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FOREST INVENTORY, TIMBER APPRAISAL, AND  
FOREST MANAGEMENT RECOMMENDATIONS ON  
3,474 ACRES OF THE CRANDON MINE PROJECT

REFERENCE

STATE DOCUMENTS  
DEPOSITORY

STATE DOCUMENTS  
DEPOSITORY

SEP 17 1984

University of Wisconsin, LRC  
Stevens Point, Wisconsin

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FOREST INVENTORY, TIMBER APPRAISAL, AND FOREST MANAGEMENT RECOMMENDATIONS  
ON 3,474 ACRES OF THE CRANDON MINE PROJECT

PREPARED FOR

EXXON MINERALS COMPANY  
RHINELANDER, WISCONSIN

BY

EDWARD F. STEIGERWALDT AND SONS  
CONSULTANT FORESTERS, INC.  
TOMAHAWK, WISCONSIN

JULY 1982

TABLE OF CONTENTS

	<u>PAGE</u>
1.0 INTRODUCTION	1
2.0 BACKGROUND INFORMATION	2
3.0 FOREST INVENTORY	4
3.1 Methods	4
Aerial Photograph Interpretation	4
Volume Sampling	6
Field Procedure	8
Acreage Determinations	9
Volume Estimates	9
3.2 Results	9
Forest Cover Type Map	9
Acreage Summary	9
Description of Forest Cover	13
Volume Estimates	13
Statistical Analysis	13
3.3 Inventory of Areas to be Disturbed during Construction and Operation	27
4.0 TIMBER APPRAISAL	35
4.1 Methods	35
Timber Sale Data Collection	35
Data Analysis	35
4.2 Results	36
Timber Sale Data Collection	36
Timber Valuation	36
4.3 Timber Appraisal of Areas to be Disturbed during Construction and Operation	37

Table of Contents

(continued)

	<u>PAGE</u>
5.0 FOREST MANAGEMENT RECOMMENDATIONS	39
5.1 Methods	39
Wisconsin Department of Natural Resources Management Policy	39
Management Objective	40
Management Recommendations	40
Consultation with Management Specialists	40
5.2 Results	41
5.2.1 Stand Descriptions and Recommendations	41
5.3 Forest Management Plan	47
5.3.1 Harvesting Schedule	47
5.3.2 Aesthetic Management Plan	49
6.0 LITERATURE CITED	51
7.0 GLOSSARY	52
APPENDIX A: Common and Scientific Names for Tree Species Within the Crandon Project	A-1
APPENDIX B: Timber Appraisals for Disturbed Areas	B-1

LIST OF FIGURES

	<u>PAGE</u>
1. Geographic location of the Crandon Project and ore deposit	3
2. Cumulative one-fifth acre tally sheet used for forest inventory	7
3. Forest cover type map of the Crandon Project area (July 1982)	12
4. Construction zones for the Crandon Project	28



LIST OF TABLES

	<u>PAGE</u>
1. Classification scheme used for interpretation of aerial photographs	5
2. Legal descriptions and acreages for property within the Crandon Project	10
3. Acreage summary of cover types on the Crandon Project area	11
4. Description of forest and nonforest cover types	14
5. Forest cover type examination of N6, well stocked northern hardwood poletimber, on 1,821 acres of the Crandon Project	16
6. Forest cover type examination of N5, medium stocked northern hardwood poletimber, on 73 acres of the Crandon Project	17
7. Forest cover type examination of A6, well stocked aspen-white birch poletimber, on 525 acres of the Crandon Project	18
8. Forest cover type examination of A5, medium stocked aspen-white birch poletimber, on 414 acres of the Crandon Project	19
9. Forest cover type examination of SC4, poorly stocked swamp conifer poletimber, on 66 acres of the Crandon Project	20
10. Forest cover type examination of SC5, medium stocked swamp conifer poletimber, on 34 acres of the Crandon Project	21
11. Forest cover type examination of F5, medium stocked upland spruce and balsam fir poletimber, on 41 acres of the Crandon Project	22
12. Forest cover type examination of P8, medium stocked pine sawtimber, on 6 acres of the Crandon Project	23
13. Total volume estimates by species and product for forest resources on the Crandon Project	24
14. A comparison of selected forest cover types based on area, volume, and the number of sample plots	25
15. A statistical analysis of sample plot information obtained in forest cover types within the Crandon Project	26

List of Tables

(continued)

	<u>PAGE</u>
16. Acreage summary of cover types within the mine/mill site	29
17. Acreage summary of cover types within the waste disposal facility	30
18. Acreage summary of cover types within the access road	31
19. Acreage summary of cover types within the railroad spurline	32
20. Acreage summary of cover types within the slurry pipeline	33
21. Timber valuation - Crandon Project total	38

## 1.0 INTRODUCTION

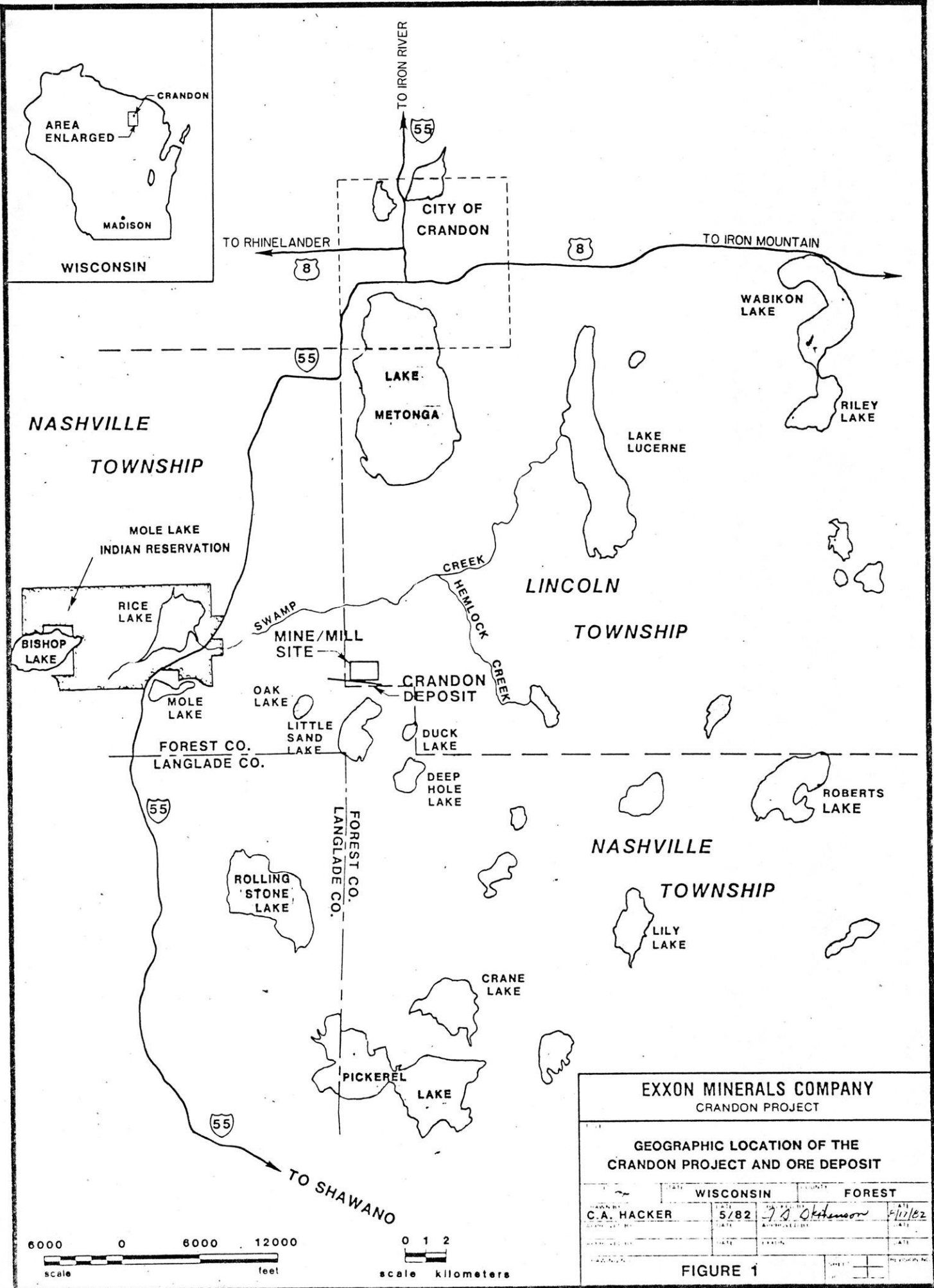
As part of preliminary development planning for the proposed Crandon Project, Exxon Minerals Company (Exxon) requested specific forest resource information on lands being considered for development. In conjunction with the Wisconsin Department of Natural Resources (DNR), Exxon determined that forest inventory, appraisal, and forest management recommendations would portray the existing forest resources and provide baseline information necessary for operational decisions. Edward Steigerwaldt and Sons were contracted to perform the forest inventory, timber appraisals, and forest management recommendations as requested by Exxon.

## 2.0 BACKGROUND INFORMATION

The subject property consisted of approximately 3,500 acres located 6 miles south of Crandon (population 1,800) and 2.5 miles east of the Mole Lake Indian Reservation (Figure 1). Major transportation arteries included U.S. Highway 8 to the north and State Highway 55 to the west. Town and private roads provided access to the forest land and the proposed Crandon Project mine/mill site.

The surrounding land ownership consisted of federal lands (U.S. Forest Service-Nicolet National Forest and Bureau of Indian Affairs), state and county forest land, industrial forest land, and smaller private parcels. Forest industry and timber harvesting are the main employment opportunities in the area. Recreation and tourism are also contributing factors to the overall local economy.

