 800 1200 1600
SCALE IN FEET
0 50 100 150 200 300 400 500
SCALE IN METERS
REVISED
DATE
BY
DESCRIPTION
Typical Representations: Refinements May Be Made During Final Engineering
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
WASTE DISPOSAL SYSTEM
SITE 41-114C
EROSION CONTROL - PHASE 5
SCALE AS SHOWN
STATE WISCONSIN
COUNTY FOREST
DRAWN BY CJD
DATE 11-85
CHECKED BY C.J. Schneider
DATE 12/6/85
APPROVED BY WJW
DATE 11-85
APPROVED BY TKD
DATE 11-85
EXXON
DATE 12/85
DRAWING NO
REVISION NO
SHEET 8 OF 7
FIGURE 4.11

reclamation is scheduled and soils would be exposed to erosion, the temporary silt control basins will again be utilized. As planned for these purposes, the silt retention basins will consist of either straw bale dams or small earthen dams with overflow structures to be located in existing drainage swales or depressions.

Since the MWDF is located in a topographical high area, there are no large quantities of surface flow through the site. Therefore, only minor surface water diversion is required in the MWDF area and no major water diversions or other water handling structures are proposed. Also, during operation of the facilities with the tailing pond(s) open, total runoff in the area of the MWDF will be reduced because all rainfall over the ponds will be collected in the pond(s).

In studies by STS Consultants Ltd. (1985) and Ayres Associates (1984, 1985), no major problems were identified that would prohibit meeting the objectives of developing a surface water handling system that effectively manages and controls surface water runoff with minimum facilities. This is true during the construction, operation, and reclamation periods when the temporary facilities are used. After reclamation has been completed, no facilities will be required.

4.3 Reclamation of Mine Waste Disposal Facility, Reclaim Pond and Mine Refuse Disposal Facility - Physical Aspects

Reclamation of the proposed MWDF entails three areas of primary concern: (1) infiltration of precipitation and seepage of tailings slurry water; (2) control of erosion and sediment runoff during operations and upon closure, and (3) return of the site, after mining cessation, to a condition similar to that which existed prior to mining.

One of the objectives in the development of the Reclamation Plan was to plan the reclamation of facilities in a manner that would avoid the need for long-term continual maintenance and attention. The handling of surface drainage and erosion control has been designed to avoid the need for permanent retention basins and similar structures since these would require long-term maintenance.

The location of the MWDF in Area 41 does not change the basic characteristic of the site as an upland area with surface drainage in all directions. Upon completion and reclamation of the MWDF the final grades will be approximately 33-66 feet higher than existing grades but the area will remain an upland area with surface drainage in all directions. The design of the reclamation cap seepage control system will reduce infiltration through the cap to a negligible level and changes the infiltration/runoff/evaporation/transpiration balances in the immediate area of the MWDF. However, this has minimal effects on the overall hydrological system as it is currently operating in Area 41 (Ayres Associates, 1984, 1985). Precipitation that would normally

infiltrate, but will be prevented from infiltration because of the seal, will flow to the perimeters of the MWDF ponds through the drain layer overlying the reclamation seal. At the MWDF pond perimeters excess water will infiltrate into the embankments and provide ground water recharge. The hydrological system will be altered in the vicinity of the MWDF, with reduced infiltration below the cap, but that will be offset by having the infiltration occur around the perimeters of the MWDF ponds.

The reclamation grades planned for the MWDF are relatively flat with a higher area near the center of each tailing pond. This grading plan will provide approximately uniform runoff rates around most of the perimeter of the MWDF and some concentration of flow in the four swale areas between the ponds. The objective in this design is to avoid large concentrations of flows and therefore avoid the need for ditches, culverts, basins, or other structures to handle the flows. Where the concentrations of flows occur in the four swale areas, additional erosion control measures will be employed. The water balance analysis for the MWDF reclamation cap was performed by Ayres Associates (1984, 1985) and the results indicate there will be minimal change in the hydrological system when considering the total area of Area 41.

Studies and analysis by Golder Associates (1982) and Ayres Associates (1985) have indicated there should be no soil erosion problems with the 3H:1V outside slopes of the MWDF. These studies compared velocities of surface runoff flow for high intensity storms against velocities known to cause soil erosion. The reclamation cap grading plan will create concentration of surface runoff in the swales

along the embankments between the four ponds. The analysis of this condition indicated the need for erosion protection on the outside embankment faces in the four areas where the swales direct drainage down the embankment face. In these areas a rip-rap facing will be incorporated to eliminate any erosion potential.

While the study and analyses substantiate the adequacy of the reclamation design, the Monitoring Plan will include regular inspections of pond T1 after reclamation for evidence of soil erosion. If such evidence develops, corrective actions, such as rip-rap facing, slope drains, or slope benches, will be planned, designed, and retrofitted to pond T1 as appropriate. Also, reclamation plans for subsequent ponds will be altered and similar corrections or revisions will be planned. Based on the time between reclamation of ponds T1 and T2 (6 years), an adequate evaluation period is available.

This design fulfills the objective of developing a facility that is maintenance free following final reclamation. As part of the MWDF monitoring, periodic inspections are scheduled throughout operations and the long-term care period and any maintenance determined necessary during these inspections will be performed.

The study work has indicated slope interruptions (benches) are not necessary from an erosion control standpoint; therefore, they are not included in the design. However, if MWDF Plan of Operations study indicates a combination of a slightly increased slope with benches is advantageous, then that change can be later incorporated. If the benches can be incorporated without any overall slope reduction, then

there is no significant disadvantage from an earthwork or cost standpoint and also no change in the overall footprint of the MWDF.

4.3.1 Tailing/Reclaim Water Pond/MRDF Seepage Control Measures

Seepage control measures for operating tailing ponds, as developed during the preliminary engineering design, will consist of an 8-inch thick bentonite modified soil liner overlain by a two layer underdrain system. The underdrain system will consist of a 6 to 12-inch thick sand and gravel drain layer covered by a minimum 12-inch thick filter layer of glacial till. Waste rock will be used in the tailing ponds as slope protection over the glacial till filter layer along those sides opposite the tailings input where free water is expected to pond.

The tailing pond bottoms will be sloped toward the outside embankments to direct seepage in the underdrain to the inside toe of the outside embankments. A collection pipe will be placed along the length of the inside toe of the embankment. Two discharge pipes per tailing pond will be placed down the embankment slope to intersect with the bottom perimeter pipe. Pumps will be placed in these discharge pipes to lift the collected seepage to the surface where it will join with the pond decant water and be piped to the reclaim pond. Additional information on the seepage control measures for the tailing ponds is presented in the MWDF Feasibility Report.

The reclaim pond will be used for water retention only. It has been designed with a synthetic liner and underdrain/venting system underlain by an 8-inch thick bentonite modified soil liner. Water will flow from cell B to cell A during normal operation procedures. A mixing

box with an overflow weir will be located between the two cells and will be used for the addition of lime. Additional information on the design of the reclaim pond is included in the EIR and Appendix B of the Water Treatment Facility Engineering Report (CH2M Hill, 1985).

The MRDF will have a seepage control system similar to that proposed for the MWDF. The design of each of the MRDF cells will include a bentonite modified soil liner, drain layer and an overlaying filter/protective cover layer. Additional information on the design and seepage control measures for the MRDF is presented in the MRDF Feasibility Report.

4.3.2 Tailing Ponds and MRDF Precipitation Infiltration Control Measures

At the end of operation the surface of a tailing pond will be covered with a cap composed of six layers. The bottom (or first) layer, composed of glacial till, will be used to grade the final pond surface to a minimum 2 percent slope, the second and third layers will be composed respectively of an 8-inch bentonite modified soil admixture seal and a 40 mil polyethylene membrane seal to prevent surface water from percolating through the tailings; the fourth layer, an 8-inch coarse gravel overdrain layer, will be placed above the composite seal to allow drainage of the final layer. The fifth layer will be a geotextile filter fabric to prevent any migration of fines into the drain layer. The final layer will be a cover of glacial till 5 feet thick to provide a plant growth medium (see subsections 4.3.3.2 and

4.4.2.6.1). The upper 9-12 inches of the final layer will be topsoil salvaged during construction of the MWDF.

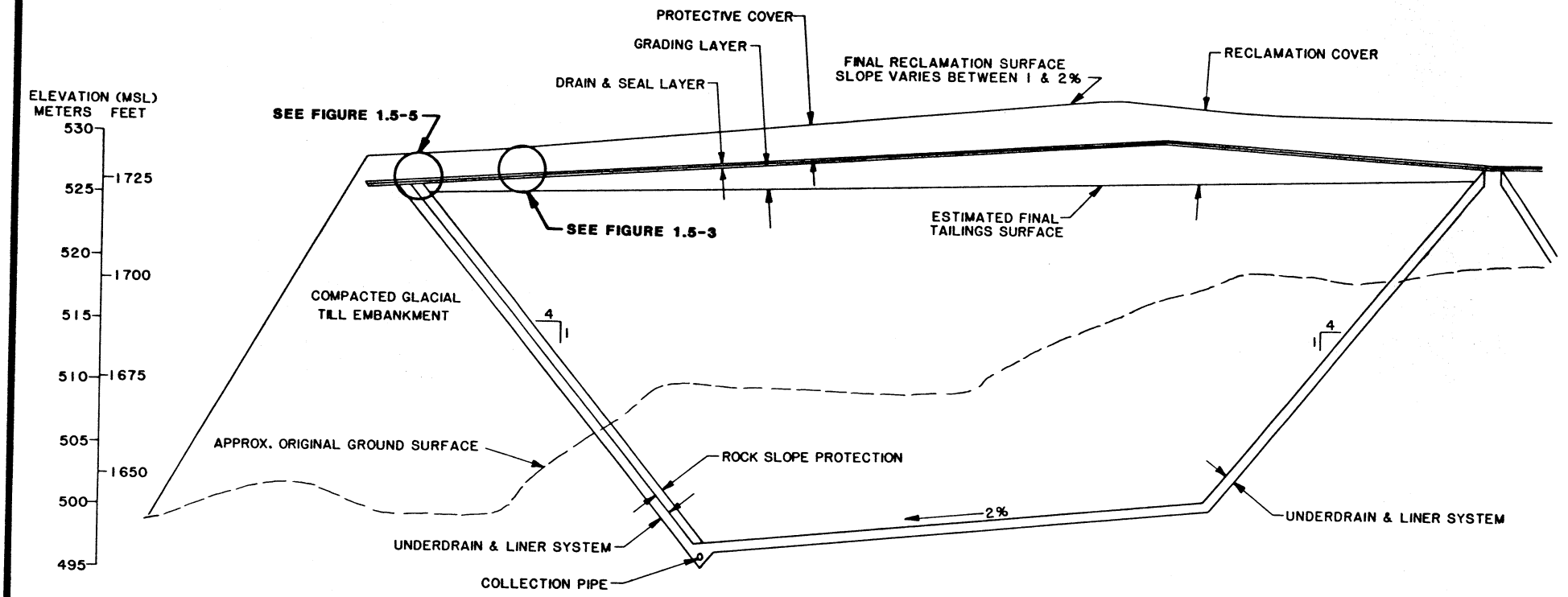
In addition to the multilayered reclamation cap, contiguous over the entire MWDF area, a special infiltration zone around the MWDF pond perimeters has also been included in the reclamation cap design. This zone allows water traveling laterally in the cap drain layer to infiltrate in the embankments of the MWDF ponds. Details of the typical reclamation elements for the MWDF are shown on Figures 4.12 through 4.14.

Infiltration control measures for the MRDF will be similar to those for the MWDF. The first layer in the MRDF reclamation cover will be a soil grading layer a minimum of 1 foot thick. An 8-inch thick soil-bentonite seal and overlying synthetic membrane will be placed over the grading layer. These layers will be overlain by a drain layer, geotextile filter fabric, and a final 4.5-foot protective cover layer with the upper 6 inches being salvaged topsoil.

4.3.2.1 Effectiveness of the Composite Bentonite Modified Soil Admixture and Synthetic Membrane Seal

The average annual precipitation in the region of the proposed MWDF is 30.55 inches for the period 1908 to 1980 (Black, 1981).

Without any capping system and assuming the total precipitation is ponded above the tailings and there is no loss by evapotranspiration or runoff, this water will percolate through the tailings to the pond bottom. For a nominal 100-acre pond this flow rate is approximately 160 gallons per minute. It is estimated that a

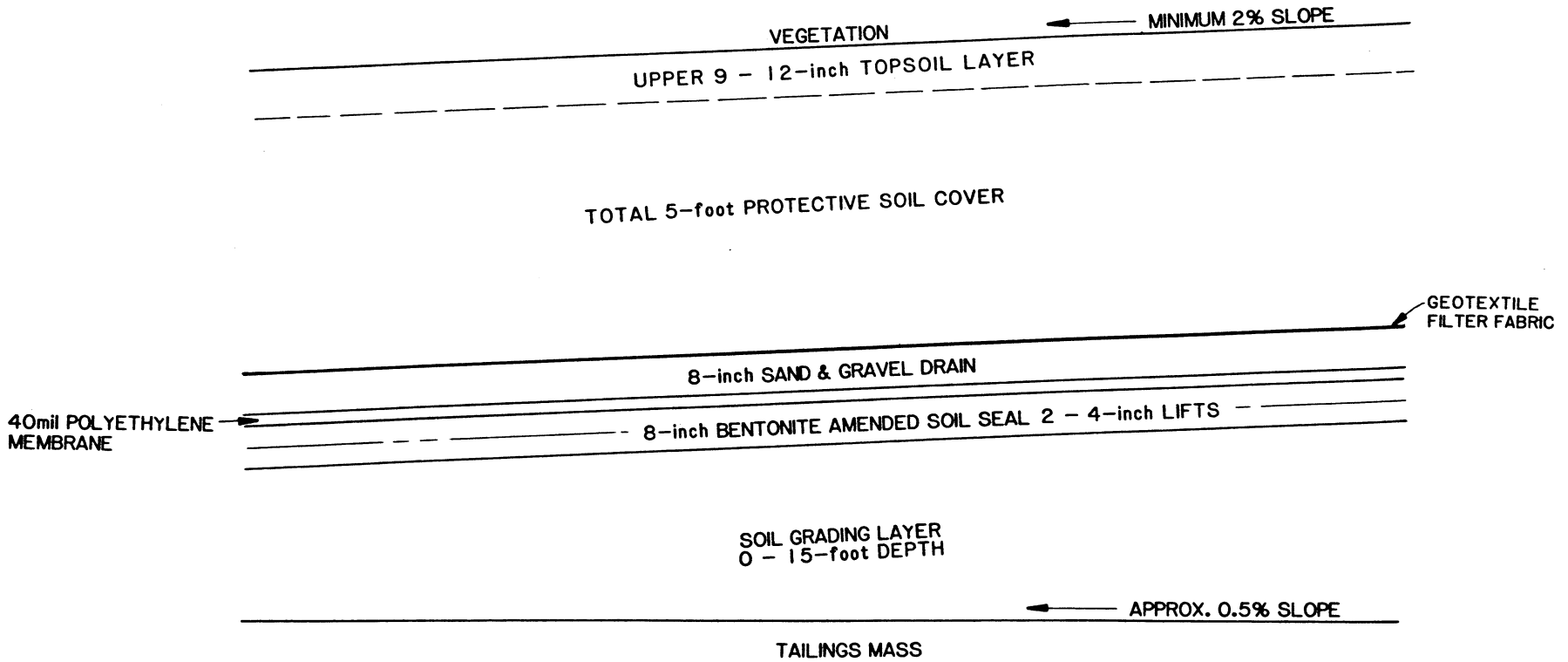


Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
TYPICAL RECLAMATION CAP

SCALE: NONE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: DR SPRINGBORN	DATE: 10/85	CHECKED BY:	DATE:
APPROVED BY:	DATE:	APPROVED BY: C.C. Schroeder	DATE: 11/13/85
APPROVED BY:	DATE:	EXXON: D. L. Zinn	DATE: 11/20
DRAWING NO: **FIGURE 4.12**		SHEET: — OF: —	REVISION NO:

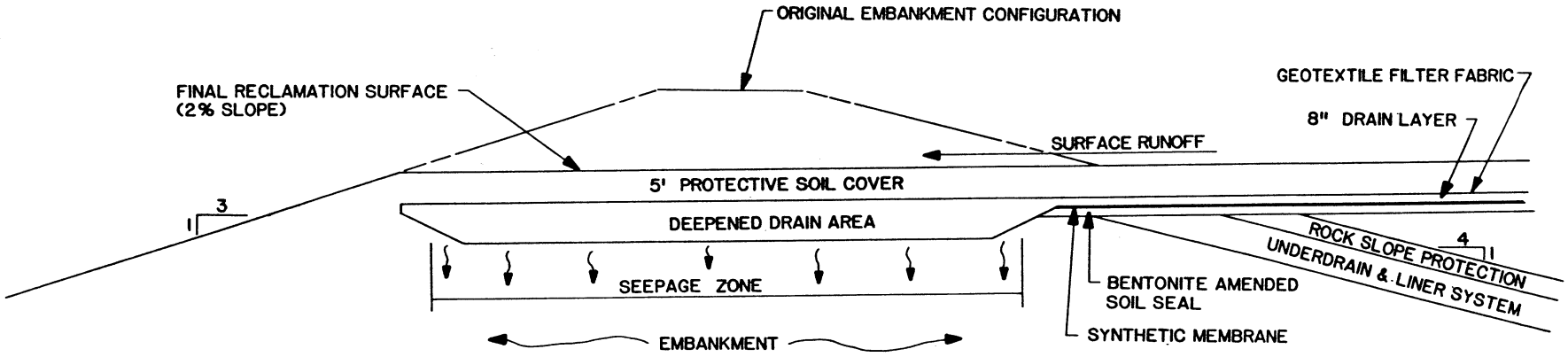


Typical Representation: Refinements May Be Made During Final Engineering

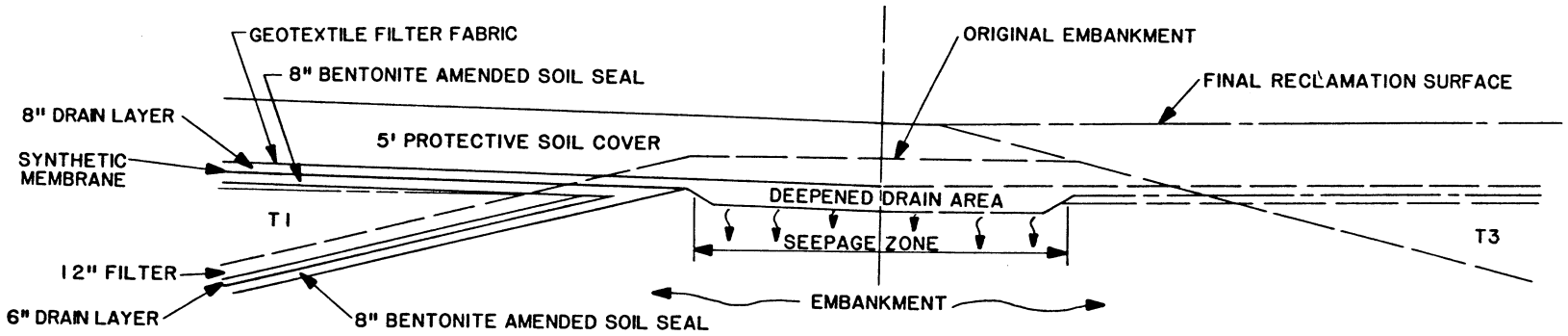
EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY RECLAMATION SEAL DETAIL

SCALE NONE	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 7/84	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.F. Mac	DATE 11-14
DRAWING NO **FIGURE 4.13**		SHEET ___ OF ___	REVISION NO



MWDF PERIMETER EMBANKMENT



MWDF INTERIOR EMBANKMENT

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
TYPICAL RECLAMATION CAP
EMBANKMENT DRAIN DETAIL

SCALE	STATE	COUNTY
NONE	WISCONSIN	FOREST

DRAWN BY	DATE	CHECKED BY	DATE
DR SPRINGBORN	9/85		
APPROVED BY	DATE	APPROVED BY	DATE
		C.C. Schweden	11/13/85
APPROVED BY	DATE	EXXON	DATE
		D.F. Pl	11-12-85

DRAWING NO **FIGURE 4.14** SHEET ___ OF ___ REVISION NO

bentonite modified soil seal layer without the overdrain layer will restrict infiltration seepage into the tailings to a maximum of about 3.4 inches per year, which is equivalent to about 18 gallons per minute for a nominal 100-acre pond. This figure assumes that the glacial till above the seal layer is saturated for 41 weeks of the year (frozen for 11 weeks) so that the seal has a constant 3-foot head of water above it. The addition of the overdrain changes the performance of the reclamation cap significantly. In the overdrain layer, cap infiltration is removed laterally to the perimeter of the pond and the seepage through the bentonite modified soil seal layer is reduced to approximately 0.7 inches per year or less than 4 gallons per minute for a nominal 100-acre pond (Ayres Associates, 1984). Using this rate, the ultimate seepage through the capping system of the totally reclaimed facility would be approximately 10 gallons per minute. With the addition of the synthetic membrane to the reclamation cap, a composite seal will be formed with the bentonite amended soil seal which will effectively reduce infiltration passing the seal to zero. However, to study the potential effects of seepage from the MWDF on ground water, a nominal seepage rate was assumed. This assumed rate (designated as Case I seepage in the MWDF Feasibility Report) is approximately 0.07 inches per year or approximately 1 gallon per minute for the entire MWDF or about 0.4 gallons per minute for a nominal 100-acre pond. This rate is based on an order of magnitude reduction from the rate established for the MWDF if a synthetic membrane is not included in the reclamation cap. Estimated unit area seepage rates for the MRDF reclamation cap are approximately the same. Because of the relatively small size of the

MRDF (approximately 3 percent of the size of the MWDF), the total seepage volumes from the MRDF will be insignificant.

4.3.3 Preparation of Final Reclamation Surfaces

The waste disposal system is designed so that reclamation can be completed in stages. After each tailing pond is filled and removed from service, the ponded water will be pumped to the reclaim pond, or in the case of the last tailing pond, to the wastewater treatment facility for treatment prior to discharge.

Construction of the reclamation cover system will involve placing a combination working mat/grading layer of till soil over the tailings surface to grade the tailing pond area surface below the bottom of the seal. The slope of the reclaimed cover system will be developed at this level. The composite seal, overdrain, and soil cover will be placed to a uniform thickness over this subgrade. The upper portions of the outside pond embankments above the tailings will also be used in this grading operation. After the pond has been graded at the subgrade level, the composite seal, overdrain, and soil cover will be installed.

4.3.3.1 Reclamation Schedule

The reclamation schedule for the four tailing ponds, the MRDF and the reclaim water pond is presented in Table 4.2 and on Figure 4.3. Regrading, capping, and permanent vegetation establishment will occur between Project Years 8 and 36.

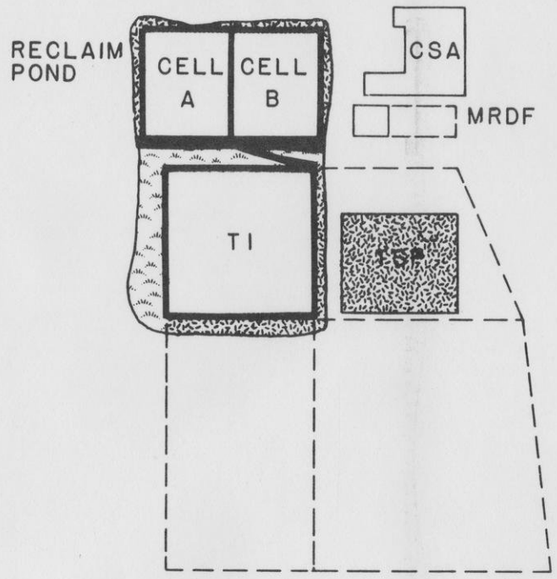
Final reclamation contours in areas where ponds adjoin cannot be finalized until the last adjoining pond is filled. The need for access for pond operations and maintenance precludes final contouring of tailing ponds T1, T2, and T3, where they have boundaries in common with the other tailing ponds. During reclamation of tailing pond T4, final reclamation contours in these adjoining areas will also be completed. Also, for operational reasons, removal and reclamation of the reclaim pond will occur during reclamation of tailing pond T4 (see subsection 4.3.3.3). The phasing of the MWDF development through construction, operation and reclamation is shown on Figure 4.15. The final reclaimed condition is shown on Figure 4.16.

Figure 4.16 illustrates the grading and routing of runoff across the MWDF cap. Segments of the embankments with rip-rap slope protection materials are designated in those areas where the drainage swales carry surface water runoff to the embankment slopes.

Final permanent access to the MWDF, on the southeast side of tailing pond T4, will be completed near the end of the reclamation period. This road (to be used during the long-term care period) will connect to the existing town road running northeast-southwest south of pond T4.

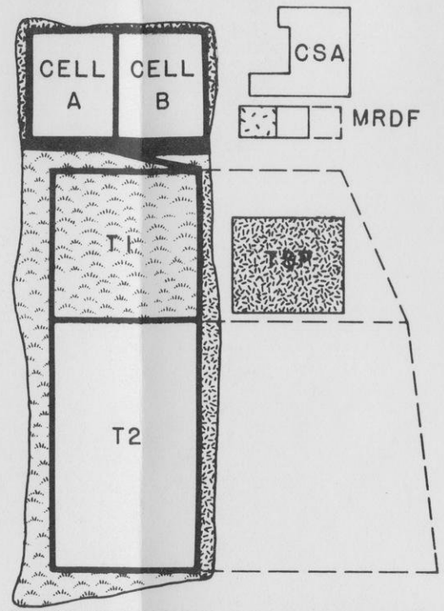
As each tailing pond is constructed, utilized and reclaimed, vegetation in the form of erosion controlling groundcover and trees and shrubs will be installed. The form, development, and composition of the vegetation through reclamation of tailing pond T4, the MRDF and the reclaim pond are discussed in more detail in Section 4.4.

PHASE 1 - YEARS 1-4



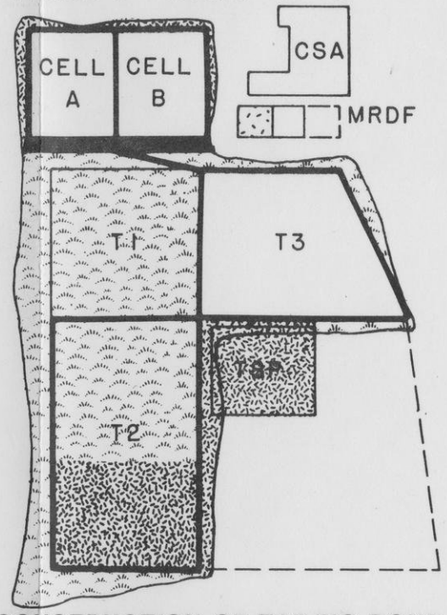
CONSTRUCTION OF TAILING POND T1, WATER RECLAIM POND, MRDF CELL 1 & CSA

PHASE 2 - YEARS 5-11



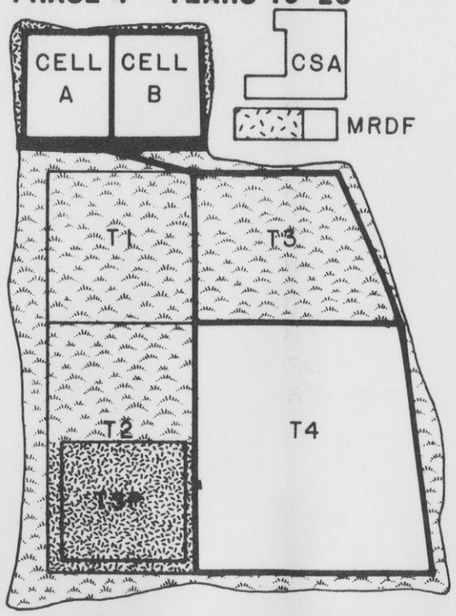
CONSTRUCTION OF TAILING POND T2 & MRDF CELL 2
RECLAMATION OF TAILING POND T1 & MRDF CELL 1

PHASE 3 - YEARS 12-16



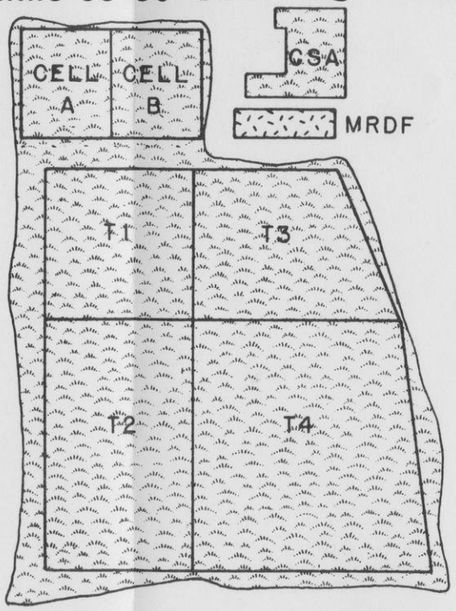
CONSTRUCTION OF TAILING POND T3
PARTIAL RECLAMATION OF TAILING POND T2

PHASE 4 - YEARS 19-23



CONSTRUCTION OF TAILING POND T4 & MRDF CELL 3
RECLAMATION OF TAILING POND T3 & MRDF CELL 2

PHASE 5 - YEARS 33-36



RECLAMATION OF TAILING POND T2 & T4, WATER RECLAIM POND, MRDF CELL 3 & CSA

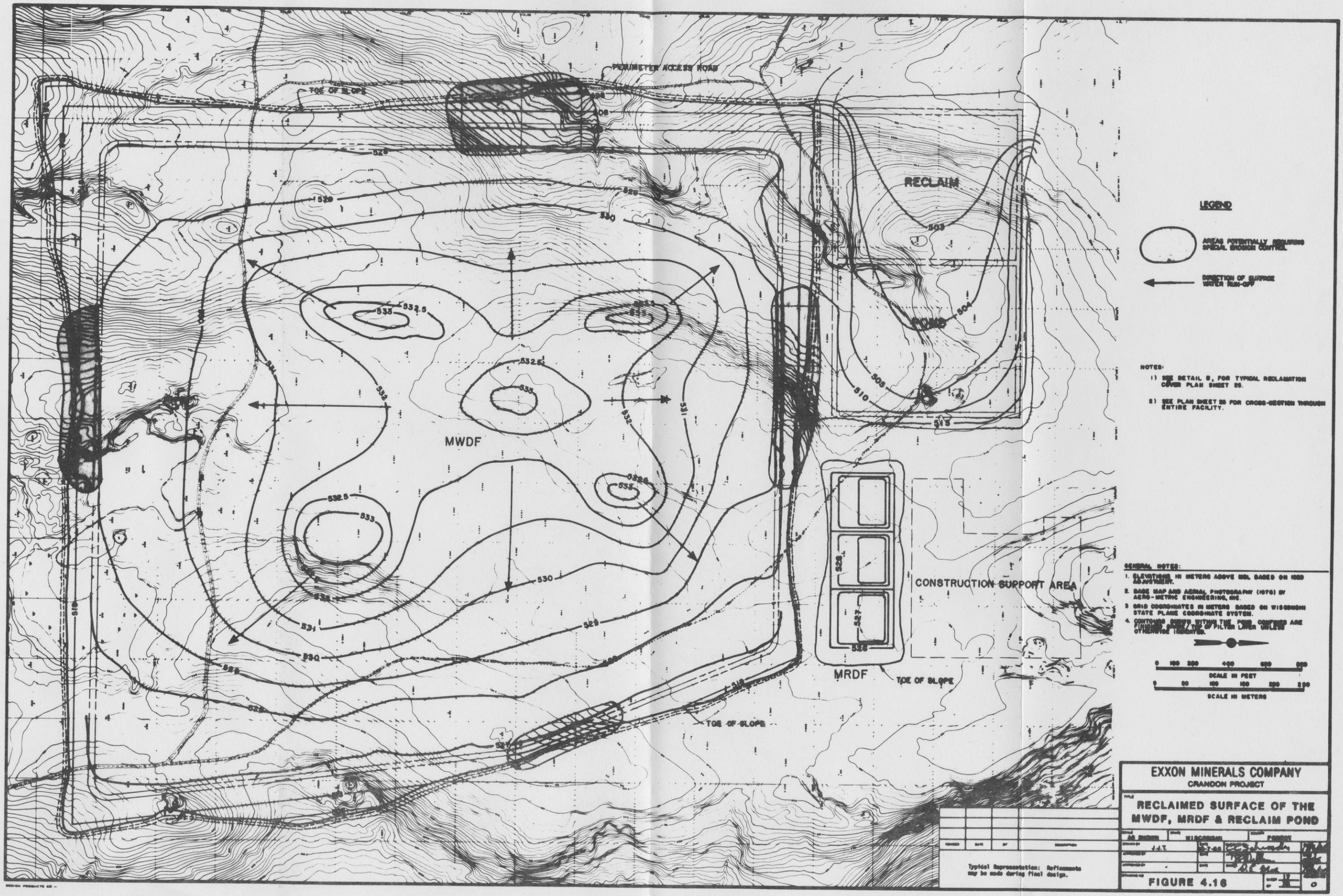
LEGEND:

- TEMPORARY HERBACEOUS COVER (INDIGENOUS & INTRODUCED SPECIES)
- PERMANENT HERBACEOUS COVER (INDIGENOUS & INTRODUCED SPECIES)
- PERMANENT HERBACEOUS COVER (INDIGENOUS & INTRODUCED SPECIES) TREE & SHRUB PLANTINGS
- CSA – CONSTRUCTION SUPPORT AREA
- TSP – TILL STOCKPILE
- MRDF – MINE REFUSE DISPOSAL FACILITY
- CREST ROADS

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MWDF, RECLAIM POND & MRDF RECLAMATION DEVELOPMENT PHASES

SCALE NONE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY C.C. Schroeder	DATE 11/13/85
APPROVED BY	DATE	EXXON D.E. Moe	DATE 11/19/85
DRAWING NO **FIGURE 4.15**	SHEET ___ OF ___		REVISION NO


PERIMETER ACCESS ROAD
TOE OF SLOPE
RECLAIM
POND
MWDF
MRDF
CONSTRUCTION SUPPORT AREA
TOE OF SLOPE
TOE OF SLOPE
LEGEND
AREAS POTENTIALLY REQUIRING SPECIAL EROSION CONTROL
DIRECTION OF SURFACE WATER RUN-OFF
NOTES:
1) SEE DETAIL 8, FOR TYPICAL RECLAMATION COVER PLAN SHEET 29.
2) SEE PLAN SHEET 29 FOR CROSS-SECTION THROUGH ENTIRE FACILITY.
GENERAL NOTES:
1. ELEVATIONS IN METERS ABOVE MSL BASED ON USGS BENCHMARK.
2. BASE MAP AND AERIAL PHOTOGRAPHY (1976) BY AERO-METRIC ENGINEERING, INC.
3. GRID COORDINATES IN METERS BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM.
4. CONTOURS SHOWN WITHIN THE POND CONTAINED ARE FOR TOP OF FILTER LAYER UNLESS OTHERWISE INDICATED.
0 100 200 400 600 800
SCALE IN FEET
0 50 100 200 300 400
SCALE IN METERS
Typical Representation: Refinements may be made during final design.
EXXON MINERALS COMPANY
CRANDON PROJECT
RECLAIMED SURFACE OF THE MWDF, MRDF & RECLAIM POND
WISCONSIN
FIGURE 4.18

4.3.3.2 Construction of Final Tailing Ponds Reclamation Cover

Construction of the final reclamation cover will begin at the tailings surface. The shape of the tailings surface can be controlled somewhat by the method of tailings deposition and will have a general slope of 0.5 percent. The tailings slopes and, hence, the reclamation cover slopes generally will be to the north and west for pond T1, to the south and west for pond T2, to the north and east for pond T3, and to the south and east for pond T4. Figure 4.16 shows the outline and final reclamation grade of the tailing ponds and the final drainage directions.

Glacial till, varying in thickness from zero at the MWDF perimeter to greater than 10 feet in the interior of the MWDF, will be used to grade the tailing ponds surfaces to a minimum slope of 2 percent. Following in order, an 8-inch thick bentonite modified soil layer, a 40-mil polyethylene membrane, an overdrain and a geotextile filter fabric will be placed. The final layer will consist of 5 feet of glacial till spread over the overdrain and geotextile (Figure 4.14). The upper 9-12 inches of the final layer will consist of salvaged topsoil stockpiled from earlier construction.

Only the 5-foot vegetative cover, consisting of till and topsoil, will be of importance in establishing vegetation. The glacial till will typically be minus 6-inch material placed in 12 to 18-inch lifts by scraper and bladed with a tractor. The topsoil will be placed similarly but in 4 to 6-inch lifts. The fill will be compacted only by

construction equipment traffic. An estimated range of factors for the reclamation cap vegetative cover soils is as follows:

1) Dry density - 115-125 pounds per cubic foot;

2) Coarse fragments (greater than 3 inches) - less than 10 percent;

3) Average annual infiltration - 4.7 inches;

4) Permeability - 10^{-3} to 10^{-4} cm/sec; and

5) Field capacity - % Saturation - 50 to 80 percent.

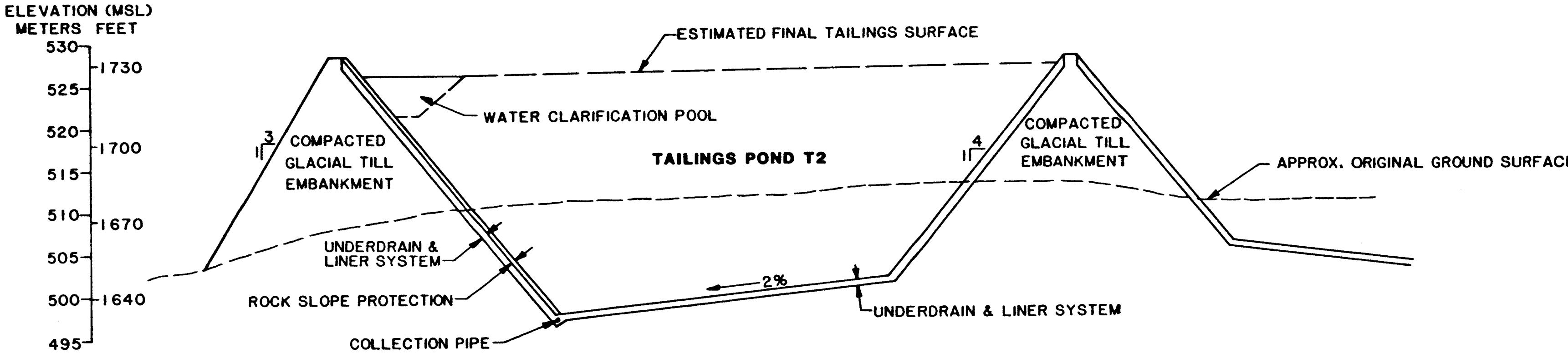
An example of the relationship between original ground surface, tailing pond construction, estimated final tailings surface, and final reclaimed surface is presented on Figure 4.17.

4.3.3.3 Surface Subsidence

Surface subsidence of the tailings cover system is not expected to occur. Additional discussion of subsidence is presented in the MWDF Feasibility Report. The identification and correction of any such subsidence, although unlikely, would occur under the requirements of NR 182.12. Revegetation procedures in such circumstances would follow those described in Section 4.4.

4.3.3.4 Removal of Reclaim Pond

On completion of milling, the water in the reclaim pond will be treated for discharge and the pond basin reclaimed. The reclaim pond liner, rock slope protection materials and water treatment sludge

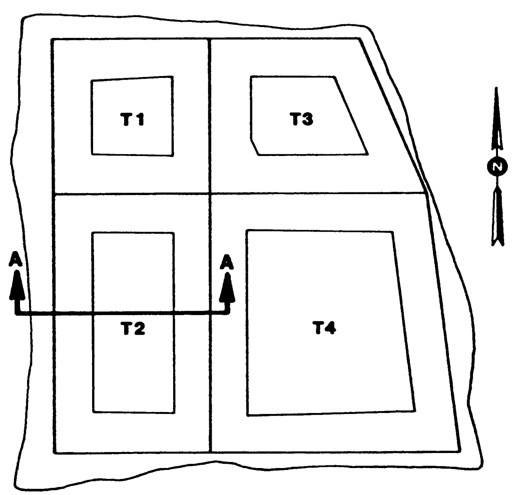


SECTION A-A

0 50 100 150
SCALE IN METERS

0 250 500
SCALE IN FEET

VERTICAL SCALE EXAGGERATED 5x



PLAN VIEW

(NOT TO SCALE)

Typical Representations: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
WASTE DISPOSAL FACILITY
PLAN & SECTION

SCALE: SHOWN	STATE: WISCONSIN	COUNTY: FOREST
DRAWN BY: DR SPRINGBORN	DATE: 10/85	CHECKED BY / DATE
APPROVED BY / DATE	APPROVED BY	DATE: 11/13/85
APPROVED BY / DATE	EXXON	DATE
DRAWING NO: **FIGURE 4.17**	SHEET ___ OF ___	REVISION NO

contained therein will be placed in tailing pond T4 before it is reclaimed. The reclaim pond area will be regraded with the glacial till soils that formed the reclaim pond embankments. The final reclaimed surface of the reclaim pond is depicted on Figure 4.16.

4.3.3.5 Reclamation of Construction Support Area

After installation of the final reclamation seal for the MWDF and the MRDF, the construction support area will be reclaimed. After removal of the equipment and any remaining stockpile materials, only minimal grading will be necessary to maintain drainage to the southeast. Stone or gravel used for any high traffic areas in the construction support area will be removed or covered and a 9 to 12-inch layer of salvaged topsoil will be placed prior to revegetating the area.

4.3.3.6 Development and Reclamation of Borrow Area

The borrow area planned on the north side of the MWDF area will be utilized in the final reclamation phase for the MWDF (tailing pond T4). As in other areas proposed for Project facilities, topsoil will be stripped and salvaged for reclamation of the borrow area. Runoff and drainage will be maintained within the excavated area and during final grading the area will be contoured to blend with the adjacent undisturbed land surface. During final reclamation, salvaged topsoil will be replaced and vegetation reestablished.

4.4 Reclamation of Mine Waste Disposal Facility, Reclaim Pond, and Mine Refuse Disposal Facility - Vegetation Aspects

4.4.1 Introduction

The land area disturbed by tailings disposal and containment and the adjacent facilities will be reclaimed to a natural landscape in terms of vegetation and wildlife populations. The physical design of the tailings disposal area is such that at abandonment final topography and surface drainage will be imitative of the area landscape. Superimposed upon that will be a vegetative cover consisting of local vegetation types. The vegetative cover, during operations and following abandonment, will provide suitable habitat for wildlife.

The revegetation program for the tailings disposal area will consist of the following vegetative types:

1) Temporary groundcover consisting of indigenous and introduced herbaceous plant species to provide control of wind and water erosion. Areas of temporary groundcover will be disturbed during final reclamation and revegetated with permanent cover.

2) Permanent groundcover consisting of indigenous and introduced herbaceous plant species to provide erosion control, wildlife habitat and aesthetic aspects for the duration of the Project.

3) Permanent herbaceous groundcover of indigenous and introduced plant species with tree and shrub plantings. The vegetative cover will provide long-term erosion control, wildlife habitat, visual diversity and enhancement, and continuity with undisturbed areas.

Table 3.2 contains a summary of the expected functional characteristics of vegetation in the reclaimed MWDF, MRDF and reclaim pond areas 15 years after final closure.

4.4.2 Revegetation of the Mine Waste Disposal Facility

Establishment of vegetation on the MWDF, MRDF and reclaim pond (Management Unit 6) will be completed in phases as indicated on Figure 4.15. Information on species composition, planting methods, materials, maintenance practices, and implementation schedule for this management unit is summarized in Table 3.1. In the subsections that follow, the reclamation concepts and processes to be used from initial land disturbance through closure and annual evaluation are described.

4.4.2.1 Seedbed Preparation

After final grading of each tailing pond, a seedbed will be provided for the establishment of herbaceous groundcover and tree and shrub species. Procedures similar to those described in subsection 3.2.1.4.1 will be followed in preparing the seedbed. A mechanical method of tilling or scarifying the soil surface will be used, if necesary, after application of 9 to 12 inches of topsoil. If required, equipment such as a chisel or ripper will be used to relieve compaction of the final graded surface or the surface of the topsoil.

Scarification may be required to prepare a satisfactory seedbed on slopes. A tracked vehicle, such as a bulldozer, may be used for "tracking-in" numerous small depressions that will collect water and favor seed germination and seedling establishment.

4.4.2.2 Plant Materials

Plant materials to be used in reclaiming the MWDF area will be the same as those described in subsection 3.2.1.4.2.

High quality seed that has been properly tested and tagged will be used to establish herbaceous cover. Depending upon availability, seed with known purity and germination percentages will be used. Pure live seed (PLS) expresses seed quality and is the percent of pure, viable seed in a particular lot of seed. Seed based on PLS will be used. Seed of agronomic species will be certified.

Specific seed mixtures, adapted to detailed site conditions, will be selected from the species listed in Tables 2.4 and 3.1. Final seed mixtures will be selected in consultation with the DNR at the time of annual permit reviews. The seed mixtures will contain a variety of species adaptable to the microclimatic conditions present at the site being revegetated. This approach of selecting specific seed mixtures for different climatic conditions will accelerate the successional process and result in more rapid development of a stable community.

Nursery grown tree and shrub stock will be used to establish forested cover over portions of the tailing ponds. Commercially grown plants will be obtained from local and regional nurseries.

4.4.2.3 Seeding and Plant Installation

Seeding methods for use in establishing indigenous and introduced herbaceous plant species will include broadcast and soil contact seeding and hydroseeding (Table 3.1). In selecting the method to be used in each area, the following factors will be taken into consideration: slope conditions, amount of area to be seeded, and the type of seed to be installed. The seeding rate will be based on the size of the seeds being seeded, type of equipment being used to

distribute the seed, and the aspect of the site being seeded. Seeding of the reclaimed areas will be completed in phases as shown on Figure 4.15 and as summarized in Table 3.1.

Trees and shrubs will be planted by hand or with the use of tree planting machines. Trees will generally be planted on 7-foot centers; however, the exact spacing for the areas to be planted with trees will be determined in conjunction with the DNR at the time of annual permit reviews. If proven effective, some tree species will be directly seeded on the reclamation cap. Trees will be planted in accordance with the schedule presented in Figure 4.15 and in Table 3.1.

Selection of vegetation for use in erosion control during each construction phase (Table 4.2) will be dependent upon the month in which construction is completed. Where construction is completed in May or June, a seed mixture of indigenous and introduced species will be seeded. Construction surfaces completed between August and September cannot be seeded with this type of seed mixture until the following spring, as there will not be sufficient time for the vegetation to reach a growth stage at which it would be winterhardy. Where that is the case, temporary vegetation (primarily annual species), e.g., oats or rye, will be seeded to provide an interim erosion control measure. This type of cover will be used where immediate erosion control or temporary (less than two growing seasons) soil stabilization is the objective. In the following spring, a mixture of perennial species will be established. Depending upon the potential for erosion, temporary annuals would be supplemented by the use of soil surface stabilizers. Either the temporary annuals or the soil stabilizers, or dual

combinations thereof, may also be used where erosion control is required for only 1 to 3 month periods during the May-September portion of the construction season on temporary construction surfaces or earth stockpiles. Erosion control and maintenance of soil quality on the long-term till stockpile will be achieved by seeding with a mixture of indigenous and introduced plant species.

Herbaceous and woody indigenous plant species will be used to establish permanent vegetative cover on the MWDF. The seed mixtures for use in establishing herbaceous cover will also include introduced species because of their importance in achieving a quick, temporary cover to stabilize the soil and control erosion. The seed mixtures will contain a variety of adaptable species, including warm and cool season species, to increase diversity and seasonal adaptability. The introduced species in the seed mixtures will primarily be annuals with a lesser percentage of perennial species. In areas of the MWDF having greater potential for soil erosion, introduced species will represent a large percentage of the seed mix. However, on the reclamation cap where slopes are generally less than 2 percent, indigenous species will constitute a greater proportion of the seed mixture. Specific seed mixtures will be recommended at the time of the annual permit revisions. All seed mixtures will be selected in conjunction with the DNR.