Exxon began initial investigations on the subject property in 1974. Core drilling and mineral sampling have continued on the property until the present. As the actual mine site and project development become more specific, baseline information on existing environmental conditions was necessary. This baseline analysis of the forest resources on the proposed Crandon Project site area provides the following: (1) forest inventory, (2) timber appraisals, and (3) forest management recommendations.



### 3.0 FOREST INVENTORY

#### 3.1 Methods

Stratified random sampling was selected as the technique for performing the forest inventory. Through the use of aerial photographs, the forest cover was segregated into similar units called strata, or forest cover types. The purpose of stratification was to reduce the variation within the forest and increase the precision of population estimates (in this case merchantable volume by species, cords, and board feet) (Husch et al., 1971). Stratified random sampling within each of the forest units yields precise volume estimates, and provides a cost effective approach to forest inventory (Freese, 1962).

Aerial Photograph Interpretation -- The most recent leaf-on aerial photographs were obtained to permit accurate stratification of the entire forest into similar areas or forest cover types. The aerial photographs, flown in July 1979 by the Wisconsin Department of Transportation, consisted of infrared black and white coverage at a scale of 1:20,000.

Section corners covering the project area were placed on the aerial photographs through the use of a "Map-O-Graph" 55C-2 projector which reduced an Exxon ownership map to the scale of each aerial photograph. A 10 x 10-inch mylar overlay, registered to the fiducial marks of each aerial photograph, was used to delineate the legal descriptions to be photo interpreted.

Aerial photograph interpretation of the forest and nonforest cover types was performed with an Old Delft Scanning Stereoscope according to the classification scheme in Table 1. The classification scheme of Edward Steigerwaldt and Sons stratifies the forest into cover types based on species

Table 1. Classification scheme used for interpretation of aerial photographs.

FOREST COVER TYPES		SIZE AND DENSITY CLASS	
Symbol	Species Association	Symbol	SAPLINGS
N	Northern Hardwood, Hemlock	1	Poorly stocked saplings 0-300 stems/acre
A	Aspen, White Birch	2	Medium stocked saplings 300-700 stems/acre
F	Upland Fir; Balsam Fir - White Spruce	3	Well stocked saplings 700+ stems/acre
P	Pine; Red, White, and Jack Pine		POLETIMBER
OX	Scrub Oak on dry sandy soils	4	Poorly stocked poles 3-7 cords/acre
SH	Swamp Hardwoods	5	Medium stocked poles 7-15 cords/acre
SC	Swamp Conifers	6	Well stocked poles 15+ cords/acre
			SAWTIMBER
		7	Poorly stocked sawtimber 1500-5000 board feet/acre
		8	Medium stocked sawtimber 5,000-10,000 board feet/acre
		9	Well stocked sawtimber 10,000+ board feet/acre
NON-FOREST TYPES		COVER TYPE EXAMPLES	
Symbol		Symbol	Interpretation
ROW	Right of Way	N7	Poorly stocked northern hardwood sawtimber with a volume in the 1,500 to 5,000 board feet per acre range.
F	Field (agricultural use)	SC2	Medium stocked swamp conifer saplings with 300 to 700 stems per acre.
G	Grassland		
U	Upland Brush		
L	Lowland Brush		
SX	Nonproductive Swamp		
<u>+</u>	Marsh		
W	Water or Frontage		

groups, size class (sapling, pole, sawtimber), and density class (poor, medium, and well stocked).

Volume Sampling - The stratified forest cover types were analyzed with volume per acre sampling to derive volume estimates for each forest type and the entire forest. Volume per acre estimates were obtained through the use of one-fifth acre fixed radius plots and cumulative tally sheets (Figure 2). The fixed radius sampling was chosen because it reveals an actual percentage of area sampled, as well as forest management information (i.e., trees per acre and precise basal area).

For purposes of forest inventory, appraisal, and management,  $\pm 10\%$  accuracy at a 95 percent confidence interval was selected as the sampling intensity and the indicator of statistical reliability in total inventory volume determinations. At the specified level of  $\pm 10\%$  accuracy the number of sample plots in each strata or forest cover type was determined from the formula (A. Ek, personal communication, University of Minnesota, St. Paul, MN, 1979):

$$N = \frac{t^2 C^2}{E^2}$$

where N = number of plots  
t = value of t at probability level = .95  
C = coefficient of variation  
E = desired limit of error of the estimate

Based upon our experience in forest inventory, knowledge of variability in each cover type, and the above formula, it was determined that



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 Consultant Foresters  
 Rt. 5. Tomahawk, Wi.

54487

FORM # F 202

SAMPLING TALLY-1/50 ACRE (16 6FT)										CUMULATIVE 1/5 ACRE TALLY SHEET										PLOT TYPE		MAP TYPE	
BA PER ACRE	DBH BNO TREES	SPECIES								NUMBER OF 8 FOOT BOLTS (4" OR LARGER) PER TREE										GROSS VOLUME		NON MER.	
11	2	G								1	2	3	4	5	6	CUT	LEAVE	TOTAL					
44	4	G								1	2	3	4	5	6								
DATE _____ ESTIMATOR _____ TALLYMAN _____										COUNTY _____ SEC _____ TWP _____ RGE _____ E-W _____										SITE _____			
FORTY _____ COURSE _____ PLOT _____																							
VOLUME IN TENTHS OF CORDS PER ACRE	SPEC.	NUMBER OF 8 FOOT BOLTS (4" OR LARGER) PER TREE										GROSS VOLUME		NON MER.									
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		10 11 12 13 14 15 16	16 18 19 21 22 24 25 27	24 26 28 30 32 35 37 39	23 26 29 32 35 37																		

Figure 2. Cumulative one-fifth acre tally sheet used for forest inventory.

approximately 170 one-fifth acre plots allocated to the various forest cover types would provide the desired  $\pm$  10% accuracy in the total volume estimate.

Field Sampling - Sample plots were randomly located within the various forest cover types using chainage grids, aerial photographs, and known starting points. As in standard forest inventory technique in the Lake States all trees 5 inches in diameter at breast height (DBH) at approximately 4.5 feet above ground and larger were tallied by 2-inch diameter class. Merchantable height was estimated to a 4-inch diameter (outside bark) to the nearest 8-foot stick for pulpwood. Sawtimber was measured to the nearest one-half log to a variable top diameter of 9 inches (outside bark). Each tree within the plot was recorded in the one-fifth acre cumulative tally sheet and reported by species volume on an acre basis. The common and scientific names of all tree species tallied are presented in Appendix A.

The cumulative tally sheet also was used to determine an estimate of basal area within each plot. Basal area (a measure of stand density expressed in square feet of tree cross sectional area at 4.5 feet above ground) was calculated by multiplying the number of trees in each diameter class by their approximate basal area factor. As in volume sampling, basal area was reported per acre.

Site index (the average total height of dominant and codominant trees at base age of 50 years) data were also obtained for the various forest cover types within the course of field sampling. Dominant and codominant trees were selected and measured for total height using Haga altimeters whereas age determinations were obtained from increment borings. Site indices

were calculated in the laboratory using appropriate curves for the various tree species. Site index is used as a measure of tree or stand productivity on a given site or area of the forest (Avery, 1967).

Field checking and volume sampling were performed with two crews over a 4-day period. Forest cover types delineated by aerial photograph interpretation were inspected for accuracy and possible changes since the date of photography. Changes and corrections were made on the individual mylar overlays.

Acreage Determinations - The total area of the project was determined through records of the tax listers office of the Langlade and Forest county courthouses. As shown in Table 2, the legal descriptions and corridors for an access road and railroad total 3,474 acres. The area of all forest and nonforest cover types was determined with acreage grids.

Volume Estimates - Volume estimates by species and product were obtained by averaging the one-fifth acre plots in each cover type, and expanding the average volume per acre by the area of each cover type.

### 3.2 Results

Forest Cover Type Map - A composite Forest Cover Type Map, prepared as an overlay to an Ownership Map Base provided by Exxon, is presented in Figure 3.

Acreage Summary - The acreage summary for the Crandon Project site area is presented in Table 3.

Table 2. Legal descriptions and acreages for property within the Crandon Project.

LANGLADE COUNTY		(Tax Listers Office*)	
T34N-R12E	Section 1	NW $\frac{1}{4}$	149 acres
	Section 2	NE $\frac{1}{4}$	149 acres
FOREST COUNTY		(Tax Listers Office*)	
T34N-R13E	Section 4	NW $\frac{1}{4}$ NW $\frac{1}{4}$	34 acres
	Section 5	entire	623 acres
T35N-R12E	Section 29	S $\frac{1}{2}$	160 acres
	Section 30	S $\frac{1}{2}$ , SE $\frac{1}{2}$ NW $\frac{1}{4}$ , SW $\frac{1}{2}$ NE $\frac{1}{4}$	400 acres
	Section 31	E $\frac{1}{2}$ NE $\frac{1}{4}$	80 acres
	Section 32	entire	640 acres
	Section 33	SW $\frac{1}{2}$ NW $\frac{1}{4}$ , W $\frac{1}{2}$ SW $\frac{1}{4}$	120 acres
T35N-R13E	Section 25	SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ , S $\frac{1}{2}$ NE $\frac{1}{4}$ , SE $\frac{1}{4}$ , E $\frac{1}{4}$ SW $\frac{1}{4}$	250 acres
	Section 35	SE $\frac{1}{4}$	160 acres
	Section 36	NE $\frac{1}{4}$ , SW $\frac{1}{4}$ , and platted parcel described and known as Kelchner ownership.	340 acres
Access Road Corridor	(Exxon Acreage)		179 acres
Railroad Spur Corridor	(Exxon Acreage)		190 acres
TOTAL ALL DESCRIPTIONS			3,474 acres

\* Acreages from the tax records have been rounded to the nearest whole number.

Table 3. Acreage summary of cover types on the Crandon Project area.

FOREST COVER TYPES	SAPLINGS			POLETIMBER			SAWTIMBER			TOTAL
	1	2	3	4	5	6	7	8	9	
	acres	acres	acres	acres	acres	acres	acres	acres	acres	
N - Northern Hardwoods					73	1,821				1,894
A - Aspen, Birch		15	236		414	525				1,190
F - Fir, Spruce					41					41
P - Pine								6		6
OX - Scrub Oak										
SH - Swamp Hardwoods										
SC - Swamp Conifers	6	55		66	34					161
<b>TOTAL</b>	6	70	236	66	562	2,346		6		3,292
<b>NONFOREST TYPES</b>	acres	<b>SUMMARY</b>						Harvesting Records		
R/W-Rights of Way	19	<b>TOTAL FOREST</b>				3,292		Year	Type	Area
F - Field	37									
G - Grass	36	<b>TOTAL NONFOREST</b>				182				
U - Upland Brush	10									
L - Lowland Brush	17									
SX - Nonproductive Swamp	-									
↙ - Marsh	22									
W - Water - Frontage	41									
<b>TOTAL</b>	182	<b>PROJECT TOTAL</b>				3,474				

(See map in folder.)

Figure 3. Forest cover type map of the Crandon Project area (July 1982).

Description of Forest Cover - Based upon interpretation of aerial photographs, field checking and acreage summary, the forest was segregated and classified (Table 4).

Forest land encompassed approximately 95 percent of the total acreage in the project area. Of the 3,292 acres in forest types, 91 percent (2,980 acres) were pole and sawtimber size class which contain the merchantable timber, and immediate potential for forest management.

Volume Estimates - A total of 168 one-fifth acre sample plots were obtained throughout the pole and sawtimber size classes of the forest cover. Based upon the stratification of forest cover types and volume sampling, the project area contained a total merchantable volume of 43,900 cords and 2,535,000 board feet.

Tables 5 through 12 are forest cover type examination sheets which list the volumes by species and product for each cover type. Also reported on the examination sheet is the average stand basal area as well as the results of site index measurements derived from site index curves from the Department of Natural Resources (1977) and U.S. Forest Service (1977). Table 13 presents the total volume estimate by species and product for the project area. A comparison of area, volume, and the number of sample plots by forest cover type is presented in Table 14.

Statistical Analysis - A statistical analysis was performed of each forest cover type to determine the reliability of the inventory information (Table 15). Each cover type (with more than 5 sample plots) was examined with 95 percent confidence intervals around the mean volume of cordwood products.

Table 4. Description of forest and nonforest cover types.

FOREST COVER TYPE	DESCRIPTION	ACRES
N5	Medium stocked northern hardwood poletimber with merchantable volume in the 7-15 cord per acre range.	73
N6	Well stocked northern hardwood poletimber in excess of 15 cords per acre.	1,821
A6	Well stocked aspen and white birch, with smaller amounts of northern hardwoods. Volume is in excess of 15 cords per acre.	525
A5	Medium stocked aspen and northern hardwoods with a volume range of 7-15 cords per acre.	414
A3	Well stocked aspen saplings regenerating after previous clear cutting. The young saplings are in excess of 700 stems per acre.	236
A2	Medium stocked aspen saplings with 300-700 stems per acre.	15
F5	Balsam fir, spruce, and mixed hardwood poles in the 7-15 cord per acre range.	41
P8	Medium stocked red pine, white pine and hemlock sawtimber in the volume range of 5,000 to 10,000 board feet per acre.	6
SC5	Medium stocked swamp conifers (black spruce, balsam, cedar, tamarack) in the 7-15 cord per acre range.	34
SC4	Poorly stocked swamp conifer and lowland hardwood poletimber with 3-7 cords per acre.	66
SC2	Swamp conifer saplings with 300-700 stems per acre.	55
SC1	Poorly stocked swamp conifer saplings with a stocking less than 300 stems per acre.	6
	TOTAL FOREST COVER TYPES	3,292



Table 4 continued.

NONFOREST TYPES	DESCRIPTION	ACRES
ROW	Right of way for roads, utilities, and easements.	19
F	Field areas which are suitable for agriculture.	37
↓	Marsh composed primarily of sedges and bog species.	22
L	Lowland brush composed of alder and willow.	17
U	Upland brush species invading previously open grass and field.	10
G	Grass and open areas.	36
W	Open bodies of water, including lakes, ponds, and streams.	41
TOTAL NONFOREST TYPES		182
TOTAL ALL COVER TYPES		3,474

Table 5. Forest cover type examination of N6, well stocked northern hardwood poletimber, on 1,821 acres of the Crandon Project.

SPECIES	AVERAGE VOLUME PER ACRE*		VOLUME BY COVER TYPE	
	acords	board feet	acords	board feet
Hard Maple	4.945	342.64	9,005	623,947
Red Maple	.593	29.41	1,080	53,556
Am. Basswood	3.300	255.88	6,009	465,957
Yellow Birch	.180	0	328	0
White Birch	3.015	122.05	5,490	222,253
Aspen	1.400	0	2,549	0
Red Oak	.863	263.23	1,573	479,342
White Oak	.012	0	22	0
White Ash	.647	58.82	1,178	107,112
Ironwood	.035	0	64	0
Black Cherry	.103	0	186	0
Am. Elm	.590	70.59	1,074	128,544
Black Ash	.012	0	22	0
Balsam Fir	.223	0	406	0
Hemlock	.050	8.82	91	16,061
White Spruce	.019	0	35	0
<b>TOTAL</b>	<b>15.987</b>	<b>1,151.44</b>	<b>29,112</b>	<b>2,096,772</b>
BASAL AREA/ACRE RANGE: 54-140 sq. feet AVERAGE BASAL AREA/ACRE: 78 sq. feet			# OF SAMPLE PLOTS: 68	
SITE INDEX:      Hard Maple = 70      Basswood = 75      White Ash = 82 Red Oak = 68      White Birch = 70      All Species = 73				

\* Values rounded for display purposes.

Table 6. Forest cover type examination of N5, medium stocked northern hardwood poletimber, on 73 acres of the Crandon Project.

SPECIES	AVERAGE VOLUME PER ACRE*		VOLUME BY COVER TYPE	
	ords	board feet	ords	board feet
Hard Maple	2.44	250.0	180	18,250
Red Maple	1.84	66.7	135	4,867
Am. Basswood	1.46	158.3	107	11,556
Yellow Birch	1.16	133.3	85	9,733
White Birch	2.33	83.3	172	6,081.
Aspen	.63	0	46	0
Red Oak	.32	233.3	23	17,036
White Ash	.65	33.3	48	2,436
Ironwood	.10	0	7	0
Black Cherry	.13	0	10	0
Am. Elm	.09	0	1	0
Balsam Fir	.13	0	9	0
Hemlock	.42	116.7	31	8,516
TOTAL	11.70	1,075.0	854	78,475
BASAL AREA/ACRE RANGE: 20-110 sq. feet			# OF SAMPLE PLOTS: 12	
AVERAGE BASAL AREA/ACRE: 61 sq. feet				
SITE INDEX: All species = 73 Same site index as N6 forest type.				

\* Values rounded for display purposes.

Table 7. Forest cover type examination of A6, well stocked aspen-white birch poletimber, on 525 acres of the Grandon Project.

SPECIES	AVERAGE VOLUME PER ACRE *		VOLUME BY COVER TYPE	
	cords	board feet	cords	board feet
Hard Maple	.680	23.1	357	12,128
Red Maple	.730	0	383	0
Am. Basswood	.540	30.8	283	16,170
Yellow Birch	.060	0	31	0
White Birch	4.640	126.9	2,436	66,622
Aspen	8.370	0	4,394	0
Red Oak	.870	196.2	456	103,005
White Ash	.180	0	94	0
Black Cherry	.050	0	26	0
Am. Elm	.220	0	115	0
Balsam Fir	.600	0	315	0
Hemlock	.003	0	2	0
White Spruce	.006	0	3	0
White Pine	.003	0	2	0
Black Spruce	.003	0	2	0
<b>TOTAL</b>	<b>16.95</b>	<b>377.0</b>	<b>8,899</b>	<b>197,925</b>
BASAL AREA/ACRE RANGE: 50-120 sq. feet AVERAGE BASAL AREA/ACRE: 71 sq. feet			# OF SAMPLE PLOTS: 26	
SITE INDEX: Aspen = 66      White Birch = 60				

Table 8. Forest cover type examination of A5, medium stocked aspen-white birch poletimber, on 414 acres of the Crandon Project.

SPECIES	AVERAGE VOLUME PER ACRE*		VOLUME BY COVER TYPE	
	cords	board feet	cords	board feet
Hard Maple	.58	24.24	240	10,035
Red Maple	.44	15.15	182	6,272
Am. Basswood	.82	9.09	339	3,763
Yellow Birch	.10	0	41	0
White Birch	1.12	12.12	464	5,018
Aspen	4.30	0	1,782	0
Red Oak	.02	24.24	8	10,035
White Ash	.23	0	95	0
Tamarack	.01	0	4	0
Black Cherry	.15	0	62	0
Am. Elm	.37	6.06	153	2,510
Black Ash	.05	0	21	0
White Spruce	.05	30.30	21	12,544
Balsam Fir	.83	0	344	0
Hemlock	.02	3.03	8	1,254
Black Spruce	.02	0	8	0
Jack Pine	.02	0	8	0
White Pine	.03	33.33	12	13,799
TOTAL	9.16	157.56	3,792	65,230
BASAL AREA/ACRE RANGE: 20-60 sq. feet			# OF SAMPLE PLOTS: 33	
AVERAGE BASAL AREA/ACRE: 45 sq. feet				
SITE INDEX: Aspen = 65      White Birch = 60				

\* Values rounded for display purposes. - 19 -

Table 9. Forest cover type examination of SC4, poorly stocked swamp conifer poletimber, on 66 acres of the Grandon Project.