On tailing pond T1, approximately 50 percent of the reclaimed area will be planted with indigenous conifer and hardwood tree species. Whips or seedlings approximately 3 years old will be planted in a strip or block pattern on the cap and embankments. Establishment of forest vegetation on tailing pond T1 will allow monitoring of long-term

reclamation cap integrity under conditions of interim and mature tree development during Project operation and the closure and long-term care period.

Tree plantings will also be established on tailing ponds T2, T3, and T4 following final grading on the reclamation cap. Tree coverage may be less extensive than on tailing pond T1. Plantings will be located to promote community diversity, to enhance aesthetic quality and to accelerate the successional process (see Table 3.2). The trees will be planted in irregular clumps or strips in patterns that, with development and maturity, will promote blending with adjacent undisturbed areas and the rehabilitated forest vegetation on tailing pond T1.

Conceptual illustrations in plan and cross-section views of the distribution and growth forms of reestablished vegetation on the MWDF in relation to adjacent undisturbed vegetation are presented in Figures 4.18 and 4.19, respectively. The distribution and scale dimensions of the vegetation on the figures depict plant development approximately 5 years after final reclamation of tailing pond T4. A large scale cross-section of the MWDF depicting the embankment of tailing pond T1 is also depicted on Figure 4.19. The scale dimensions of the vegetation represent development 5 years after final reclamation of tailing pond T4.

EXISTING UPLAND FOREST

Clearing Limits

Special Erosion Control Area

Perimeter Access Road

EXISTING UPLAND FOREST

EXISTING DECIDUOUS SWAMP

RECLAIM POND AREA

Clearing Limits

EXISTING UPLAND FOREST

EXISTING UPLAND FOREST

Special Erosion Control Area

EXISTING DECIDUOUS SWAMP

BORROW AREA

Special Erosion Control Area

EXISTING CONIFEROUS SWAMP

MINE REFUSE DISPOSAL FACILITY

CONSTRUCTION SUPPORT AREA

EXISTING UPLAND FOREST

Clearing Limits

Clearing Limits

EXISTING UPLAND FOREST

Special Erosion Control Area

Perimeter Access Road

T1

T2

T3

T4

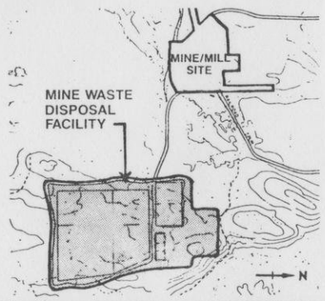
N

0 200 400 600 800

SCALE IN FEET

NOTES:

1. See Table 3.1 for listing of plant species to be used in reclamation.



SCHREIBER / ANDERSON ASSOCIATES

Landscape Architecture
Urban Design

923 Williamson Street
Madison, Wisconsin 53703
Phone 608 255 0800

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY

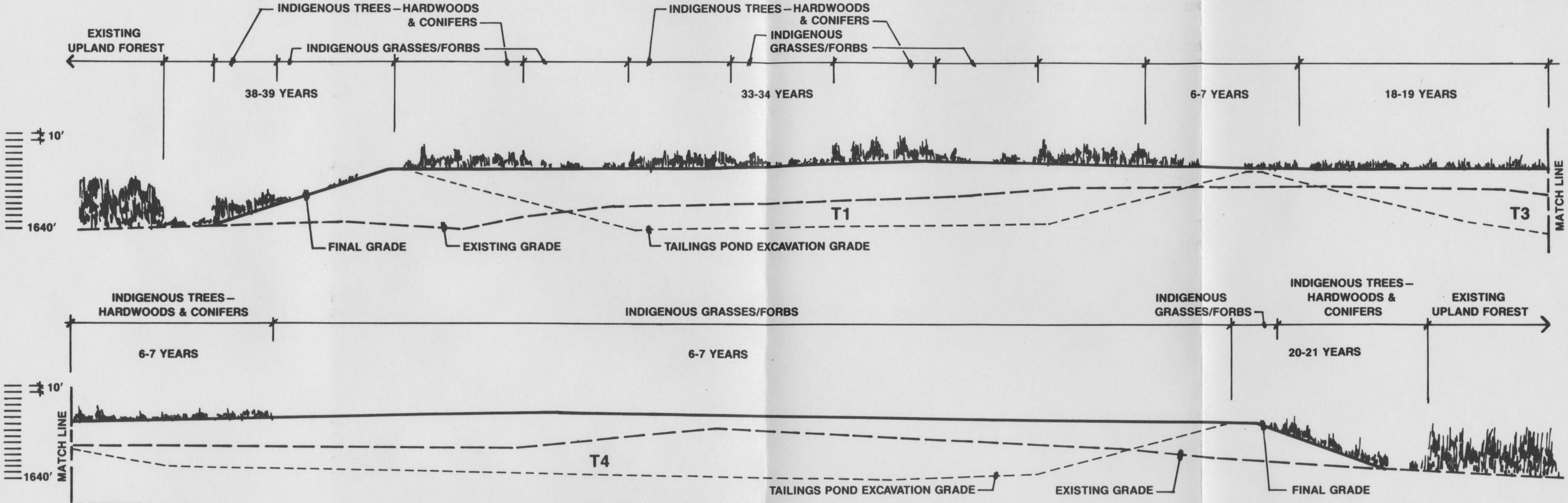
CRANDON PROJECT

TITLE: CONCEPTUAL LANDSCAPE PLAN,

MINE WASTE DISPOSAL FACILITY, YEAR 5 OF LONG-TERM CARE PERIOD

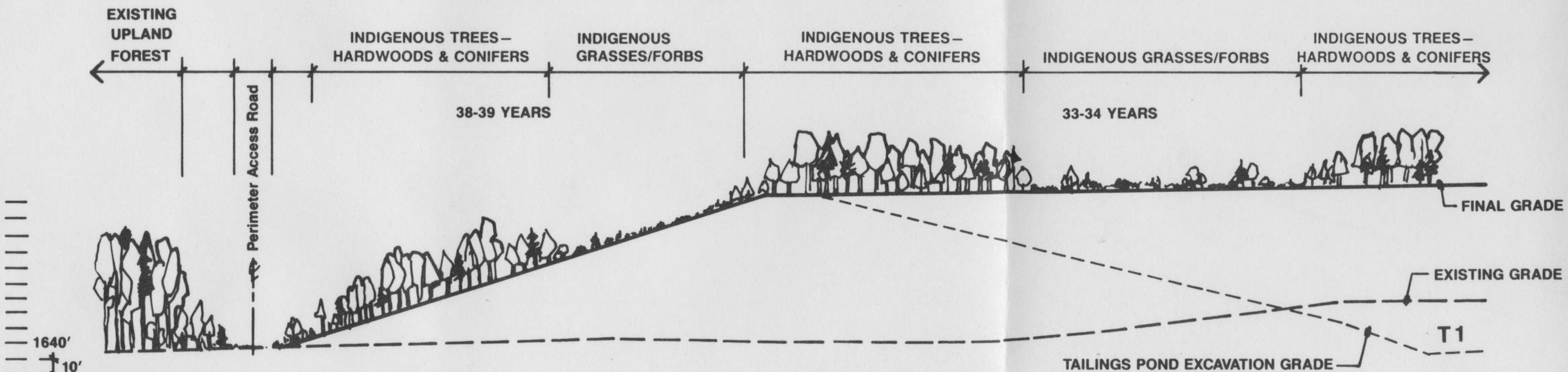
SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST
DRAWN BY:	DATE:	CHECKED BY: H S Swan 1/86
APPROVED BY:	DATE:	APPROVED BY: Lt. Schneider 1-17-86
APPROVED BY:	DATE:	EXXON: DATE
DRAWING NO:		SHEET ___ OF ___ REVISION:

FIGURE 4.18



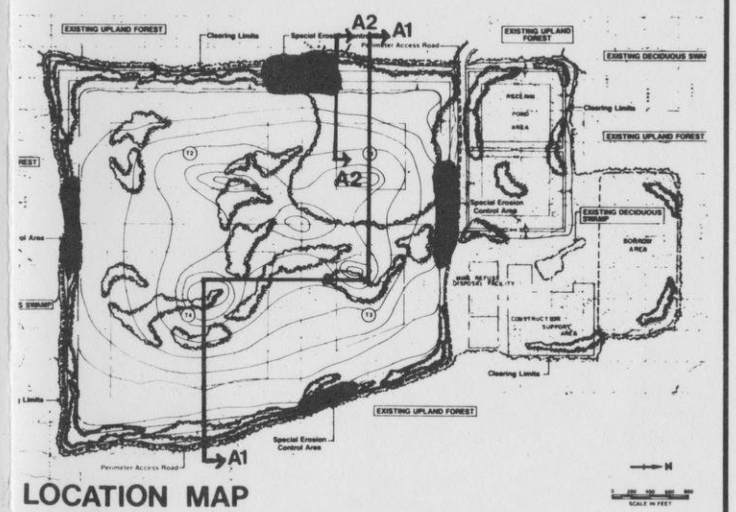
SECTION A1-A1

PROJECT YEAR 5 OF THE LONG-TERM CARE PERIOD



SECTION A2-A2

PROJECT YEAR 5 OF THE LONG-TERM CARE PERIOD



LOCATION MAP

NOTES:

1. Years indicate length of time site has been reclaimed.

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EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE **CONCEPTUAL LANDSCAPE SECTIONS, MINE WASTE DISPOSAL FACILITY, YEAR 5 OF LONG-TERM CARE PERIOD**

SCALE AS SHOWN | STATE WISCONSIN | COUNTY FOREST
DATE 1-86

FIGURE 4.19

4.4.2.4 Mulching

Organic mulches will be applied, as needed, on the reclaimed tailing ponds, MRDF cells, and reclaim pond after reseeding. Typical mulches that will be used are described in subsection 3.2.1.4.4.

4.4.2.5 Erosion and Vegetation Maintenance Practices

During operation and following final closure of the MWDF, standard erosion control and vegetation maintenance procedures will be used. These procedures will include regrading and reseeding as required. To minimize the potential for fires, a cleared zone will be maintained around the perimeter fence by mowing. Proposed maintenance practices in the MWDF area over the life of the Project are summarized in Table 3.1.

Further information on the vegetation inspection, monitoring and long-term maintenance programs are presented in Section 5.0.

4.4.2.6 Soil Characteristics and Vegetation Development

Following the establishment of herbaceous and woody cover on the reclamation cap, additional indigenous vegetation will be established through the process of plant colonization and succession. Plant species from nearby communities will provide the seed source for further colonization of the site by native species. The depth of overburden layers supporting forested communities (subsection 4.4.2.6.1) and rooting characteristics of the tree species likely to be planted or invade the reclamation cap (subsection 4.4.2.6.2) were analyzed in developing the plan for vegetating the MWDF area.

4.4.2.6.1 Depth of Overburden Layer

Studies on rooting depth of agricultural and forest species indicate that an overburden depth of approximately 36 inches would be sufficient to maintain a herbaceous plant cover followed by a forest system above the tailings disposal area. The effectiveness of 36 inches of overburden as an adequate rooting depth, particularly for forest species, can be substantiated as discussed below.

Shallow soils (Lithosols) are a recognized soil grouping in North America (USDA, 1938). This group includes immature soils thinly developed over rock formations under conditions of ample to excessive moisture. The soils have a wide range in geographic and topographic distribution and much of the areas are covered with timber. For example, the Muskingum-Lehew soils area of part of the Appalachian Mountains supports a native vegetation consisting chiefly of hardwood forest with a scattering of pines and hemlock; dominant hardwoods are chestnut, white oak, red oak, maple, and chestnut. In general, overall soil depth over bedrock rarely exceeds 40 inches and lesser depths are generally common. Another group of soils, exhibiting shallow profiles, are those described as Undifferentiated Rough Stony Loam and Shallow Podzols (Forested). These occur in the mountainous sections of Maine, New Hampshire, Vermont, New York, northern Michigan, and northern Minnesota. These soils primarily support coniferous forests. The occurrence of these native forest communities on shallow soils provides further supporting evidence that soil depths greater than 36 to 48 inches are not necessary for forest establishment. Greater soils depths are required for the production of commercial timber; however, a forest

cover with accompanying effects of evapotranspiration can be maintained in soils 36 to 48 inches thick.

Except in very shallow soils, depth has little direct influence on tree growth. However, depth has considerable indirect effect because it influences available water storage capacity, nutrient availability, and aeration (Pritchett, 1979). The absolute and effective depths of a soil are not necessarily the same, because a high water table, toxic substances, or an impervious layer may completely restrict root penetration in a soil that would otherwise permit deep rooting. Some difficulty in using soil depth to estimate productivity may also be encountered where drought, erosion, or poor drainage are products of surface soil thickness or depth of soil above some restricting layer. In each of these instances, there may be soil fertility interactions important to tree growth that cannot be determined from depth measurements alone. Optimum soil depths reported by Pritchett (1979) range from 20 to 40 inches, depending upon species and region.

As described in subsection 4.3.3.2, the proposed overburden depth on the reclamation cap is 60 inches. This soil depth will support forest communities typical of those found in the site area. Existing soil depths in the Project area range from less than 25 feet to more than 300 feet; however, as indicated in subsection 4.4.2.6.2, approximately 99 percent of the root systems for the tree species in the site area occurs within 36 inches of the ground surface.

4.4.2.6.2 Rooting Characteristics of Some Forest Species

The mean rooting depth, maximum rooting depth, and the expected distribution of roots by depth of tree species in the site area are summarized in Table 4.3. These data indicate that at least 99 percent of the roots of these species are located within 36 inches of the ground surface. On rare occasions, the roots may penetrate to 118 inches.

Tree rooting depths are extremely dependent on the physical properties of the rooting medium. Lack of oxygen and soil density are the two main parameters limiting rooting depths (Grigal, 1984). Roots will not penetrate into saturated zones due to the lack of oxygen. The cover system will have such a saturated zone immediately above the processed drain layer. This zone will be saturated to a depth of approximately 6 inches due to the differential capillary potentials between the upper till material and the underlying coarse grained processed drain material (Baver et al., 1972). The bulk density which would limit root growth in a till material is approximately 109 to 112 pounds per cubic foot (Grigal, 1984; Sutton, personal communication, 1984); however, existing bulk densities of till soils in the site area exceed these levels and the soils are supporting forested plant communities with no apparent effect on growth. This compares to anticipated MWDF till and bentonite modified soil bulk densities of 125 to 130 pounds per cubic foot (STS Consultants Ltd., 1984). Based on the existence of a high bulk density seal, saturated soil layer, and low percentage of roots below a 36-inch depth, the potential for root penetration into the bentonite modified soil layer is minimal.

TABLE 4.3

ROOTING DEPTH FOR TREE SPECIES OCCURRING IN THE SITE AREA

Forest Species	Mean Depth (Inches)	Maximum Depth (Inches)
Sugar Maple	8	73
American Basswood	--	83
Aspen	--	114
Red Maple	7	47
Elm	24	104
White Birch	12	55
Ash	3	18
White Pine	--	81
Red Pine	--	118
Red Oak	11	25
Eastern Hemlock	--	--
Balsam Fir	6	--

Depth (Inches)	Cumulative Pecent				
	Maple-Oak[a]	Aspen[b]	Beech-Birch-Maple[c]	Mixed Oak[d]	White Pine[e]
0	0	0	0	0	0
2	33	25	41	73	34
4	43	47	51	79	44
8	57	87	65	86	57
12	67	100	74	90	66
16	75		82	93	74
20	82		89	96	80
24	88		94	98	86
28	94		99	100	91
31	99				95
35					99
39					

[a]Sandberg, 1951.
[b]Safford, 1974.
[c]Coile, 1937.
[d]Lutz et al., 1937.
[e]Scully, 1942.

Soil structure influences root growth. Roots penetrate more easily and more rapidly into soil that is composed of stable aggregates of about 0.08 to 0.23 inches diameter than in the same soil that is finely powdered. The increased ease of root penetration is usually accompanied by more rapid vegetative growth of the entire plant which results in higher yields.