SPECIES	AVERAGE VOLUME PER ACRE *		VOLUME BY COVER TYPE	
	cords	board feet	cords	board feet
Hard Maple	.080	0.0	5	0
Red Maple	.420	16.7	28	1,102
Yellow Birch	.056	16.6	4	1,096
White Birch	.008	0	1	0
Aspen	.100	0	7	0
Black Ash	.016	0	1	0
Tamarack	.890	0	59	0
Black Spruce	1.260	0	83	0
White Cedar	.275	25.0	18	1,650
Balsam Fir	.383	0	25	0
Hemlock	.500	108.3	33	7,148
White Pine	.230	16.7	15	1,102
<b>TOTAL</b>	<b>4.22</b>	<b>183.3</b>	<b>279</b>	<b>12,098</b>
BASAL AREA/ACRE RANGE: 10-50 sq. feet AVERAGE BASAL AREA/ACRE: 30 sq. feet			# OF SAMPLE PLOTS: 12	
SITE INDEX: Black Spruce = 30 Balsam & Tamarack = 50				

\* Values rounded for display purposes. - 20 -

Table 10. Forest cover type examination of SC5, medium stocked swamp conifer poletimber, on 34 acres of the Crandon Project.

SPECIES	AVERAGE VOLUME PER ACRE*		VOLUME BY COVER TYPE	
	ords	board feet	ords	board feet
Red Maple	.770	0	26	0
Yellow Birch	.110	0	4	0
White Birch	.014	0	0	0
Black Ash	1.060	185.7	36	6,314
Tamarack	.860	0	29	0
Black Spruce	2.990	0	102	0
White Cedar	.870	0	30	0
Balsam Fir	.460	0	16	0
Hemlock	.680	0	23	0
White Spruce	.070	0	2	0
White Pine	1.040	428.6	35	14,572
TOTAL	8.92	614.3	303	20,886
BASAL AREA/ACRE RANGE:		20-70 sq. feet	# OF SAMPLE PLOTS: 7	
AVERAGE BASAL AREA/ACRE:		55 sq. feet		
SITE INDEX:		Black Spruce = 40		

\* Values rounded for display purposes. - 21 -

Table 11. Forest cover type examination of F5, medium stocked upland spruce and balsam fir poletimber, on 41 acres of the Crandon Project.

SPECIES	AVERAGE VOLUME PER ACRE*		VOLUME BY COVER TYPE	
	ords	board feet	ords	board feet
Red Maple	.100	0	4	0
White Birch	.500	0	21	0
Aspen	4.500	0	184	0
Black Cherry	.275	0	11	0
Am. Elm	.038	0	2	0
Tamarack	.612	0	25	0
Black Spruce	1.475	0	60	0
White Cedar	.287	0	12	0
Balsam Fir	3.630	0	149	0
White Spruce	1.510	237.5	62	9,738
White Pine	.075	75.0	3	3,075
<b>TOTAL</b>	<b>13.00</b>	<b>312.5</b>	<b>533</b>	<b>12,813</b>
BASAL AREA/ACRE RANGE: 40-80 sq. feet AVERAGE BASAL AREA/ACRE: 62 sq. feet			# OF SAMPLE PLOTS: 8	
SITE INDEX: Balsam Fir = 55				

\* Values rounded for display purposes. - 22 -



Table 12. Forest cover type examination of P8, medium stocked pine sawtimber, on 6 acres of the Crandon Project.

SPECIES	AVERAGE VOLUME PER ACRE*		VOLUME BY COVER TYPE	
	ords	board feet	ords	board feet
Hard Maple	.10	0	1	0
Red Maple	1.20	500.0	7	3,000
Aspen	3.50	0	21	0
Balsam Fir	.40	0	2	0
Hemlock	2.65	1,650.0	16	9,900
White Pine	4.20	3,200.0	25	19,200
White Birch	.95	0	6	0
Red Oak	.50	100.0	3	600
Red Pine	3.10	2,950.0	19	17,700
<b>TOTAL</b>	<b>16.60</b>	<b>8,400</b>	<b>100</b>	<b>50,400</b>
BASAL AREA/ACRE RANGE: N/A			# OF SAMPLE PLOTS: 2	
AVERAGE BASAL AREA/ACRE: 110 sq. feet				
SITE INDEX: Red Pine = 55				

Table 13. Total volume estimates by species and product for forest resources on the Crandon Project.

SPECIES	CORD VOLUME	BOARD FT. VOLUME
Hard Maple	9,788	664,360
Red Maple	1,845	68,797
American Basswood	6,738	497,446
Yellow Birch	493	10,829
White Birch	8,590	299,974
Aspen	8,983	0
Red Oak	2,063	610,018
White Oak	22	0
White Ash	1,415	109,548
Ironwood	71	0
Black Cherry	295	0
American Elm	1,345	131,054
Black Ash	80	6,314
Tamarack	117	0
Black Spruce	255	0
White Cedar	60	1,650
Balsam Fir	1,266	0
Hemlock	204	42,879
White Spruce	123	22,282
White Pine	92	51,748
Red Pine	19	17,700
Jack Pine	8	0
<b>TOTAL</b>	43,872	2,534,599

Table 14. A comparison of selected forest cover types based on area, volume, and the number of sample plots.

Forest Cover Type	Area <sup>a</sup>		Volume				Plots	
	Acres	%	Cords	%	1000 Board Feet <sup>b</sup>	%	Number	%
N6	1,821	61.1	29,112	66.4	2,097	82.7	68	40.5
N5	73	2.5	854	2.0	78	3.1	12	7.1
A6	525	17.6	8,899	20.3	198	7.8	26	15.5
A5	414	13.9	3,792	8.6	65	2.6	33	19.6
SC4	66	2.2	279	.6	12	.5	12	7.1
SC5	34	1.1	303	.7	21	.8	7	4.2
F5	41	1.4	533	1.2	13	.5	8	4.8
P8	6	.2	100	.2	50	2.0	2	1.2
Total	2,980	100.0	43,872	100.0	2,534	100.0	168	100.0

<sup>a</sup> Based on 1,980 acres of pole and sawtimber cover types. Nonforest and sapling stands excluded for comparison.

<sup>b</sup> Board foot volumes rounded to nearest 1,000 feet.

Table 15. A statistical analysis of sample plot information obtained in forest cover types within the Crandon Project.

FOREST COVER TYPES				POLETIMBER STANDS				
STATISTIC *	N6	N5	A6	A5	SC5	SC4	F5	Total
MEAN	15.99	11.70	16.95	9.16	8.92	4.23	13.01	--
# OF PLOTS	68	12	26	33	7	12	8	166
STANDARD DEVIATION	5.04	4.05	5.54	3.58	2.89	1.64	4.11	--
VARIANCE	25.4	16.40	30.70	12.78	7.16	2.68	16.91	--
STD. ERROR (MEAN)	.61	1.71	1.09	.62	1.09	.47	1.46	--
STUDENTS' t n-1 .05	1.99	2.20	2.06	2.05	2.45	2.20	2.36	--
upper	17.20	14.27	19.19	10.43	11.59	5.27	16.45	
CONFIDENCE LIMITS X	15.99	11.70	16.95	9.16	8.92	4.23	13.01	--
lower	14.77	9.13	14.71	7.89	6.25	3.18	9.56	
% ERROR (+)	7.6	21.9	13.2	13.9	29.9	24.6	26.5	--
ERROR VOLUME BY TYPE (+)	2,213	187	1,175	527	91	69	141	4,403
COVER TYPE VOLUME	29,112	854	8,899	3,792	303	279	533	43,772
WEIGHTED ERROR								± 10.1

\* All statistics given in cords per acre. P8, with only two samples, is excluded.

As indicated in Table 15, the percentage of error increased as the number of sample plots in each cover type decreased. Before final field sampling was completed, it was determined that N6 (well stocked northern hardwood poles) encompassed the majority of the project area and required the greatest number of sample plots. Much smaller cover types contributing minor volume to the project total received less sampling intensity and subsequent increases in the percentage of error.