4.4.2.6.3 Other Reclamation Cap Soil Characteristics and Implications on Vegetation Growth

Other factors that could affect vegetation growth on the reclamation cap include available water, nutrients, aeration, pH, drainage, restrictive layers and toxic materials. Each of these factors is discussed below:

Available Water - A water balance analysis of the reclamation cap indicates that sufficient moisture will be retained in the 5 feet of till cover to support plant growth and development (Ayres Associates, 1985). The proposed reclamation cap design will provide adequate soil moisture storage capacity in the till cover and suitable conditions for root development under average and dry climatic conditions.

Nutrients - Representative soil samples will be taken on each planting site and analyzed to evaluate the supply of available nutrients. If the soils are lacking in essential nutrients required to support vigorous plant growth, fertilizer will be applied to correct the nutrient deficiencies. At the time of tree planting, fertility levels will be established to ensure soil conditions are suitable for satisfactory growth of the species being planted. Existing nutrient

levels in site area soils are currently supporting vigorous plant growth in the communities represented.

A mixture of salvaged topsoil and wetland organic soil will be applied to a depth of 9 to 12 inches as a top dressing during the final grading of the reclamation cap. The organic matter in the material will provide a source of nutrients in the upper soil layer.

Aeration - The 5 feet of till top cover on the reclamation cap will consist of well mixed soils salvaged from the till stockpile or transported from the borrow area. These soils will not be compressed during application and final grading and, therefore, the soil pore space occupied by air and water should be sufficient to support the root systems for forest growth. Air and water permeability of the soil on the cap should be sufficient to meet plant growth requirements.

pH - The pH of soils in the site area ranges from 3.6 to 8.4 (USDA-SCS Soil Survey Interpretation Sheets) which is not considered a limitation to the growth of indigenous tree species. The silvicultural importance of the pH value lies in its ability to indicate unsatisfactory soil or site conditions rather than limitations related to the concentration or activity of H and OH ions (Wilde, 1958). In a favorable forest soils growth environment, as will be provided on the reclamation cap, the range of suitable pH values could be considerably extended beyond optimum reaction, especially in the direction of soil acidity (Wilde, 1958).

Drainage - Soils that will be applied on the reclamation cap will be well mixed and will contain no impervious layers to impede soil drainage. The 8-inch processed drain layer on the cap will prevent

saturation in the upper till cover layer during average and wet years (Ayres Associates, 1985).

Restrictive Layers - Because well mixed till soils will be used to form the 5-foot top cover, no restrictive layers to movement of soil moisture or growth of plant roots are expected to develop. In the final grading and contouring of the soil cover, procedures will be employed to ensure the area is uniformly graded to prevent soil compaction and formation of restrictive layers to water infiltration.

Toxic Agents - Soil toxicity rarely occurs under natural forest conditions (Wilde, 1958). Because well mixed native till soils will be used on the reclamation cap, there is no reason to expect the presence of ions or compounds in toxic concentrations. No toxic levels of soil elements have been measured to date in till samples analyzed from the site area. Oil and grease entering the soil from construction equipment could cause very localized deterioration of tree stock, but any such occurrence would likely be confined to a small random portion of the cap.

4.4.2.7 Vegetation Development and Succession

Following final grading of the area underlain by the reclamation cap of each tailing pond, a groundcover of indigenous and introduced plant species will be established to stabilize the soil surface and to minimize erosion (see subsection 4.4.2.3). The plant species to be seeded on the reclamation cap will be selected from those listed in Tables 2.4 and 3.1. A seed mixture will be selected that will

ensure development of a variety of plant species. Indigenous tree species will also be planted in the reclamation cap.

Invasion of herbaceous and woody plant species from adjacent communities will be allowed to occur on the revegetated cap. The actual species that initially invade the area and the subsequent forest development will be dependent on the species' ability to become established under the present environmental conditions. Two important parameters for this establishment are the existing vegetation and climatic conditions at the site. Studies of old field succession have shown that vigorous herbaceous cover limits the ability of woody species to become readily established (Grigal, 1984). The ability of species to invade open areas depends upon the climatic conditions that are favorable to them.

A study by the DNR on artificially created forest openings in the North Central District (McCaffery et al., 1981) provides an indication of the species composition of herbaceous and woody plants that could become established on the reclaimed MWDF through natural invasion. The primary study areas included the Enterprise area in Oneida County and the Arbor Vitae and Vandercook areas in Vilas County. Based on the forest types and soils present, the Enterprise study area was judged to be most similar to the Project site area. The herbaceous species reported in the clearings 3 years after construction and seeding with clover, bluegrass and oats are presented in Table 4.4. Woody plants were a major component of the vegetation in the openings in the Enterprise area and were quantitatively sampled after four and six growing seasons (Tables 4.5 and 4.6). Because of differences in size of

TABLE 4.4

COMPOSITION OF GROUND LAYER PLANT SPECIES IN OPENINGS
3 YEARS AFTER CONSTRUCTION,
ENTERPRISE TOWNSHIP, ONEIDA COUNTY, WISCONSIN*

Scientific Name	Common Name
Poa pratensis	Kentucky blue grass
Aster ciliolatus	Aster
Carex pensylvanica	Sedge
Rubus idaeus	European raspberry
Pteridium aquilimum	Bracken fern
Trifolium repens	White clover
Rubus allegheniensis	Common blackberry
Hieracium aurantiacum	King-devil
Agropyron repens	Quack grass
Carex spp.	Sedges
Muhlenbergia spp.	Satin or Muhly grasses
Aster macrophyllus	Large-leaved aster
Solidago spp.	Goldenrods
Trifolium hibridum	Alsike clover
Agrostis perennans	Upland bent grass
Bromus spp.	Brome grass
Fragaria virginiana	Strawberry
Lactuca spp.	Lettuces
Hieacium florentinum	Yellow devil's paintbrush
Cirsium spp.	Thistles
Chrysanthemum leucanthemum	Ox-eye daisy
Populus tremuloides	Quaking aspen
Oryzopis asperifolia	Rice grass
Schizachne purpurascens	False medic grass
Achillea millefolium	Yarrow
Potentilla spp.	Cinquefoils

*Source: McCaffery et al. (1981).

TABLE 4.5

COMPOSITION OF WOODY PLANT SPECIES IN OPENINGS
3 YEARS AFTER CONSTRUCTION,
ENTERPRISE TOWNSHIP, ONEIDA COUNTY, WISCONSIN*

Scientific Name	Common Name
Tall Shrubs (>24 inches tall)	
Rubus allegheniensis	Common blackberry
Rubus idaeus	European raspberry
Prunus virginiana	Choke cherry
Salix app.	Willows
Corylus cornuta	Beaked hazel
Spiraea alba	Meadow-sweet
Amelanchier spp.	Service berries
Rhus typhina	Staghorn sumac
Tree Seedlings (<24 inches tall)	
Populus tremuloides	Quaking aspen
Acer rubrum	Red maple
Betula papyrifera	Paper birch
Prunus serotina	Black cherry
Populus grandidentata	Large-toothed aspen
Established Tree Seedlings (>24 inches tall)	
Populus tremuloides	Quaking aspen
Prunus serotina	Black cherry
Quercus rubra	Red oak
Populus grandidentata	Large-toothed aspen
Acer rubrum	Red maple
Betula papyrifera	Paper birch

*Source: McCaffery et al. (1981).

TABLE 4.6

COMPOSITION OF WOODY PLANT SPECIES IN OPENINGS
6 YEARS AFTER CONSTRUCTION,
ENTERPRISE TOWNSHIP, ONEIDA COUNTY, WISCONSIN*

Scientific Name	Common Name
Shrubs	
Rubus idaeus	European raspberry
Rubus allegheniensis	Common blackberry
Prunus virginiana	Choke cherry
Salix app.	Willows
Corylus cornuta	Beaked hazel
Viburnum sp.	Viburnums
Rosa sp.	Roses
Tree Seedlings	
Prunus serotina	Black cherry
Populus tremuloides	Quaking aspen
Betula papyrifera	Paper birch
Larix laricina	Tamarack
Ostrya virginiana	Ironwood

*Source: McCaffery et al. (1981).

openings, seedbed preparation, and the composition of species initially established (when comparing the constructed openings in the Enterprise area studied by the DNR versus the MWDF area), species composition and initial succession of the reclaimed MWDF area by herbaceous and woody plants may differ somewhat from that reported by McCaffery et al. (1981). However, the composition of ground layer and woody plants reported in the DNR study (Tables 4.4 through 4.6) provides a good indication of the species that are expected to invade the MWDF.

Adaptation numbers have been developed that indicate species' ability to become established under open sunlight conditions (low adaptation numbers) and in shaded areas (high adaptation numbers) (Curtis, 1959). The following data summarize the average percentage of relative dominance for various species based on an inventory of three stands of northern hardwoods (EIR, Section 2.6) and species adaptation numbers:

Forest Species	Average Relative Dominance %	Adaptation Numbers
Sugar Maple	37.5	10
American Basswood	19.5	8
Aspen	8.5	2
Red Maple	8.0	6
Elm	5.5	8
White Birch	5.0	5
Ash	4.5	8
White Pine	3.5	5
Red Pine	3.0	3
Red Oak	2.0	6
Eastern Hemlock	2.0	8
Balsam Fir	1.0	7

These data suggest that the initial invasion would consist of aspen, red pine, and birch species and in those areas where only herbaceous vegetation is initially established would eventually evolve into a forest condition similar to the average percentages shown above, with sugar maple as the probable dominant species. Over the long-term period, the dominant species will vary, indicating that at some point in time each of the species listed above could inhabit the reclaimed area.

The initial reclamation will involve the cultivation of a vigorous herbaceous cover and establishment of tree seedings and shrubs. This cover will increase the time frame prior to invasion by native tree species. The herbaceous cover will inhibit certain species, such as red pine, from becoming established due to the physical and biological nature of their propagules.

4.4.3 Revegetation of Reclaim Pond

Following the removal of the reclaim pond (subsection 4.3.3.4), the regraded site area will be seeded with a mixture of indigenous and introduced herbaceous plant species. Procedures for seedbed preparation, selection of plant material, seeding, and mulching will be the same as those described in subsection 3.2.1.4. Scattered clumps and strips of indigenous trees and shrubs will be planted over a portion of the regraded reclaim pond area (Figure 4.18). Planting methods, species to be established, and age of the plant stock will be the same as that described in subsection 4.4.2.3 for the MWDF. Natural invasion and colonization of the seeded area by local shrubs and tree species will be allowed. Final reclamation of the reclaim pond will occur in Year 33.

Annual inspections of the reclaim pond will be performed and grading and/or reseeding will be completed as required.

4.4.4 Revegetation of Mine Refuse Disposal Facility

The MRDF will be revegetated as each cell is filled, regraded and capped. The same procedures described in subsection 3.2.1.4 will be followed in preparing the seedbed, selecting the plant material, applying the seed, and mulching. Herbaceous cover, consisting of indigenous and introduced species, will be established. Final reclamation of cells 1, 2 and 3 will occur in Years 11, 22 and 36, respectively.

Annual inspections of each reclaimed cell will be performed and regrading and/or reseeding will be completed as required. Further information on the vegetation inspection, monitoring and long-term maintenance programs are presented in Section 5.0.

4.4.5 Revegetation of Construction Support Area

After grading and topsoil placement in the construction support area, the disturbed area will be seeded with a mixture of indigenous and introduced herbaceous plant species. The procedures described in subsection 3.2.1.4 for seedbed preparation, selection of plant material, seeding, and mulching will be followed. Trees and shrubs will be planted in irregular clumps and strips over a portion of the reclaimed construction support area (Figure 4.18). Planting methods, species to be established, and age of the plant stock will be the same as that described in subsection 4.4.2.3 for the MWDF. Final reclamation of the construction support area will occur in Year 35.

The reclaimed construction support area will be inspected annually and regrading and/or reseeding will be completed as required.

4.4.6 Revegetation of Borrow Area

The borrow area will be seeded with a mixture of indigenous and introduced herbaceous plant species after the required soil volume has been removed. Procedures for seedbed preparation, selection of plant material, seeding, and mulching will be the same as those described in subsection 3.2.1.4. A portion of the reclaimed borrow area will be planted in clumps and strips of trees and shrubs (Figure 4.18). Planting methods, species to be established, and age of the plant stock to be used are described in subsection 4.4.2.3. Final reclamation of the borrow area will occur in Year 36.

The reclaimed borrow area will be inspected annually and regrading and/or reseeding will be completed as required.

4.4.7 Revegetation of Access Inspection Road

The access inspection road constructed in the 50-foot wide corridor at the foot of the tailing ponds embankments (subsection 4.2.3.1) will remain in place and be sufficiently maintained until completion of the closure period. At that time, maintenance will be discontinued and the roads will be left in a condition similar to existing logging roads on the property. The non-road portion of the corridor will not be maintained and will be allowed to revert to a natural vegetative cover through shrub and tree invasion from adjacent undisturbed plant communities.

5.0 MONITORING AND LONG-TERM MAINTENANCE PLAN

The proposed monitoring program developed for the Project is consistent with the requirements of NR 132 and NR 182. The program contains the following elements:

1) Liner performance monitoring for facilities with seepage control systems;

2) Reclamation top seal performance monitoring through the use of moisture sensing instrumentation;

3) Ground water monitoring;

4) Surface water monitoring; and

5) Tailings dusting monitoring.

The details of this program are presented in the Monitoring and Quality Assurance Plan. Specific information pertaining to the inspection, monitoring and long-term maintenance of vegetation is presented in the following subsection.

5.1 Vegetation Inspection, Monitoring and Long-Term Maintenance

Monitoring and long-term maintenance of vegetation established at the mine/mill site, railroad spur, access road, and haul road/ tailings transport corridor will begin following completion of construction. Such monitoring and maintenance will continue throughout the operating life of the Project, but will be restricted largely to standard landscape vegetation and erosion control practices. Upon reclamation and closure, more intensive monitoring will occur and will be supplemented, where and if necessary, by maintenance practices. The details of this post-operation monitoring will be determined in conjunction with the DNR.

At the MWDF, monitoring and long-term maintenance will begin following completion of phase 1 construction at which time tailing pond T1 and the reclaim pond will have been built (Table 4.2). As each subsequent construction phase is completed, the monitoring and long-term maintenance program will be expanded to include new areas of construction. The program, designed in conjunction with the DNR, will be conducted in more detail and with greater depth of investigation than that for the mine/mill site and other facilities prior to cessation of mining. This is required by NR 182.12 (Inspection), NR 182.13 (Monitoring), and NR 182.14 (Record Keeping and Reporting).

In the mine/mill site area, a self-sustaining and maintenance free plant cover will have been established on regraded areas which will eventually be supplemented by encroachment of plant species from surrounding native communities. Maintenance practices will be limited to ensuring acceptable establishment of herbaceous cover and maintaining

the efficiency of site drainage systems until reclaimed surfaces have been stabilized.

Similar maintenance practices will be implemented following establishment of herbaceous and tree and shrub cover upon the reclaimed MWDF. Ecological succession will be allowed to occur in the MWDF area after establishment of the herbaceous cover. To ensure the most rapid and efficient forest cover development, standard maintenance practices for commercial forest establishment will be implemented.

Monitoring and inspection of vegetative growth will be undertaken to ensure establishment of stable plant communities in reclaimed areas. The vegetation monitoring also will allow identification of undesirable physical and/or chemical changes in the subterranean environment of reclaimed areas and ensure that the final land use objective (i.e., returning the reclaimed areas to forestry, recreation and agricultural uses) is being achieved (see Section 6.0).

A monitoring program will be developed that will allow determination of plant species composition and diversity, relative frequency of occurrence, relative dominance, relative density and vigor. Measurements to determine percent cover (proportion of an area covered by the vertical projection of plant crowns or basal area to the ground surface) also will be included in the monitoring program. Biomass sampling will be performed to allow comparisons against biomass values recorded for other plant communities.

Data for the vegetation monitoring program will be collected using plots, plotless techniques, or a combination of the two methods. The details of the plot sampling (i.e., shape, size, number and method

of distribution of the plots) will be determined jointly with the DNR. Monitoring will be conducted annually over a representative segment of the reclaimed area for the first 5 years following final reclamation. Upon completion of 5 years of monitoring, the results will be evaluated and will serve as the basis for determining the scope of any future monitoring.

As part of the monitoring program and reporting of results in the annual report, maps, diagrams, and/or photographs will be provided that illustrate spatial distribution of vegetation and the horizontal and vertical structure of the rehabilitated plant communities.

Photographic evaluations will be included as part of the monitoring program to depict the vegetative conditions. These photographs will be used to show the changes in vegetative composition which occur over time as a result of normal ecological succession. Photographs will be taken annually at marked points of reference to ensure a representative cross-section of the reclaimed area is included. These ground level photographs will be used in conjunction with the aerial photographs, as described in the following paragraph, to monitor the development of vegetation in the reclaimed areas.

The vegetation monitoring program will also include aerial photography required by NR 182.14(1)(d)1 prior to construction activities and continuing through operation and reclamation. This will be accomplished by color infrared (CIR) photography at periodic intervals. The CIR photography may be supplemented with other types of aerial photography if these other types provide essential monitoring information not available with CIR. The aerial photos will be taken

during the season when the plant communities being specifically monitored are in the growth phase most sensitive to assessment (e.g., Carrel et al., 1980).

If data from the air quality or MWDF inspection program indicate a need for either more frequent aerial photography or particular terrestrial ecosystem quantitative analyses, they will be designed, planned, and conducted at that time. Similarly, should the analysis and interpretation of the CIR aerial photography indicate the need for a more frequent or specific sampling study, it would be designed and evaluated.

Changes in vegetative growth patterns will not necessarily be an indicator that undesirable physical and/or chemical changes are occurring. For example, insect infestation, not apparent to casual observation, can result in symptoms of apparent nutrient deficiency in plants (Sprague, 1964). By initiating a vegetation monitoring program immediately after construction activities and continuing the program through the operational phase, it will be possible to develop data and experience which will allow accurate interpretation of changes in vegetation that may occur after final vegetation establishment.

6.0 FINAL USE

This section of the reclamation plan contains a description of the proposed final uses of the reclaimed mine development area in relation to surrounding land and land use. Specifically, the requirements of NR 132.08(1)(d) are addressed. A brief discussion of alternative uses is also included.

The proposed plan for revegetating the reclaimed area has been designed to conform with the requirements of NR 132.08(2)(g). The majority of the area to be affected during construction and operation is currently forested and the objective of the reclamation plan is to reestablish in the disturbed areas forest communities representative of those found in the site area. The principal existing uses of land in the proposed mine development area and the surrounding site area are forestry, recreation and agriculture (EIR, Section 2.9). No major changes in these land uses are projected to occur at the time of Project closure and final reclamation. The proposed final uses for reclaimed land associated with all major Project facilities are presented in Table 6.1 and are designated on Figure 6.1. General use of the reclaimed areas for the proposed final land uses will be at the discretion of the owner at the time of issuance by the DNR of a certificate of completion for the reclamation plan. The expected vegetation characteristics of the reclaimed Project areas 15 years after final closure are summarized in Table 3.2 for each of the proposed final uses.

Alternative final land uses that were considered for the Project area included an industrial complex using existing Project facilities in the mine/mill site and agricultural or intensive forestry (i.e., pine plantation) uses of the MWDF area. The alternative uses are

TABLE 6.1

PROPOSED FINAL LAND USES FOR RECLAIMED PROJECT LAND

Project Facility	Area Reclaimed Acres	Year Reclamation Complete From Start of Initial Construction	Proposed Final Use*
Access Road Corridor	35	36	Forestry/Recreation/Agricultural
Railroad Spur Corridor	45	35	Forestry/Recreation/Agricultural
Mine/Mill Site	115	36	Forestry/Recreation
Haul Road/Tailings Transport Corridor	10	36	Forestry/Recreation
MWDF/MRDF/Reclaim Pond	495	36	Forestry/Recreation
Water Discharge Pipeline Corridor	15	2	Forestry/Recreation

*The proposed final uses are the same as the existing uses in 1985. The proposed final uses will be established if no other acceptable use is identified for the facilities.

AGRICULTURE

FORESTRY/RECREATION

TOWN OF NASHVILLE
TOWN OF LINCOLN

ACCESS ROAD

RAILROAD SPUR

MINE/MILL SITE

CRANDON FORMATION

MYDE ROAD

FUTURE BORROW AREA

RECLAIM POND

CELL A

CELL B

CONSTRUCTION SUPPORT AREA

MINE REFUSE DISPOSAL FACILITY

MINE WASTE DISPOSAL FACILITY

RECREATION

WATER DISCHARGE PIPELINE

2.0 miles TO DISCHARGE POINT AT SWAMP CREEK

POTABLE WATER WELL

T 35 N
FOREST CO
LANGLADE CO
T 34 N

TOWN OF LINCOLN
TOWN OF NASHVILLE

INSERT

SWAMP CREEK

WATER DISCHARGE

PIPELINE

MATCHLINE

MOLE LAKE

32 33 34

SCALE IN METERS

SCALE IN FEET

SCALE IN METERS

Typical Representation: Refinements may be made during final design.

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
PROPOSED FINAL LAND USE OF RECLAIMED PROJECT LAND

SCALE SHOWN	STATE WISCONSIN		COUNTY FOREST
DRAWN BY DR SPRINGBORN	DATE 10/85	CHECKED BY	DATE 12/6/85
APPROVED BY	DATE	APPROVED BY	DATE 4-17-86
APPROVED BY	DATE	EXXON	DATE 12/4/86
DRAWING NO		SHEET 4 OF 35	REVISION NO 0

FIGURE 6.1

described in greater detail in Chapter 3 of the EIR. The industrial and agricultural uses are not considered feasible at this point in the development of the Project. If, because of changing conditions later in the life of the Project, an alternative use proves to be more beneficial in all or part of the area to be reclaimed than the proposed uses of forestry, recreation and agriculture, an amended reclamation plan containing a description of the new proposed use will be submitted to the DNR in accordance with NR 132.12(3)(a).

The long-term goal of the reclamation plan is to allow ecological succession to occur in all the reclaimed areas. However, to ensure the establishment of a variety of woody plant species in the mine/mill site and MWDF area, selected plantings of mixed hardwoods and coniferous species will be established at various locations in both of these management units. This will ensure the establishment of diverse plant communities which will enhance the recreational attributes of the reclaimed areas and will provide habitat for a variety of indigenous wildlife species. As plant succession progresses in the reclaimed areas, the wildlife species inhabiting these areas also will change. The plan will not include a specific management scheme that will require maintenance of a certain stage of plant development or succession for the benefit of one or two target game species. Rather, the plant communities will be allowed to develop to be compatible with adjacent undisturbed communities.

General use of the reclaimed areas for the access road, railroad spur, mine/mill site, haul road/tailings transport corridor and water discharge pipeline corridor will be dependent, in part, upon when

the regraded soil surface is stabilized and vegetative cover is established. A decision to allow use of these reclaimed lands by anyone other than authorized Project personnel or DNR representatives will be made after a certificate of completion regarding the reclaimed land is issued pursuant to NR 132.13(1).

In the MWDF area the fence will remain in place during the 30-year long-term care period and no recreation or forestry uses will be permitted within the confines of the fenced area. This will permit the long-term monitoring and maintenance activities associated with this facility to be performed without interference from unauthorized personnel, and will ensure stabilization of the soil surface of the reclamation cap and the establishment of vegetative cover. The access/inspection roads will not be reclaimed following Project closure. These roads will be maintained to allow access for inspecting the reclaimed facility and for monitoring during the period of long-term care. A decision to allow use of the reclaimed MWDF will be reached in conjunction with the DNR after issuance of the certificate(s) of completion for the reclamation plan and when use of the land will not affect monitoring and other long-term care requirements.

Forestry and recreational uses of reclaimed land associated with the access road and railroad spur and undisturbed land owned by EMC adjacent to these facilities will persist as the final use for the period that EMC maintains control of the property. Should EMC sell or lease to other individuals/companies any of the land now under control

for the Project, land use would be at the discretion of the new owner/leasee. As illustrated on Figure 6.1, final use of these reclaimed corridors will be primarily for forestry and recreational pursuits and to a lesser extent for agricultural purposes.

Forestry and recreation will be the principal final land uses in the reclaimed mine/mill site and haul road/tailings transport corridor to the MWDF. Management of these forested areas will be consistent with forestry practices used by the DNR on state and county owned land in north-central Wisconsin. A silvicultural system most appropriate for these reclaimed areas will be developed with the DNR or with a forestry consultant to ensure optimal benefits for both forestry and recreational uses.

A plan for management of the forested communities in the MWDF area will be developed with the DNR. Some restrictions may be imposed on harvesting of trees in the reclaimed MWDF area to ensure the integrity of the reclamation cap. For example, limitations could be placed on the areas where use of heavy equipment would be allowed (i.e., restricted to established roads that are used for inspections and monitoring) and the time of year when harvesting of trees would be allowed (i.e., winter season when soil conditions are frozen).

The proposed final uses for reclaimed Project land (Figure 6.1) will be continued for the duration of EMC ownership. If property ownership should change, land use for all reclaimed Project land except the MWDF would be at the discretion of the new owner. A suitable mechanism, such as a deed restriction, will be sought to ensure final land use of the reclaimed MWDF will be restricted to those uses that will not adversely affect the function and integrity of this facility.

7.0 RECLAMATION COSTS

Reclamation costs for the Crandon Project are presented in the Mining Permit Application, Section A - Item 12.

8.0 NOTIFICATION

Questions and correspondence related to the Reclamation Plan should be addressed to the Permitting Manager, Exxon Minerals Company, Rhinelander, Wisconsin; telephone (715) 369-2800. The DNR will be notified prior to start-up of the name of the individual who will have the responsibility for long-term maintenance. The DNR also will be notified of subsequent changes in the name of the individual having this responsibility.

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APPENDIX 1.1A

RECLAMATION PLAN CONFORMANCE WITH NR 132 AND NR 182

APPENDIX 1.1A

Reclamation Plan Conformance With NR 132 and NR 182

Requirements of NR 132	Reclamation Plan Conformance Section/Subsection
132.08 **Reclamation Plan**	
The reclamation plan for the mining site shall include the following:	
(1) Detailed information and maps on the reclamation procedures including:	
(a) Manner, location, sequence and anticipated duration of reclamation.	2.0, 3.0, 4.0
(b) Ongoing reclamation procedures during mining operations.	3.1, 3.2 4.2, 4.3, 4.4
(c) Proposed interim and final topography and slope stabilization.	3.2 4.2, 4.3, 4.4
(d) Proposed final land use and relationship to surrounding land and land use.	6.0
(e) Plans for long-term maintenance of mining site including:	
(1) Monitoring of wastes and ground and surface water quality.	5.0
(2) Names of persons legally and operationally responsible for long-term maintenance.	8.0
(f) Projected costs of reclamation including estimated cost to the State of fulfilling the reclamation plan.	7.0

Requirements of NR 132	Reclamation Plan Conformance Section/Subsection
132.08 Reclamation Plan (continued)	
(2) Evidence satisfactory to the department that the proposed reclamation will conform with the following minimum standards:	
(a) All toxic and hazardous wastes, refuse, tailings and other solid waste shall be disposed of in conformance with applicable State and Federal Statutes or Regulations.	3.2 4.1, 4.2, 4.3 5.0
(b) All tunnels, shafts or other underground openings shall be sealed in a mannner which will prevent seepage of water in amounts which may be expected to create a safety, health or environmental hazard, unless the applicant can demonstrate alternative uses which do not endanger public health and safety, and which conform to applicable environmental protection and mine safety laws and rules.	3.3
(c) All underground and surface runoff waters from mining sites shall be managed, impounded or treated so as to prevent soil erosion to the extent practicable, flooding, damage to agricultural lands or livestock, damage to wild animals, pollution of ground or surface waters, damage to public health or threats to public safety.	2.2 to 2.4 3.2 4.1, 4.2, 4.3 Appendix 2.1A

Requirements of NR 132	Reclamation Plan Conformance Section/Subsection
132.08 Reclamation Plan (continued)	
(d) All surface structures constructed as a part of the mining activities shall be removed, unless they are converted to an acceptable alternate use.	3.2 4.3 6.0
(e) Adequate measures shall be taken to prevent significant surface subsidence, but, if such subsidence does not occur, the affected area shall be reclaimed.	4.3
(f) All topsoil from surface areas disturbed by the mining operation shall be removed and stored in an environmentally acceptable manner for use in reclamation.	2.4 3.2 4.2, 4.3 Appendix 2.4A
(g) All disturbed surface areas shall be revegetated as soon as practicable after the disturbance to stabilize slopes and prevent air and water pollution, with the objective of re-establishing a variety of plants and animals indigenous to the area immediately prior to mining, unless such re-establishment is inconsistent with the provisions of S.144.81(15), Stats. Plant species not indigenous to the area may be used if necessary to provide rapid stabilization of slopes and prevention of erosion, if such species are acceptable to the department, but the ultimate goal of re-establishment of indigenous species shall be maintained.	2.4 3.1, 3.2 4.2, 4.3, 4.4 Appendix 2.1A Appendix 2.4B Appendix 3.3A

Requirements of NR 132	Reclamation Plan Conformance Section/Subsection
132.08 Reclamation Plan (continued)	
(3) If it is physically or economically impracticable or environmentally or socially undesirable for the reclamation process to return the affected area to its original state, the reasons therefor and a discussion of alternative conditions and uses to which the affected area can be put.	3.2 6.0
(4) If the anticipated life and total area of the mineral deposit are of sufficient magnitude as determined by the department, a comprehensive long-term plan showing, in detail satisfactory to the department, the manner, location and estimated sequential timetable for reclamation of the entire area of contiguous land which will be affected by mining and which is owned, leased or under option for purchase or lease by the operator at the time of application. When a mineral deposit lies on or under the lands of more than one operator, the department shall require the operators to submit mutually consistent comprehensive plans.	See This Reclamation Plan

Requirements of NR 182			Reclamation Plan Conformance Section/Subsection
182.08	(2)(j)	Closure and long-term care. An economic analysis, including an engineer's cost estimate for site closing and long-term care, which may be provided by reference to the Reclamation Plan submitted pursuant to S.144.85(3)(b) Stats., and Section NR 132.08 Wis. Adm. Code.	7.0
182.12		Inspections	5.0
182.13		Monitoring	5.0
182.15	(2)	Any persons who maintains or operates a solid waste disposal site or facility shall, when the facility or a portion thereof reaches final grade, or when the department determines that closure is required, close it in accordance with the Reclamation Plan as referenced in the plan of operation.	See This Reclamation Plan
	(3)	The owner or operator shall re-establish and develop the finished surface in any closed portion in accordance with the approved facility final use.	4.3, 4.4 6.0
	(4)	At completion of closure, all closed facilities, or closed portions thereof, shall be reasonably secured so that injurious contact with waste by humans or animal life will be minimized, and so that discharges harmful to health will not occur.	4.3, 4.4 6.0
	(5)	At the completion of closure, all required equipment shall be provided and arrangements shall be made to continue post-closure monitoring as required in this chapter.	5.0

Requirements of NR 182			Reclamation Plan Conformance Section/Subsection
182.16	(2)	The closure requirements of this chapter shall be incorporated in and made part of the Reclamation Plan submitted pursuant to S144.85(3)(b), Stats., and S.NR 132.08, Wis. Adm. Code, but shall be referenced in the plan or operation submitted pursuant to S.NR 182.09.	See This Reclamation Plan
182.17	(1)	The intent of this section is to coordinate the financial responsibility requirements of Chapter NR 132, Wis. Adm. Code, and this chapter as they affect the long-term care of a mining site as defined in S.144.441(2), Stats. The long-term care requirements of this chapter are to be incorporated in and made part of the mine Reclamation Plan.	5.0 7.0
	(2)	An owner of a mine waste facility shall be responsible for the long-term care of the facility for 30 years after closure. The long-term care requirements of this chapter shall be incorporated in and made part of the Reclamation Plan submitted pursuant to S.144.85(3)(b), Stats., and S.NR 132.08, Wis. Adm. Code, but shall be referenced in the plan of operation submitted pursuant to S.NR 182.09.	5.0

APPENDIX 2.1A

SOIL EROSION AND SEDIMENT CONTROL PRACTICES DURING CONSTRUCTION

APPENDIX 2.1A

SOIL EROSION AND SEDIMENT CONTROL PRACTICES DURING CONSTRUCTION

Table 2.1A.1 presents a summary of potential erosion control treatment practices that may be employed during Project construction. Some of the practices are utilized for special conditions or applications and may not be used during Project development. However, if an unanticipated condition develops, Table 2.1A.1 identifies the practices that are available and their advantages and considerations for application.