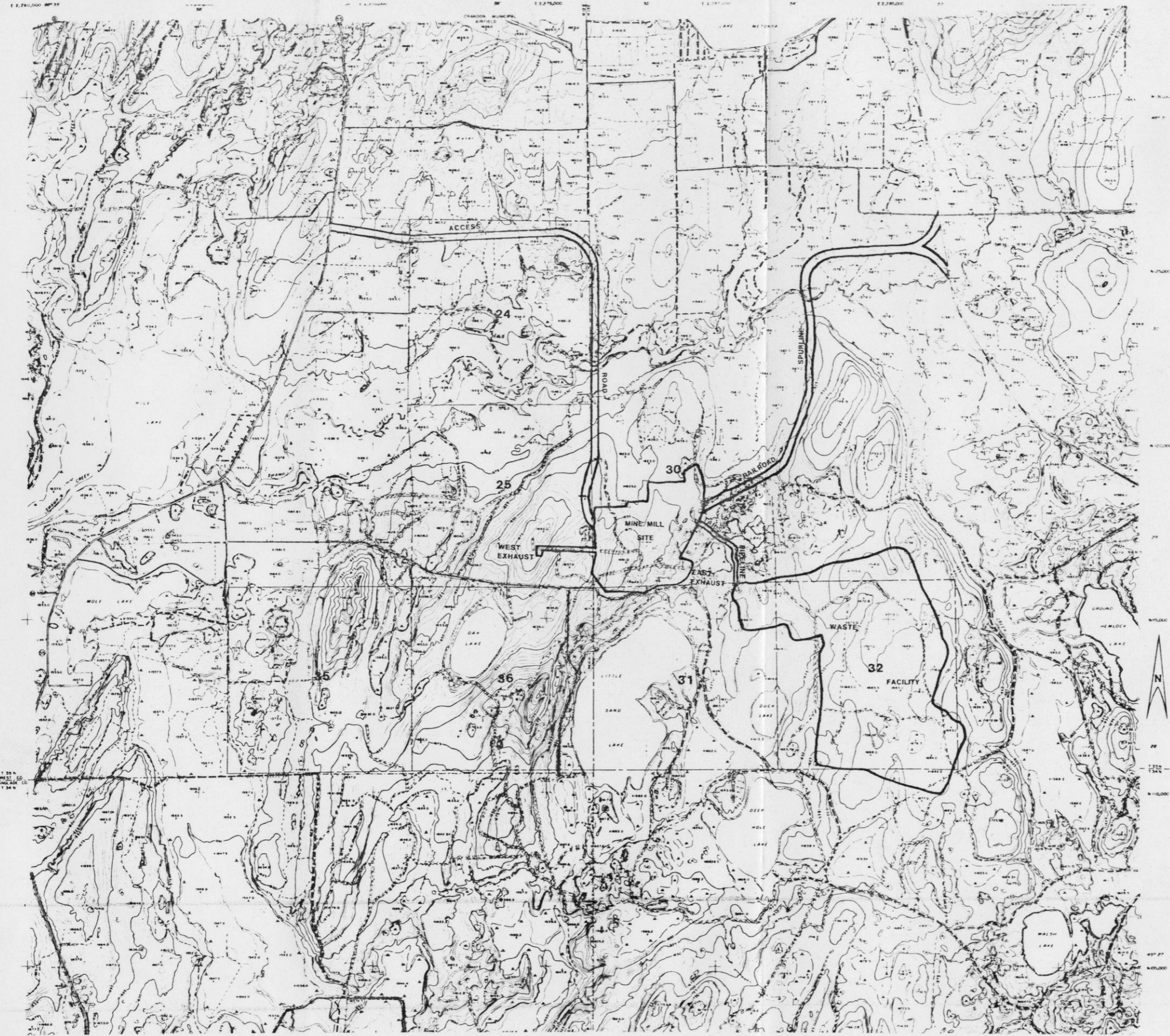
Although the smaller cover types have error above the desired  $\pm 10\%$ , a weighted average of volume and percentage of error by map type (Table 15) revealed that total volume estimates were within the  $\pm 10\%$  accuracy as anticipated. The higher sampling intensity in the larger and more variable N6 cover type improved overall inventory accuracy.

### 3.3 Inventory of Areas to be Disturbed during Construction and Operation

Areas which may be disturbed during construction and operation of the Crandon Project were defined by Exxon (Figure 4). These areas are within the project area, and were analyzed by separate inventory and appraisal reports.

Forest cover types for each potential disturbed area were determined from the original interpretation of aerial photographs. As in the preceding inventory, an acreage summary was prepared for each of these areas (Tables 16 - 20). Volume estimates were derived from the stand and stocking data (Tables 5 - 12) and the acres of each forest cover type in the disturbed areas.

Based upon the forest inventory information, each disturbed area would contain the following merchantable volume:



<b>EXXON MINERALS COMPANY</b>			
CRANDON PROJECT			
<b>CONSTRUCTION ZONES FOR THE CRANDON PROJECT</b>			
SCALE	STATE	WISCONSIN	COUNTY
			FOREST
DRAWN BY	DATE	CHECKED BY	DATE
JP BECKER	9/82		
APPROVED BY	DATE	APPROVED BY	DATE
		EXXON	
DRAWING NO.	<b>FIGURE 4</b>		SHEET OF
			REVISION NO.

Table 16. Acreage summary of cover types within the mine/mill site.

FOREST COVER TYPES	SAPLINGS			POLETIMBER			SAWTIMBER			TOTAL
	1 acres	2 acres	3 acres	4 acres	5 acres	6 acres	7 acres	8 acres	9 acres	
N - Northern Hardwoods					11	148				159
A - Aspen, Birch			10		29					39
F - Fir, Spruce										
P - Pine										
OX - Scrub Oak										
SH - Swamp Hardwoods										
SC - Swamp Conifers										
<b>TOTAL</b>			10		40	148				198
<b>NONFOREST TYPES</b>	acres	<b>SUMMARY</b>						Harvesting Records		
R/W-Rights of Way		<b>TOTAL FOREST</b>				198		Year	Type	Area
F - Field		<b>TOTAL NONFOREST</b>				3				
G - Grass	1									
U - Upland Brush	2									
L - Lowland Brush										
SX - Nonproductive Swamp										
∇ - Marsh										
W - Water - Frontage										
<b>TOTAL</b>	3	<b>AREA #1 TOTAL</b>				201				

Table 17. Acreage summary of cover types within the waste disposal facility.

FOREST COVER TYPES	SAPLINGS			POLETIMBER			SAWTIMBER			TOTAL
	1 acres	2 acres	3 acres	4 acres	5 acres	6 acres	7 acres	8 acres	9 acres	
N - Northern Hardwoods						462				462
A - Aspen, Birch					102	13				115
F - Fir, Spruce										
P - Pine										
OX - Scrub Oak										
SH - Swamp Hardwoods										
SC - Swamp Conifers	6	12		15						33
<b>TOTAL</b>	6	12		15	102	475				610
<b>NONFOREST TYPES</b>	acres	<b>SUMMARY</b>						Harvesting Records		
R/W-Rights of Way		<b>TOTAL FOREST</b>				610	Year	Type	Area	
F - Field		<b>TOTAL NONFOREST</b>				4				
G - Grass	4									
U - Upland Brush										
L - Lowland Brush										
SX - Nonproductive Swamp										
✓ - Marsh										
W - Water - Frontage										
<b>TOTAL</b>	4	<b>AREA #2 TOTAL</b>				614				



Table 18. Acreage summary of cover types within the access road.

FOREST COVER TYPES	SAPLINGS			POLETIMBER			SAWTIMBER			TOTAL
	1	2	3	4	5	6	7	8	9	
	acres	acres	acres	acres	acres	acres	acres	acres	acres	
N - Northern Hardwoods					1					1
A - Aspen, Birch			13		25	9				47
F - Fir, Spruce					12					12
P - Pine										
OX - Scrub Oak										
SH - Swamp Hardwoods										
SC - Swamp Conifers										
<b>TOTAL</b>			13		38	9				60
<b>NONFOREST TYPES</b>	acres	<b>SUMMARY</b>						Harvesting Records		
R/W-Rights of Way		<b>TOTAL FOREST</b>						Year	Type	Area
F - Field	10						60			
G - Grass	3	<b>TOTAL NONFOREST</b>								
U - Upland Brush	2						15			
L - Lowland Brush										
SX - Nonproductive Swamp										
∇ - Marsh										
W - Water - Frontage										
<b>TOTAL</b>	15	<b>AREA #3 TOTAL</b>					75			

Table 19. Acreage summary of cover types within the railroad spurline.

FOREST COVER TYPES	SAPLINGS			POLETIMBER			SAWTIMBER			TOTAL
	1 acres	2 acres	3 acres	4 acres	5 acres	6 acres	7 acres	8 acres	9 acres	
N - Northern Hardwoods						31				31
A - Aspen, Birch		5	5		7	5				22
F - Fir, Spruce										
P - Pine										
OX - Scrub Oak										
SH - Swamp Hardwoods										
SC - Swamp Conifers		1		1	3					5
<b>TOTAL</b>		6	5	1	10	36				58
<b>NONFOREST TYPES</b>	acres	<b>SUMMARY</b>						Harvesting Records		
R/W-Rights of Way		<b>TOTAL FOREST</b>				58	Year	Type	Area	
F - Field	4	<b>TOTAL NONFOREST</b>				16				
G - Grass	10									
U - Upland Brush	1									
L - Lowland Brush										
SX - Nonproductive Swamp										
∇ - Marsh										
W - Water - Frontage	1	<b>AREA #4 TOTAL</b>				74				
<b>TOTAL</b>	16									

32 -

Table 20. Acreage summary of cover types within the slurry pipeline.

FOREST COVER TYPES	SAPLINGS			POLETIMBER			SAWTIMBER			TOTAL
	1 acres	2 acres	3 acres	4 acres	5 acres	6 acres	7 acres	8 acres	9 acres	
N - Northern Hardwoods						2				2
A - Aspen, Birch					6					6
F - Fir, Spruce										
P - Pine										
OX - Scrub Oak										
SH - Swamp Hardwoods										
SC - Swamp Conifers										
<b>TOTAL</b>					6	2				8
<b>NONFOREST TYPES</b>	acres	<b>SUMMARY</b>						Harvesting Records		
R/W-Rights of Way		<b>TOTAL FOREST</b>				8	Year	Type	Area	
F - Field										
G - Grass		<b>TOTAL NONFOREST</b>				0				
U - Upland Brush										
L - Lowland Brush										
SX - Nonproductive Swamp										
∇ - Marsh										
W - Water - Frontage		<b>AREA #5 TOTAL</b>				8				
<b>TOTAL</b>										

	<u>Area</u>	<u>Acres</u>	<u>Cord Volume</u>	<u>Board Foot Volume</u>
#1	Mine/mill site	201	2,761	186,795
#2	Waste disposal	614	8,603	555,720
#3	Access road	75	550	12,157
#4	Railroad spur	74	676	40,709
#5	Slurry pipeline	8	87	3,245
		<u>972</u>	<u>12,677</u>	<u>798,626</u>

Areas which may be disturbed during construction and operation of the Crandon Project would contain 12,677 cords and 798,626 board feet of merchantable forest products.

#### 4.0 TIMBER APPRAISAL

##### 4.1 Methods

For purposes of timber appraisal, market value is defined as the highest price in terms of money which standing timber (i.e., stumpage) will bring in a competitive open market, under all conditions requisite of a fair sale, the buyer and seller each acting prudently, knowledgeably, and assuming the price is not affected by undue stimulus (Boyce, 1975).