Table 2.1A.2 presents the erosion control practices expected to be employed during construction. The expected practices have been selected for each management unit and the average existing surface grade category in the management unit.

TABLE 2.1A.1

SUMMARY OF POTENTIAL SOIL EROSION AND SEDIMENT CONTROL PRACTICES FOR USE DURING CONSTRUCTION

Treatment Practice	Advantages	Considerations
ROADWAY DITCHES		
Check Dams	Maintain low velocities. Catch sediment. Can be constructed of logs, shot rock, lumber, masonry, or concrete.	Close spacing on steep grades. Require clean-out. Unless keyed at sides and bottom, erosion may occur.
Sediment Traps/Straw Bale Filters	Can be located as necessary to collect sediment during construction. Clean-out often can be done with on-the-job equipment. Simple to construct.	Little direction on spacing and size. Sediment disposal may be difficult. Specification must include provisions for periodic clean-out. May require seeding, sodding, or pavement when removed during final clean-up.
Sodding	Easy to place with a minimum of preparation. Can be repaired during construction. Immediate protection.	Requires water during first few weeks. Sod not always available. Will not withstand high velocity or severe abrasion from sediment load.
Seeding with Mulch and Matting	Usually least expensive. Effective for ditches with low velocity.	Will not withstand medium to high velocity.
Paving, Rip-rap, Rubble	Effective for high velocities. May be part of the permanent erosion control effort.	Cannot always be placed when needed because of construction traffic and final grading and dressing. Initial cost is high.
ROADWAY SURFACE		
Crowning to Ditch or Sloping to Single Berm	Directing the surface water to a prepared or protected ditch minimizes erosion.	None - should be part of good construction procedures.
Compaction	The final lift of each day's work should be well compacted and bladed to drain to ditch or berm section. Loose or uncompacted material is more subject to erosion.	None - should be part of good construction procedures.
Aggregate Cover	Minimizes surface erosion. Permits construction traffic during adverse weather. May be used as part of permanent base construction.	Requires reworking and compaction if exposed for long periods of time. Loss of surface aggregates can be anticipated.
Seed/Mulch	Minimizes surface erosion.	Must be removed or is lost when construction of pavement is commenced.

TABLE 2.1A.1 (continued)

Treatment Practice	Advantages	Considerations
CUT SLOPES		
Berm at Top of Cut	Diverts water from cut. Collects water for slope drains/paved ditches. May be constructed before grading is started.	Access to top of cut. Difficult to build on steep natural slope or rock surface. Concentrates water and may require channel protection or energy dissipation devices. Can cause water to enter ground, resulting in sloughing of the cut slope.
Diversion Dike	Collects and diverts water at a location selected to reduce erosion potential. May be incorporated in the permanent project drainage.	Access for construction. May be continuing maintenance problem if not paved or protected. Disturbed material or berm is easily eroded.
Slope Benches	Slows velocity of surface runoff. Collects sediment. Provides access to slope for seeding, mulching, and maintenance. Collects water for slope drains or may divert water to natural ground.	May cause sloughing of slopes if water infiltrates. Requires additional ROW. Not always possible due to rotten material, etc. Requires maintenance to be effective. Increases excavation quantities.
Slope Drains (pipe, paved, etc.)	Prevents erosion on slope. Can be temporary or part of permanent construction. Can be constructed or extended as grading progresses.	Requires supporting effort to collect water. Permanent construction is not always compatible with other project work. Usually requires some type of energy dissipation.
Seeding/Mulching	The end objective is to have a completely grassed slope. Early placement is a step in this direction. The mulch provides temporary erosion protection until grass is rooted. Temporary or permanent seeding may be used. Mulch should be anchored. Larger slopes can be seeded and mulched with smaller equipment if stage techniques are used.	Difficult to schedule high production units for small increments. Time of year may be less desirable. May require supplemental water.
Sodding	Provides immediate protection. Can be used to protect adjacent property from sediment and turbidity.	Difficult to place until cut is complete. Sod not always available. May be expensive.
Slope Pavement, Rip-rap	Provides immediate protection for high risk areas and under structures.	Expensive. Difficult to place on high slopes. May be difficult to maintain.

TABLE 2.1A.1 (continued)

Treatment Practice	Advantages	Considerations
Temporary Cover	Plastics are available in wide rolls and large sheets that may be used to provide temporary protection for cut or fill slopes. Easy to place and remove. Useful to protect high risk areas from temporary erosion.	Provides only temporary protection. Original surface usually requires additional treatment when plastic is removed. Must be anchored to prevent wind damage.
Serrated Slope	Lowers velocity of surface runoff. Collects sediment. Holds moisture. Minimizes amount of sediment reaching roadside ditch.	May cause minor sloughing if water infiltrates. Construction compliance.
FILL SLOPES		
Berms at Top of Embankment	Prevent runoff from embankment surface from flowing over face of fill. Collect runoff for slope drains or protected ditch. Can be placed as a part of the normal construction operation and incorporated into fill or shoulders.	Cooperation of construction operators to place final lifts at edge for shaping into berm. Failure to compact outside lift when work is resumed. Sediment build-up and berm failure.
Slope Drains	Prevent fill slope erosion caused by embankment surface runoff. Can be constructed of full or half section pipe, bituminous, metal, concrete, plastic, or other waterproof material. Can be extended as construction progresses. May be either temporary or permanent.	Permanent construction as needed may not be considered desirable by contractor. Removal of temporary drains may disturb growing vegetation. Energy dissipation devices are required at the outlets.
Fill Berms or Benches	Slows velocity of slope runoff. Collects sediment. Provides access for maintenance. Collects water for slope drains. May utilize waste.	Requires additional fill material if waste is not available. May cause sloughing. Additional ROW may be needed.
Seeding/Mulching	Timely application of mulch and seeding decreases the period a slope is subject to severe erosion. Mulch that is cut in or otherwise anchored will collect sediment. The furrows made will also hold water and sediment.	Seeding season may not be favorable. Not 100 percent effective in preventing erosion. Watering may be necessary. Steep slopes or locations with high velocities may require supplemental treatment.
PROTECTION OF ADJACENT PROPERTY		
Brush Barriers	Use slashing and logs from clearing operation. Can be covered and seeded rather than removed. Eliminates need for burning or disposal off ROW.	May be considered unsightly in urban areas.

TABLE 2.1A.1 (continued)

Treatment Practice	Advantages	Considerations
Straw Bale Barriers	Straw is readily available in many areas. When properly installed, they filter sediment and some turbidity from runoff.	Require removal. Subject to vandal damage. Flow is slow through straw requiring considerable area.
Sediment Traps	Collect much of the sediment spill from fill slopes and storm drain ditches. Inexpensive. Can be cleaned and expanded to meet need.	Do not eliminate all sediment and turibidity. Space is not always available. Must be removed (usually).
Sediment Pools	Can be designed to handle large volumes of flow. Both sediment and turibidity are removed. May be incorporated into permanent erosion control plan.	Require prior planning, additional ROW and/or flow easement. If removal is necessary, can present a major effort during final construction stage. Clean-out volumes can be large. Access for clean-out not always convenient.
Energy Dissipators	Slow velocity to permit sediment collection and to minimize channel erosion off project.	Collect debris and require cleaning. Require special design and construction of large shot rock or other suitable material from project.
Level Spreaders	Convert collected channel or pipe flow back to sheet flow. Avoid channel easements and construction off project. Simple to construct.	Adequate spreader length may not be available. Sodding of overflow berm is usually required. Must be a part of the permanent erosion control effort. Maintenance forces must maintain spreader until no long required.
Plastic Filter Sheet	Permit good drainage and control of soil particle movement. Cost and long-term effectiveness.	Variability in effectiveness between products. Requires careful installation for long-term effectiveness.
Construction Dike	Permits work to continue during normal stream stages. Controlled flooding can be accomplished during periods of inactivity.	Usually requires pumping of work site water into sediment pond. Subject to erosion from stream and from direct rainfall on dike.
Cofferdam	Work can be continued during most anticipated stream conditions. Clear water can be pumped directly back into stream. No material deposited in stream.	Expensive.
Temporary Stream Channel Change	Prepared channel keeps normal flows away from construction.	New channel usually will require protection. Stream must be returned to old channel and temporary channel refilled.

TABLE 2.1A.1 (continued)

Treatment Practice	Advantages	Considerations
Rip-rap	Sacked sand with cement or stone easy to stockpile and place. Can be installed in increments as needed.	Expensive.
Temporary Culverts for Haul Roads	Eliminate stream turbulance and turbidity. Provide unobstructed passage for fish and other water life. Capacity for normal flow can be provided with storm water flowing over the roadway.	Space not always available without conflicting with permanent structure work. May be expensive, especially for larger sizes of pipe. Subject to washout.
Rock-lined Low-level Crossing	Minimizes stream turbidity. Inexpensive. May also serve as ditch check or sediment trap.	May not be fordable during rainstorms. During periods of low flow passage of fish may be blocked.
BORROW AREAS		
Selective Grading and Shaping	Water can be directed to minimize off-site damage. Flatter slopes enable mulch to be cut into soil.	May not be most economical work method for contractor.
Stripping and Replacing of Topsoil	Provides better seed bed. Conventional equipment can be used to stockpile and spread topsoil.	May restrict volume of material that can be obtained for a site. Topsoil stockpiles must be located to minimize sediment damage. Cost of rehandling material.
Dikes, Berms Diversion Ditches Settling Basins Sediment Traps Seeding and Mulch	See other practices.	See other practices.

Source: U.S. Highway Research Board (1973); Haliburton et al. (1978).

TABLE 2.1A.2

EXPECTED APPLICATION OF SOIL EROSION AND SEDIMENT CONTROL METHODS DURING CONSTRUCTION[a]

Management Unit/ Slope %	Major Soil Disturbing Construction Activities					
	Clear and Grub	Topsoil Removal	Excavation/Embankment	Grading	Topsoil Replacement	Revegetation
ACCESS ROAD						
0 - 3 (Upland Soils)	---	---	Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding
(Lowland Soils)	Straw bale barriers[b] Silt fence	---	Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding
4 - 15	---	---	Straw bale barriers Silt fence Sediment traps Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover
>15	Straw bale barriers Silt fence	---	Sediment traps Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover
RAILROAD SPUR						
0 - 3 (Upland Soils)	---	---	Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding
(Lowland Soils)	Straw bale barriers[b]	---	Check dams Silt fence	---	---	Seeding/mulching Seeding with mulch and matting Sodding
4 - 15	---	---	Straw bale barriers Silt fence Sediment traps Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover
>15	Straw bale barriers Silt fence	---	Sediment traps Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover

TABLE 2.1A.2 (continued)

Management Unit/ Slope %	Major Soil Disturbing Construction Activities					
	Clear and Grub	Topsoil Removal	Excavation/Embankment	Grading	Topsoil Replacement	Revegetation
MINE/MILL SITE						
0 - 3 (Upland Soils)	---	Sediment pools Sediment traps Check dams	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding
(Lowland Soils)	Straw bale barriers[b] Silt fence	Sediment pools Sediment traps Check dams	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding
4 - 15	---	Sediment pools Sediment traps Check dams	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding
>15	Straw bale barriers Silt fence	Sediment pools Sediment traps Check dams	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover
DISCHARGE PIPELINE CORRIDOR						
0 - 3 (Upland Soils)	---	---	---	---	---	Seeding/mulching
(Lowland Soils)	---	Straw bale barriers[b]	---	---	---	Seeding/mulching
4 - 15	---	---	---	---	---	Seeding/mulching
>15	---	Straw bale barriers Silt fence	---	---	---	Seeding/mulching

TABLE 2.1A.2 (continued)

Management Unit/ Slope %	Major Soil Disturbing Construction Activities					
	Clear and Grub	Topsoil Removal	Excavation/Embankment	Grading	Topsoil Replacement	Revegetation
MWDF ACCESS ROAD/TAILINGS TRANSPORT PIPELINE CORRIDOR						
0 - 3 (Upland Soils)	---	---	Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding
(Lowland Soils)	Straw bale barriers[b] Silt fence	---	Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding
4 - 15	---	---	Straw bale barriers Silt fence Sediment traps Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover
>15	Straw bale barriers Silt fence	---	Sediment traps Check dams	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover

TABLE 2.1A.2 (continued)

Management Unit/ Slope %	Major Soil Disturbing Construction Activities					
	Clear and Grub	Topsoil Removal	Excavation/Embankment	Grading	Topsoil Replacement	Revegetation
RECLAIM POND/MRDF/MWDF						
0 - 3 (Upland Soils)	---	Sediment pools Sediment traps Straw bale barriers	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover Rip-rap
(Lowland Soils)	---	Sediment pools Sediment traps Straw bale barriers	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover Rip-rap
4 - 15	---	Sediment pools Sediment traps Straw bale barriers	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover Rip-rap
>15	---	Sediment pools Sediment traps Straw bale barriers	---	---	---	Seeding/mulching Seeding with mulch and matting Sodding Temporary cover Rip-rap

[a] Erosion control methods for successive activities are additive (i.e., as additional construction steps occur, previous erosion control methods are continued and additional methods are begun).

[b] Primarily to trap runoff erosion before it enters wetland areas or water bodies.

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APPENDIX 2.4A

SUMMARY OF MATERIALS AND METHODS FOR VEGETATION ESTABLISHMENT

APPENDIX 2.4A

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2.4A.1 Topsoil Use and Ouality Control

Wisconsin Code NR 182.04(50) defines "Topspoil as natural loam, sandy loam, silt clay loam or clay loam humus bearing soils or other material that will easily produce and sustain dense growths of vegetation capable of preventing wind and water erosion of the material itself and other materials beneath."

Wherever possible, the standard defined in NR 182.04(50) shall be met by following standards comparable to Section 625, Topsoil and Salvaged Topsoil, (State of Wisconsin, 1981). Topsoil refers to soil obtained away from the construction site; salvaged topsoil refers to soil removed from the construction site prior to construction. A variance to NR 182.11 (1)(e) and an exemption to NR 132.08(2)(f) may be required because of the impracticality of removing all topsoil where the soil layer is thin.

All areas from which such soils are procured shall be cleared, if necessary, of trees and shrubs by felling and grubbing or by means of mowing weeds or other herbaceous vegetation to a height of approximately 6 inches, and then freed from any litter such as brush, rock, or foreign material of objectionable size or quantity.

Such soils, thus stripped from these areas may be stockpiled on designated areas for future replacement on defined areas, or it may be placed directly on the defined areas provided they have been prepared to receive the same. Where such soils are stockpiled for future replacement, they shall be

seeded with a suitable plant species mixture to prevent wind and water erosion and to preserve topsoil quality.

2.4A.2 Peat Humus

Although NR 182.04(50) does not include "peat humus" in the definition of topsoil, such material may form a valuable substrate for the generation or sustenance of plant growth. Therefore, where applicable, such peat humus will be salvaged during construction activities and utilized in the reclamation plans. Where applicable, the utilization of peat humus shall follow specifications comparable to Section 626, Peat Humus (State of Wisconsin, 1981).

When marsh excavation is an item in the construction plan, the contractor shall select from the material encountered those portions containing the more fibrous material consisting of decomposed vegetable matter, moss, etc., as distinguished from the more or less purely muck-like substances. The material shall be obtained from such marshes as are indicated on the plans or in the contract to have suitable material and to the extent that it is available or necessary for the work intended. The select material shall be placed into piles separate and apart from the materials encountered that are to be wasted. These piles of selected material shall be so located and of such size as to ensure a reasonable amount of drainage from the material contained therein so that the material can be readily and conveniently handled when it is to be incorporated in the work.

2.4A.3 Fertilizer Use and Quality Control

Fertilizers intended for use in connection with seeding, sodding, or other plantings during the reclamation program shall be standard, commercial,

packaged, or bulk products in granular or liquid form conforming to the requirements of the Wisconsin Statutes and of the Wisconsin Administrative Code.

2.4A.4 Type of Seed and Quality Control

Seed of species selected for use in the reclamation program shall conform, where applicable,to the quality standards designated by State of Wisconsin (1981).

2.4A.5 Methods of Seeding

Three types of seeding equipment will be used for reclamation: (1) broadcast seeders, (2) hydroseeders, and (3) specialized planters.