Of the three approaches to appraisal (cost, income, and market), the market approach was selected as the most reliable indicator of stumpage value of the merchantable forest resources. Competitive bidding on county, state, and federal timber sales surrounds the subject property. This public information is considered the best indicator of stumpage market value.

Date of timber appraisal was June 1, 1982.

Timber Sale Data Collection - The most recent timber sale information from surrounding county, state, and federal lands was obtained through local government offices. Industrial and private timber sales from Edward Steigerwaldt and Sons' files were also used as indicators of stumpage value.

Data Analysis - Those sales judged most comparable to the timber on the subject property were selected as indicators of market value.

Such factors as timber character and quality, volume per acre, tract size, location, road network, and logging operability were of prime importance in relation to timber on the subject property. In addition to these factors,

competitive bidding was also considered to be a desired characteristic in the analysis and selection of comparable sales.

Those timber sales judged most comparable to the forest resources on the subject property were selected and utilized to establish the fair market value.

#### 4.2 Results

Timber Sale Data Collection - The most recent timber sale information in Forest County consisted of May 1981 competitive bidding on county forest timber sales. Timber sales for 1982 on Forest County lands will not be released for bid and opened until later in June 1982.

Timber sale information in Langlade County consisted of May and December 1981, and May 1982 competitive bidding. The May 1982 sales represented the most recent timber sale information available.

The U.S. Forest Service provided timber sale information on areas of the Nicolet National Forest tributary to the subject property. The sale information consisted of transactional evidence from the period March 1981 to February 1982 which had been averaged by volume and listed for various zones of the Nicolet National Forest.

Timber Valuation - For appraisal and marketing purposes some individual species of pulpwood and sawtimber were grouped into similar product classes (i.e., mixed hardwood pulpwood). The product classes in the following valuation were based upon the actual comparable sales selected for the timber appraisal.

Over 80 timber sales were collected, of which 25 were selected as comparable to the subject property. Based upon stumpage reported in the 25

comparable sales, and knowledge of timber resources on the subject property, the merchantable forest resources would have the value as presented in Table 21. Based on this analysis, the forest resources on the Crandon Project would have a market value of \$434,600.00.

4.3 Timber Appraisal of Areas to be Disturbed during Construction and Operation

Areas which may be disturbed during construction and operation of the Crandon Project were defined by Exxon. These areas are within the project area, and were analyzed with separate inventory and appraisal reports.

The volume of merchantable forest products on each disturbed area was determined from acreage summaries (Tables 16 - 20), stand and stocking date (Tables 5 - 12), and the original interpretation of aerial photographs. The value of forest products was determined from the preceding analysis and selection of comparable timber sales in the area.

Based upon the forest inventory and comparable sales analysis, each disturbed area would contain the following value of merchantable timber:

Summary of Timber Values on Disturbed Areas:

Mine/mill site . . . . .	\$ 28,300.00
Waste disposal facility. . . . .	86,800.00
Access road. . . . .	4,500.00
Railroad spur. . . . .	6,700.00
Slurry pipeline. . . . .	<u>780.00</u>
TOTAL	\$127,080.00

Timber appraisals for each of these areas are presented in Appendix B.

Based on the forest inventory and comparable sales analysis, the forest resources on areas which may be disturbed during construction and operation would have a market value of \$127,080.00.

Table 21. Timber valuation - Crandon Project total.

PULPWOOD

<u>SPECIES</u>	<u>CORDS</u>	<u>PRICE/CORD</u>	<u>VALUE</u>
Mixed Hardwood	17,417	\$ 7.00	\$121,919.00
Aspen	8,983	8.75	78,601.25
White Birch	8,590	6.35	54,546.50
American Basswood	6,738	2.00	13,476.00
Balsam Fir	1,266	6.00	7,596.00
Mixed Conifer	432	4.00	1,728.00
Hemlock	204	5.00	1,020.00
White Spruce	123	6.00	738.00
White Pine	92	9.00	828.00
Jack and Red Pine	27	18.00	486.00
TOTAL	43,872		\$280,938.75

SAWTIMBER

<u>SPECIES</u>	<u>BOARD FEET</u>	<u>PRICE/THOUSAND</u>	<u>VALUE</u>
Hard Maple	664,360	\$ 70.00	\$ 46,505.20
Red Oak	610,018	70.00	42,701.26
American Basswood	497,446	60.00	29,846.76
White Birch	299,974	40.00	11,998.96
American Elm	131,054	55.00	7,207.97
White & Black Ash	115,862	45.00	5,213.79
Red Maple	68,797	50.00	3,439.85
Red & White Pine	69,448	65.00	4,514.12
Hemlock	42,879	15.00	643.19
Yellow Birch	10,829	85.00	920.47
Misc. Species	23,932	30.00	717.96
TOTAL	2,534,599		\$153,709.53

VALUATION SUMMARY:

Pulpwood.....	\$280,938.75
Sawtimber.....	<u>\$153,709.53</u>
Total	\$434,648.28



## 5.0 FOREST MANAGEMENT RECOMMENDATIONS

### 5.1 Methods

In accordance with recommendations provided by the DNR to Exxon, forest management recommendations (similar to current practices on county and state lands) would be required to analyze the current and potential utilization of the forest resource.

To facilitate sound forest management on the Crandon Project, Exxon requested specific silvicultural and management guidelines which can be initiated on the forest. The following forest management recommendations are based upon DNR silvicultural guidelines (Wisconsin Department of Natural Resources, 1977); however, the forest management plan was prepared for Exxon as a private landowner.

Wisconsin Department of Natural Resources Management Policy - Forest management by the DNR follows specific guidelines set forth in Memorandum 2431.5 titled, "Silvicultural and Forest Aesthetics Handbook," (Wisconsin Department of Natural Resources, 1977). The handbook describes applications of aesthetic forest management and silvicultural guidelines which are to be conducted on county and state lands under DNR jurisdiction.

Management policy on State of Wisconsin forest land is directed towards public use and public perception of forest management. State forests are properly managed for multiple use involving public recreation and timber production. To facilitate public recreation, the main objectives of forest management have been modified to include aesthetic management (along roads

and water) and "Big Tree Silviculture" (propagation of old growth timber). These objectives take precedent over maximizing timber yields.

In areas of less intensive public use, such as county forests, aesthetic management is performed along selected roads and water bodies; however, timber production is the primary objective.

Management Objective - Based upon guidelines set forth in the DNR handbook, management objectives for the subject property were developed to stimulate timber production through prescribed stand treatments, and to maintain aesthetic qualities along public corridors and areas of water-oriented recreation.

Management Recommendations - Forest inventory and stand information collected throughout the field sampling formed the basis for management recommendations. Such characteristics as stand basal area, age, volume/acre, and site index were analyzed before developing the management decisions.

Characteristics of each forest cover type were compared to silvicultural guidelines published by the DNR (Wisconsin Department of Natural Resources, 1977) and the U.S. Forest Service (U.S. Department of Agriculture, 1977). Published forest research and the contractor's experience in forest management provided the framework for management recommendations on the subject property.

Consultation with Management Specialists - Preliminary management recommendations were reviewed and critiqued by forest management specialists from the DNR and U.S. Forest Service (M. Beaufeaux and K. Gehrke, personal

communication, Wisconsin Department of Natural Resources and USDA - Forest Services, respectively, 1982). An outside analysis of inventory, stand information, and silvicultural guidelines served to reinforce the management objectives and recommendations. Their critical review has been incorporated into the following forest management recommendations.

## 5.2 Results

### 5.2.1 Stand Descriptions and Recommendations

Forest Cover Type: Northern Hardwoods

Classification: N6, well stocked poletimber - 1,821 acres

This was the largest cover type on the subject property, and consisted of second-growth hardwood poles that originated from previous clear cutting of the virgin hardwood timber. The stands were fairly uniform in age, with most trees in the 35-45 year age bracket.

The site index averaged 73 for the hardwood species, which indicated that northern hardwoods were well suited to the site and soil types. The N6 types contained an average volume of 16 cords and 1,150 board feet per acre. Average basal area for the cover type was 72 square feet, and included sample plots affected by numerous mine drilling sites, openings, and other edges of forest cover. Excluding plots affected by openings, the stand basal area consistently was 90-130 square feet.

According to northern hardwood management guidelines (Tubbs, 1977), desirable stocking for good continuous growth would be approximately 118 trees/acre and 85 square feet of basal area (in trees 5 inches DBH and larger). An analysis of our sample plots revealed an average of 200 trees/

acre (in trees 5 inches DBH and larger), of which 75 percent were in the small diameter range classes of 6 and 8 inches.

Based upon high basal area, and an over stocking of trees/acre, it is recommended that the N6 cover type receive a light selection harvest, removing excessive 6 and 8 inch trees to improve spacing and growth on the residual stand. Forest management goal for this cover type is to eventually produce sustained yields of high value saw log products (Tubbs, 1977). Selected thinning will increase growth on all size classes and push the residual growing stock into larger sized diameters.

A recommended selection harvest will reduce stand basal area to 60-70 square feet/acre, producing approximately 5-7 cords/acre of pulpwood products. It is recommended that the N6 cover type be prepared for harvest in 1982.

When the basal area reaches 90-100 square feet from future in-growth, the type would be ready for another marked harvest. Normally, this would occur between 8 and 12 years after the initial thinning. In all-age northern hardwood management, the stand would normally be ready for a perpetual sustained harvest at 10-year intervals.

Classification: N5, Medium stocked poletimber - 73 acres

This stand was similar to the N6 cover type in site index, age, and species composition; however, it was moderately harvested approximately 2 years ago. The current basal area of 60-65 square feet/acres, and average volume of 11.7 cords/acre, do not warrant any stand treatment at this time.

Our management recommendation is to let the N5 cover type grow until the second selection harvest is in the surrounding N6 type in 1992.

Harvesting schedules for the N5 cover type should be identical to the surrounding N6 type once initiated into northern hardwood management in 1992.