2.4A.5.1 Broadcast Seeders

The broadcast seeder is used to broadcast small grains such as oats, wheat, barley, and grass or legume seed. Broadcast seeders may be either the centrifugal-type spreader or the full width-feed broadcaster, also called the field distributor. These seeders do not have furrow openers; therefore, the seedbed must be totally prepared by a tillage tool. Also, broadcast seeders usually do not cover the seed. Seed covering may be done later with a spike-tooth harrow or similar piece of equipment.

Centrifugal Type Broadcaster - The centrigual-type broadcast seeder or end-gate seeder provides an economical method of applying granular and pelleted fertilizers as well as seeding most varieties of seeds. Centrifugal-type broadcasters generally have an effective spreading width of from

20 to 40 feet depending upon the physical characteristics of the seed (size, shape, weight per bushel, etc.).

Field Distributor - The field distributor or full-width feed broadcaster consists of a seed box with metering devices along its full width. Field distributors may be used to apply fertilizers as well as seeds.

2.4A.5.2 Hydroseeders

A combination of one or more of seeds, fertilizers, soil improvement materials, adhesives and mulch with water are mixed together in a holding tank to form a slurry. A special heavy pump produces the required pressure to spray the mixture onto the area to be seeded. The mixture must be agitated continuously throughout the entire spraying process to ensure consistency.

The method enables rapid revegetation of steep slopes (2:1 or greater) where revegetation by any other method (including spreading of topsoil) would be difficult and much more expensive. The site must be easily accessible to the hydroseeding unit. With hoses attached to the unit it is possible to achieve a maximum range of 490 feet, but normal seeding range is between 80 and 130 feet, depending upon weather conditions at seeding time. Although hydroseeding is primarily used for seeding of sloping areas, it is also used for the seeding of large areas such as highway shoulders, other rights-of-way, rough surface areas where conventional agricultural seeders cannot be used adequately.

2.4A.5.3 Specialized Planters

Grass Seeder - Special equipment has been designed for seeding small-seed legumes and grasses. This type of seeder uses a fluted feed to

meter the seeds from the hopper. The seedbed is prepared in previously tilled soil by a front roller which breaks up clods and eliminates voids or air spaces in the soil. The rear roller covers the seeds to a maximum depth of 0.5 inch and firms the soil around the seed to ensure optimum germination. It is anticipated that the grass seeder will be the predominant equipment type used in the reclaim program where topography is 3:1 or less, such as the final tailings disposal area surface and the final surface of the mine/mill facility site after regrading at cessation of mining.

Shrub and Tree Planters - Specialized planters such as those developed for the planting of shrubs and tree seedlings or transplanting of more mature shrubs and trees will be used where it is deemed appropriate.

2.4A.6 Erosion Control Products and Materials

2.4A.6.1 Mulches

A mulch is a layer of plant residue or inorganic material, applied to the soil surface to temporarily stablize the soil and aid in plant growth. When applied to a seedbed, the purpose of a mulch is to conserve soil moisture, insulate against intense solar radiation, dissipate energy from falling rain and reduce erosion caused by overland flow. It is also used in place of chemical stabilizers to provide temporary erosion protection during delays in grading or revegetation.

2.4A.6.1.1 Common Types

Wood (Brush) Chips - Wood chips are a waste material resulting from chipping small branches, shrubs, and trees during clearing operations. Chips

may be spread with a modified straw mulcher after seed and fertilizer have been applied.

Straw/Hay - Loose straw or hay is the most commonly used and one of the best temporary soil stabilizing and mulching materials. It conserves soil moisture, dissipates energy from falling raindrops, insulates against intense solar radiation, and reduces erosion caused by overland sheet flow. It can be applied by hand, but is best applied using a mulch blower that shreds, cuts, and evenly scatters the straw. It is best anchored using a specially designed crimper or a form disc pulled along the ground contour. Where wind is not a major problem, straw or hay can also be satisfactorily anchored using asphalt or chemical binders, or in extreme cases, netting. The application rate of straw or hay varies with local conditions, but is generally about 2 tons per acre.

Wood Fiber - Wood fiber mulch is a fine-textured, short-fiber wood product produced from wood chips. It is designed specifically for use in a hydroseeder. It is best utilized on steep slopes where conventional seeding and mulching (straw or hay) practices cannot be used or on relatively flat areas where soil erosion will not be a major problem. In hydroseeder slurries, wood fiber mulch can be applied along with seed, lime, and fertilizer. The rate of application is generally between 1,000 and 1,500 pounds per acre.

2.4A.6.2 Chemical Binders and Tacks

Chemical binders and tacks are latex emulsions, plastic films, or resin-in-water emulsions, usually sprayed on bare soils or mulches to bind soil particles or mulch material, reduce soil moisture loss and enhance plant

growth. The purpose of a chemical binder or tack is to temporarily stabilize soil against wind and water erosion and prevent evaporation of water from the soil surface until the treated area becomes vegetatively stabilized.

Chemical binders and tacks may be used on any disturbed area which is being reclaimed. They may be applied along with seed, limestone, and fertilizers. If reclamation is being performed at a time when seeding cannot be done (e.g., summer, late fall, or winter), chemical binders may be used to temporarily stabilize the soil until seeding can be performed. Many products are available for use as temporary soil stabilizers, mulches, or mulch tacks (Table 2.4A.1). Selection of any product should be based on the following criteria: (1) intended use, (2) effectiveness, (3) cost (including labor and any special equipment required for application), (4) availability, and (5) field test data when possible.

2.4A.6.3 Other Stabilization Materials

Netting/Jute Netting - Nettings of fiberglass, plastic, and paper yarn can be used to anchor straw, hay, wood chips, or grass and sod in drainageways and in other areas subject to concentrated runoff. Jute netting is made up of thick, fibrous strands of jute, and is one of the most popular materials for temporarily stabilizing and mulching seeded drainageways. When fastened in place (using metal staples), tightly bonded to the soil surface, it shields the soil from the erosive action or rain splash and runoff and provides a favorable environment for seed germination and plant development.

TABLE 2.4A.1

EXAMPLES OF CHEMICAL BINDERS AND TACKS

Name	Uses: Temporary Soil Stabilizer	Uses: Mulch Tack	Description	Application Method
Aerospray 52 Binder	X		Water dispersible, alkyd emulsion.	Any nonair entraining equipment as for liquid fertilizer, asphalt emulsions, and water.
Aerospray 70 Binder	X	X	Water dispersible, liquid polyvinyl acetate emulsion.	Hydroseeder; seed, fertilizer, and wood fiber may be applied with product.
Curasol AE	X	X	Water dispersible, polyvinyl acetate copolymer emulsion.	Hydroseeder; seed, fertilizer, and wood fiber may be applied with product.
Curasol AH	X	X	Water dispersible, high polymer synthetic resin.	Hydroseeder; seed, fertilizer, and wood fiber may be applied with product.
DCA-70	X	X	Water dispersible, polyvinyl acetate emulsion.	Hydroseeder or any nonair entraining equipment.
Genequa 169	X		Water dispersible, modified liquid acrylic resin.	Hydroseeder; seed, fertilizer, and wood fiber may be applied with product.
Liquid Asphalt		X	Asphalt cement that is dispersed or suspended in water or various solvents.	Hand-spray nozzle or an offset distributor bar attached to an asphalt distributor truck.
M-145	X		Water dispersible, liquid resin polymer.	Hydroseeder; seed and fertilizer may be applied with product.

TABLE 2.4A.1 (continued)

Name	Uses: Temporary Soil Stabilizer	Uses: Mulch Tack	Description	Application Method
Petroset SB	X	X	Water dispersible oil emulsion.	Any spraying equipment.
Terra Tack	X	X	Water dispersible, powdered vegetable gum.	Hydroseeder or, for dry application, standard hopper spreaders (as for fertilizers or lime).
XB-2386	X		Water dispersible, liquid reactive polymer.	Injected into slurry at the nozzle of a hydroseeder.

Source: U.S. Environmental Protection Agency (1976).

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APPENDIX 3.3A

RECLAMATION AT THE CRANDON PROJECT AREA, 1977-1982

APPENDIX 3.3A

RECLAMATION AT THE CRANDON PROJECT AREA, 1977-1982

3.3A.1 Introduction

Exploration and assessment activities on the Crandon Project area resulted in numerous, small disturbed sites. In 1977 Exxon began reclamation of more than 100 drill sites. As assessment studies were continued, e.g., soil sampling and hydrology programs, a reclamation procedure was developed for disturbed areas, the results of which have been continuously monitored through October 1982.

3.3A.2 1977-1978 Reclamation

The initial reclamation effort on the Crandon Project encompassed 80 acres of slashing on the west half of the Project area. This acreage was purchased after the merchantable timber had been clear cut. The slashing area contained numerous broken trees and considerable leaning timber which required attention.

A contractor used a crawler tractor with brush rake to crush the slashing to ground level. Trees leaning were dropped in advance by a brushing crew. The stumps were collected and hauled to an off-site disposal area. Large rocks and boulders were rolled into piles. Many of these rocks were subsequently used as rip-rap elsewhere on the Project.

Reclamation of the slashing recovery area was completed in mid-summer of 1977 and by the end of the growing season, poplar saplings of 1 to 3 inches diameter and 8 feet high were common. By the end of the first full growing season (1978), saplings up to 3 to 4 inches diameter and 12 feet

high were common. After five full growing seasons, the poplar saplings have attained heights up to 25 feet and were 4 to 6 inches in diameter.

In August 1977 Exxon met with the Wisconsin Department of Natural Resources (DNR) to discuss the reclamation of the Crandon Project drilling sites. As a result of this meeting, it was decided to use a seeding mixture which was the optimum for maintaining forestry openings for game management. The mixture initially recommended for site reclamation was composed of White Dutch clover (Trifolium repens) and Kentucky bluegrass (Poa pratensis) at 8 and 6 pounds per acre, respectively. Oats (Avena sativa) at 55 pounds per acre was also recommended if seeding took place in early spring. An application of 200 pounds per acre of a 16:4:4 fertilizer was made at seeding.

For those areas used as staging areas by drilling contractors and on extensive drill sites, a "highway" mix was recommended. That seed mixture was seeded at 25 pounds per acre and consisted of 63 percent creeping red fescue (Festuca rubra), 20 percent perennial ryegrass (Lolium perenne), 10 percent Kentucky bluegrass, 5 percent White Dutch clover, and 2 percent red clover (Trifolium pratense). A 10:10:10 fertilizer was applied at 200 pounds per acre at seeding.

In June 1978 contractor crews under Exxon supervision began reclamation of more than 100 drill sites. Those sites, from 0.12 to 2 acres in size, and the initial contractor staging area, totaled approximately 15 acres. Due to the nature of the drilling operations, each of these areas required considerable attention. Sites were built up by the construction crews using pit-run gravel. When drilling activities were completed and

all traffic on the sites had ceased, it was necessary to cover the barren sand and gravel surface with topsoil. Topsoil was purchased from farms in the Crandon area and trucked to each area of reclamation.

The standard procedure developed for this initial reclamation season was as follows:

1) Topsoil: Spread approximately 3 to 5 inches thick and raked to loosen surface and remove rocks and roots.

2) Fertilizer: 16:4:4 fertilizer at an application rate of 200 pounds per acre initially. Subsequently reduced to about 50 pounds per acre based on test results.

3) Seed: The White Dutch clover and Kentucky bluegrass mixture was first used. The tests indicated that faster and more abundant plant development was obtained using the "highway" mix.

4) Mulching: Straw was hand spread over all freshly seeded areas at a rate of 6 to 8 bales per acre.

Several attempts were made at covering the sand and gravel with chips generated from local underbrush and tree limbs, then fertilizing, seeding, and mulching. These attempts were mostly unsuccessful and it was

necessary to apply topsoil and rework the sites several weeks later. That method of reclamation was considered to have potential if the chips could have been allowed to rot. However, time constraints on the program did not allow full evaluation.

From the results of 1978 field tests, a "Crandon Project" seeding formula and reclamation procedure was developed for drilling sites:

1) Topsoil: Spread at approximately 4 inches, raked to loosen surface and remove rocks and roots.

2) Fertilizer: 20:5:5 or 16:4:4 rate of 30 pounds per acre.

3) Seed Mixture:

White Clover	25%	10 pounds per acre
Kentucky Bluegrass	25%	10 pounds per acre
Creeping Red Fescue Perennial Rye	50%	20 pounds or per acre

A few select sites seeded in the spring were also sown with oats at 55 pounds per acre when mixed with the above seed mixture or at 165 pounds per acre when sown alone. The oats germinated rapidly (within 10 days) and provided quick cover. Heavy rains, however, tended to wash out the oats unless they were sown with the grass-legume seeds mixture.

By the fall of 1978, all sites, roads, and staging areas which were no longer in use had been reclaimed with a high success rate. The

implementation of the reclamation procedures and the resulting plant growth on the various areas was inspected on several occasions in 1978 by the DNR.

3.3A.3 1979-1982 Reclamation

Drilling sites which were used and subsequently reclaimed during this period followed the standard Project reclamation program developed during 1978. Minor variation in seed mixture was the only change of routine procedures.

3.3A.4 Special Reclamation Efforts

3.3A.4.1 Wetland Area

In 1978 a DNR inspection revealed that minor silting of the large wetland on the east end of the Project was occurring as a result of rainfall runoff along the side of a drill road which bordered the northern edge of the wetland and on both sides of a road through the head of this wetland.

The access road across the head of the wetland was dug up and a 16 inch culvert with wingwalls was installed. The roadway was then rebuilt to grade and large boulders from the Project area were used as rip-rap on both shoulders of the road. Seeding and heavy mulching of potential runoff slopes were also necessary.

The road along the northern edge of the main wetland was blocked off at each end and the road embankment was also rip-rapped using local boulders. The road was then covered with topsoil, seeded, fertilized and heavily mulched to prevent washouts by rains. This road has been successfully reclaimed with no siltation of the adjacent wetland.

3.3A.4.2 Soil Sampling/Hydrology Programs

When soil sampling and hydrology studies were initiated, it was evident that following standard Project reclamation procedures would be expensive and time consuming. It was decided to conserve all local topsoil and replace it upon the completion of drilling.

In most instances, the original topsoil was replaced and standard seed and fertilizer programs were followed. A few sites were treated with double the usual rate of high-nitrogen fertilizer (20:5:5) where acceptable topsoil was lacking. Some of those sites required up to 3 weeks before significant germination was noted. By the end of the fourth week, however, plant growth at those sites appeared normal in all respects when compared to growth at other Project sites.

A few sites were deliberately left untouched after replacing the native topsoil. In these trials, it took between 4 and 8 weeks for significant vegetation to appear. Where growth did not occur, standard seeding and fertilizing methods were subsequently employed.

3.3A.4.3 Pumping Test Program

Upon the completion of the 1981 pumping tests, additional reclamation experiments on the 18 drilling sites were performed. A minimal seeding mixture, fertilizer, and mulching program was developed: (1) application of 4 inches of topsoil; (2) fertilization with 20:5:5 at 20 pounds per acre; (3) spreading a seed mixture at 20 pounds per acre consisting of White Dutch clover (10 percent), Kentucky bluegrass (20 percent), and creeping red fescue or perennial ryegrass (70 percent); and (4) straw mulching at approximately 225 pounds per acre. Those treated sites were, within one growing season, essentially identical to those reclaimed in 1978.

3.3A.4.4 1982 Soil Sampling Program

Continued reclamation methods were carried out subsequent to the 1982 soil sampling program. Twenty drilling sites were available for investigation. Half of the sites, each about 0.5 acre in area, received no mulch. The sites took between 2 and 3 weeks longer to exhibit significant germination. Approximately four sites did not show any germination and were retreated and additionally mulched before a vegetative cover was established.

3.3A.5 Summary

From field investigations over five growing seasons, acceptable revegetation is possible on disturbed sites in the Crandon Project area. A minimum topsoil depth of 0.5 inch, a general all-purpose grass-legume seed mixture and relatively low fertilizer application are the basic requirements. On sites exposed to full solar radiation, a mulch is required to retain soil moisture, insulate against high temperatures, and to ensure rapid germination and acceptable plant establishment. Sites reclaimed in 1978 exhibit woody species encroachment, to the extent that herbaceous vegetation is declining.