Forest Cover Type: Aspen-White Birch

Classification: A6, Well stocked aspen-birch poletimber -  
525 acres

The A6 forest type averaged about 17 cords and 380 board feet per acre. Aspen and white birch were the dominant species, followed by minor amounts of mixed hardwoods. A site index of 65 for aspen and 60 for white birch indicated that the site was well suited for aspen-birch productivity.

Aspen averaged 51 years old within the A6 cover type. According to DNR guidelines, the rotation age at site index 65 would be approximately 45 years of age. Based upon published guidelines and inspection of the A6 types, these stands are mature and should be harvested in the immediate future.

Clear cutting aspen types is the silvicultural method of regenerating fully stocked stands of the species (Perala, 1977). Coppice sprouts arise immediately after harvesting and comprise the next manageable aspen stand. The future aspen stand should be harvested again at approximately 45 years of age.

Classification: A5, Medium stocked aspen and mixed  
hardwood poles - 414 acres

These areas averaged 9 cords and 160 board feet/acre. Aspen and white birch were the dominant species, followed by minor amounts of mixed hardwoods and some conifers. The site index for aspen was 65, and 60 for white birch. The average age of aspen in this type was 36 years.

The A5 forest types appear to have developed in former openings in the forest. These areas have succeeded into a mixed forest cover of aspen,

balsam, northern hardwoods, and upland brush. Some portions of these stands were associated with lowland hardwoods of black ash, elm, and red maple. The predominant species in volume and basal area was aspen, with 4.3 cords and 25-30 square feet of basal area/acre.

It is recommended that the A5 types be allowed to grow until the aspen reaches maturity at age 45-50. The A5 cover type, although mixed with northern hardwoods, should be managed as aspen in nearly all locations. Upon reaching maturity, the A5 types should be clear cut and regenerated into aspen. Along public access roads, the A5 type could be converted to hardwood areas through aesthetic management guidelines (see aesthetic management under the forest management plan).

Classification: A2, Medium stocked aspen saplings - 15 acres  
A3, Well stocked aspen saplings - 236 acres

These cover types consisted of aspen and hardwood saplings that had regenerated after clear cutting of mature aspen.

Since these areas were medium and well-stocked with reproduction, the best course of action would be to permit the trees to grow until maturity at age 45-50.

Forest Cover Type: Swamp conifers

Classification: SC5, Medium stocked swamp conifer poles -  
34 acres

The medium stocked swamp conifers were composed primarily of black spruce, balsam fir, cedar, tamarack, black ash, and minor miscellaneous species. The average volume/acre was 9 cords and 615 board feet. The black spruce averaged 60 years of age and had a site index of 40.

According to DNR and U.S. Forest Service guidelines, the SC5 types have a harvest or rotation age of approximately 100 years. The management recommendations would be to permit the stands to grow for approximately 30-40 years until mature. The stands should be checked periodically to investigate mortality and stand deterioration. The harvest age may be less than 100 years if tree mortality becomes excessive.

Classification: SC4, Poorly stocked swamp conifer poles -  
66 acres

These stands consisted of poorly stocked swamp conifer poles with only 4.2 cords and 180 board feet/acre. As in the SC5 types, swamp conifers were the dominant trees, although small areas of lowland hardwoods (black ash and red maple) did exist.

The average age for black spruce was 50 years. The site index for balsam and tamarack was 50, whereas it was 30 for black spruce. According to management guidelines, the harvest age for these stands occurs at age 100. Our recommendation is to allow the stands to grow for approximately 50 years until mature.

Upon maturity and clear cutting of the SC4 and SC5 cover types, the sites should be regenerated back into black spruce through site preparation and seeding (Johnston, 1977).

Classification: SC2, Medium stocked swamp conifer saplings -  
55 acres

SC1, Poorly stocked swamp conifer saplings -  
6 acres

These areas contained swamp conifer saplings predominantly tamarack and black spruce. No management of these areas would be practical until

merchantability is evident. Harvest age would be 100 years if the saplings are able to develop into pole stands on these poor sites.

Forest Cover Type: Upland Fir-Spruce

Classification: F5, Medium stocked upland balsam and spruce  
poletimber - 41 acres

These stands averaged 13 cords per acre of balsam fir, white and black spruce, cedar, tamarack, aspen, and other hardwoods. The sites were predominantly upland, with some seasonal low and wet areas.

Balsam fir was approximately 45 years old, and had a site index of 55. According to available management guidelines, the balsam fir types should be clear cut at age 50 on these sites. Spruce budworm infestations were evident in the F5 type, and were causing tree mortality. It is our management recommendation to harvest the F5 forest types in the near future to prevent excessive losses of merchantable timber.

Reproduction after clear cutting the overstory will be predominantly aspen and balsam fir. If insufficient stocking results from natural reproduction, the F5 areas should be disced and planted to white spruce or red pine on the most upland areas.

Forest Cover Type: Pine Sawtimber

Classification: P8, Medium stocked red and white pine  
sawtimber - 6 acres

This small stand was composed of red pine, white pine, and hemlock sawtimber, along with mixed hardwood poles. The stand averaged 16.6 cords and 8,400 board feet/acre. The site index for red pine was 55, while basal area averaged 110 square feet.



According to management guidelines, basal area for red pine sawtimber can exceed 140 square feet/acre before thinning is necessary (Benzie, 1977). Accordingly, no immediate management would be necessary. However, a light stand improvement harvest should be performed to remove competing aspen and hardwood poletimber. Management efforts should be aimed at maintaining the pine sawtimber type. Periodic removal of hardwood and other conifers would favor the growth of pine crop trees, and influence red and white pine natural reproduction.

### 5.3 Forest Management Plan

Based upon the preceding management recommendations, a forest management plan can be devised which outlines a course of action for implementing necessary management activities. The following forest management plan is a practical approach to stimulate forest productivity, improve wildlife habitat, and preserve aesthetics along public routes.

#### 5.3.1 Harvesting Schedule

The preceding forest management recommendations delineate four major cover types (N6, A6, F5, P8) that need immediate stand treatment to stimulate productivity. The cover types encompass 2,393 acres and include individual tree selection harvesting in the northern hardwoods and pine types, and clear cutting of aspen and upland balsam types. Harvesting all 2,393 acres in 1982 is possible; however, it would not be the most advantageous harvesting schedule for wildlife and aesthetics.

Ruffed grouse (Bonasa umbellus) and white-tailed deer (Odocoileus virginianus) are the two most popular upland game species within the project

area and northern Wisconsin as well. Successful management of these species is largely dependent upon age class diversity in the management of aspen forest cover (Gullion, 1977). Aspen regeneration provides immediate food for white-tailed deer, and necessary cover for ruffed grouse. Age class diversity ensures a continued supply of food and cover for these popular game species.

To promote age class diversity in the aspen resource and create manageable harvesting operations, it is recommended that a 3-year harvesting schedule be implemented for the 2,393 acres in need of immediate management. In each of the next 3 years approximately 800 acres of forest land could be designated for harvest. Each 800 acre block would include approximately one-third of the mature aspen and one-third of the well stocked northern hardwoods. Within this initial management plan, the pine sawtimber (6 acres) and upland balsam fir (41 acres) would also receive their recommended harvesting. As further wildlife management considerations, logging roads, in addition to the existing core drilling sites, also can be seeded to clover and grass species.

The next phase of the management plan would begin when the northern hardwoods again reach 90-100 square feet of basal area/acre (in about 10 years). A similar 3-year harvesting schedule designed to selectively harvest the northern hardwoods and clear cut the current A5 types could be initiated in 1992.

Subsequent phases of the management plan would be devised for continued northern hardwood management and associated harvesting of swamp conifers and aspen types at maturity.

### 5.3.2 Aesthetic Management Areas

The DNR guidelines for aesthetic management center on public perception of forests as scenic attraction. Normal timber harvesting and management prescriptions are altered to maintain scenic qualities along public roads and water frontages.

As indicated on the Forest Cover Type Map (Figure 3), aesthetic management would include adjacent areas along existing public roads, the proposed road corridor, and lake frontages. Forest management recommendations for the cover types within aesthetic management areas remain intact, with the exception of aspen clear cutting. Aspen clear cutting along aesthetic areas can be modified to selected harvesting of mature aspen, leaving all sound hardwoods and conifers. It is anticipated that the selectively harvested aspen areas will eventually convert to more aesthetic northern hardwoods.

To promote aesthetics, timber harvesting along public roads and water frontages should be performed in accordance with the following guidelines:

- 1) Timber sale boundaries (particularly aspen clear cutting) should be determined by foresters with sensitivity and experience in scenic valuation. Aesthetic management areas should be blended into the surrounding forest.
- 2) Actual logging within aesthetic zones should be performed to reduce visual impact. Slash and debris can be knocked down to within 18 inches of the ground. No tops of harvested trees shall be permitted on roads, shoulders, or in lakes and streams.
- 3) Excess road building and earth moving along roads and water frontages should be prohibited.
- 4) Document forest management activities with informative interpretive signs. This has worked well for Wisconsin forest industries, government agencies on public lands, and consultant foresters for their clients.

Forest management geared towards visual quality should be an important characteristic in the overall development of the Crandon Project.

Based upon sound forest management recommendations and a forest management plan, Exxon has the necessary information to initiate proper management on the forest resources within the Crandon Project site area.

6.0 LITERATURE CITED

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## 7.0 GLOSSARY

basal area: The area of the cross-section of a tree stem at 4.5 feet above the ground.

board foot: The amount of timber equivalent to a piece 1 foot long by 1 foot wide, and 1 inch thick.

conifer: The order of Gymnosperms comprising evergreens bearing cones, with needle-shaped or scale-like leaves.

cord: A unit of gross volume for stacked pulpwood. A standard cord contains 128 cubic feet, and implies a stack 4 feet high, 4 feet wide, and 8 feet long.

DBH: Diameter at breast height; now a standard of 4.5 feet above the ground.

fiducial marks: Index marks superimposed on an aerial photograph negative to define it's principal point.

forest cover type: A classification of the forest defined by the dominant species, or species.

hardwood: The order of Angiosperms comprised of broad-leaved trees.

poletimber: Trees with a diameter at breast height larger than 5 inches, but less than 11 inches.

sapling: Trees with a diameter at breast height less than 5 inches.

sawtimber: Trees with a diameter at breast height larger than 11 inches.

silviculture: The theory and practice of controlling establishment, composition, and growth of forests.

site index: A measure of site productivity based on the height of dominant and codominant trees in a stand, at a base age of 50 years.

stand: A community of trees possessing sufficient uniformity in regard to composition, age, distribution, and condition to be distinguishable from adjacent communities, and forming a silvicultural or management entity.

stocking: A subjective indication of the number of trees in a stand as compared to a more desirable number for better results.

APPENDIX A

Common and Scientific Names for Tree Species  
Within the Crandon Project Area

Common and Scientific Names for Tree Species  
Within the Crandon Project Area

<u>COMMON NAME</u>	<u>SCIENTIFIC NAME</u>
Hard Maple	<u>Acer saccharum</u>
Red Maple	<u>Acer rubrum</u>
American Basswood	<u>Tilia americana</u>
Yellow Birch	<u>Betula alleghaniensis</u>
White Birch	<u>Betula papyrifera</u>
Aspen - Quaking	<u>Populus tremuloides</u>
Aspen - Bigtooth	<u>Populus grandidentata</u>
Red Oak	<u>Quercus rubra</u>
White Oak	<u>Quercus alba</u>
White Ash	<u>Fraxinus americana</u>
Black Ash	<u>Fraxinus nigra</u>
Ironwood	<u>Ostrya virginiana</u>
Black Cherry	<u>Prunus serotina</u>
American Elm	<u>Ulmus americana</u>
Tamarack	<u>Larix laricina</u>
Black Spruce	<u>Picea mariana</u>
White Spruce	<u>Picea glauca</u>
White Cedar	<u>Thuja occidentalis</u>
Balsam Fir	<u>Abies balsamea</u>
Hemlock	<u>Tsuga canadensis</u>
White Pine	<u>Pinus strobus</u>
Red Pine	<u>Pinus resinosa</u>
Jack Pine	<u>Pinus banksiana</u>



APPENDIX B

Timber Appraisals for Disturbed Areas

TIMBER VALUATION - Area #1, Mine/Mill Site

PULPWOOD

<u>SPECIES</u>	<u>CORDS</u>	<u>PRICE/CORD</u>	<u>VALUE</u>
Mixed Hardwood	1,313	\$ 7.00	\$ 9,191.00
Aspen	339	8.75	2,966.25
White Birch	504	6.35	3,200.40
American Basswood	528	2.00	1,056.00
Balsam Fir	58	6.00	348.00
Mixed Conifer	0	4.00	0.00
Hemlock	13	5.00	65.00
White Spruce	4	6.00	24.00
White Pine	1	9.00	9.00
Jack and Red Pine	1	18.00	18.00
TOTAL	2,761		\$ 16,877.65

SAWTIMBER

<u>SPECIES</u>	<u>BOARD FEET</u>	<u>PRICE/THOUSAND</u>	<u>VALUE</u>
Hard Maple	54,164	\$ 70.00	\$ 3,791.48
Red Oak	42,228	70.00	2,955.96
American Basswood	39,875	60.00	2,392.50
White Birch	19,327	40.00	773.08
American Elm	10,623	55.00	584.27
White & Black Ash	9,071	45.00	408.20
Red Maple	5,523	50.00	276.15
Red & White Pine	967	65.00	62.86
Hemlock	2,672	15.00	40.08
Yellow Birch	1,466	85.00	124.61
Misc. Species	879	30.00	26.37
TOTAL	186,795		\$ 11,435.56

VALUATION SUMMARY:

Pulpwood.....\$ 16,877.65

Sawtimber.....\$ 11,435.56

Total \$ 28,313.21

Based on the above analysis, the forest resources on the mine/mill site would have a market value of \$28,300.00.

TIMBER VALUATION - Area #2, Waste Facility

PULPWOOD

<u>SPECIES</u>	<u>CORDS</u>	<u>PRICE/CORD</u>	<u>VALUE</u>
Mixed Hardwood	3,930	\$ 7.00	\$ 27,510.00
Aspen	1,194	8.75	10,447.50
White Birch	1,567	6.35	9,950.45
American Basswood	1,616	2.00	3,232.00
Balsam Fir	202	6.00	1,212.00
Mixed Conifer	39	4.00	156.00
Hemlock	33	5.00	165.00
White Spruce	14	6.00	84.00
White Pine	6	9.00	54.00
Jack and Red Pine	2	18.00	36.00
TOTAL	8,603		\$ 52,846.95

SAWTIMBER

<u>SPECIES</u>	<u>BOARD FEET</u>	<u>PRICE/THOUSAND</u>	<u>VALUE</u>
Hard Maple	161,070	\$ 70.00	\$ 11,274.90
Red Oak	126,630	70.00	8,864.10
American Basswood	119,550	60.00	7,173.00
White Birch	59,275	40.00	2,371.00
American Elm	33,230	55.00	1,827.65
White & Black Ash	27,180	45.00	1,223.10
Red Maple	15,386	50.00	769.30
Red & White Pine	3,650	65.00	237.25
Hemlock	6,034	15.00	90.51
Yellow Birch	250	85.00	21.25
Misc. Species	3,465	30.00	103.95
TOTAL	555,720		\$ 33,956.01

VALUATION SUMMARY:

Pulpwood.....	\$ 52,846.95
Sawtimber.....	\$ 33,956.01
Total	\$ 86,802.96

Based on the above analysis, the forest resources on the waste facility would have a market value of \$86,800.00.

TIMBER VALUATION - Area #3, Access Road

PULPWOOD

<u>SPECIES</u>	<u>CORDS</u>	<u>PRICE/CORD</u>	<u>VALUE</u>
Mixed Hardwood	86	\$ 7.00	\$ 602.00
Aspen	238	8.75	2,082.50
White Birch	78	6.35	495.30
American Basswood	28	2.00	56.00
Balsam Fir	69	6.00	414.00
Mixed Conifer	28	4.00	112.00
Hemlock	1	5.00	5.00
White Spruce	19	6.00	114.00
White Pine	2	9.00	18.00
Jack and Red Pine	1	18.00	18.00
TOTAL	550		\$ 3,916.80

SAWTIMBER

<u>SPECIES</u>	<u>BOARD FEET</u>	<u>PRICE/THOUSAND</u>	<u>VALUE</u>
Hard Maple	1,064	\$ 70.00	\$ 74.48
Red Oak	2,606	70.00	182.42
American Basswood	661	60.00	39.66
White Birch	1,529	40.00	61.16
American Elm	152	55.00	8.36
White & Black Ash	33	45.00	1.49
Red Maple	446	50.00	22.30
Red & White Pine	1,733	65.00	112.65
Hemlock	193	15.00	2.90
Yellow Birch	133	85.00	11.31
Misc. Species	3,607	30.00	108.21
TOTAL	12,157		\$ 624.94

VALUATION SUMMARY:

Pulpwood.....	\$ 3,916.80
Sawtimber.....	\$ 624.94
Total	\$ 4,541.74

Based on the above analysis, the forest resources on the access road would have a market value of \$4,500.00.

TIMBER VALUATION - Area #4, Railroad Spur

PULPWOOD

<u>SPECIES</u>	<u>CORDS</u>	<u>PRICE/CORD</u>	<u>VALUE</u>
Mixed Hardwood	278	\$ 7.00	\$ 1,946.00
Aspen	117	8.75	1,023.75
White Birch	125	6.35	793.75
American Basswood	111	2.00	222.00
Balsam Fir	17	6.00	102.00
Mixed Conifer	28	4.00	112.00
Hemlock	0	5.00	0.00
White Spruce	0	6.00	0.00
White Pine	0	9.00	0.00
Jack and Red Pine	0	18.00	0.00
TOTAL	676		\$ 4,199.50

SAWTIMBER

<u>SPECIES</u>	<u>BOARD FEET</u>	<u>PRICE/THOUSAND</u>	<u>VALUE</u>
Hard Maple	10,907	\$ 70.00	\$ 763.49
Red Oak	9,311	70.00	651.77
American Basswood	8,150	60.00	489.00
White Birch	4,505	40.00	180.20
American Elm	2,230	55.00	122.65
White & Black Ash	2,380	45.00	107.10
Red Maple	1,035	50.00	51.75
Red & White Pine	1,535	65.00	99.78
Hemlock	402	15.00	6.03
Yellow Birch	0	85.00	0.00
Misc. Species	254	30.00	7.62
TOTAL	40,709		\$ 2,479.39

VALUATION SUMMARY:

Pulpwood.....	\$ 4,199.50
Sawtimber.....	\$ <u>2,479.39</u>
Total	\$ 6,678.89

Based on the above analysis, the forest resources on the railroad spur would have a market value of \$6,700.00.

TIMBER VALUATION - Area #5, Slurry Pipeline

PULPWOOD

<u>SPECIES</u>	<u>CORDS</u>	<u>PRICE/CORD</u>	<u>VALUE</u>
Mixed Hardwood	26	\$ 7.00	\$ 182.00
Aspen	30	8.75	262.50
White Birch	12	6.35	76.20
American Basswood	13	2.00	26.00
Balsam Fir	6	6.00	36.00
Mixed Conifer	0	4.00	0.00
Hemlock	0	5.00	0.00
White Spruce	0	6.00	0.00
White Pine	0	9.00	0.00
Jack and Red Pine	0	18.00	0.00
TOTAL	87		\$ 582.70

SAWTIMBER

<u>SPECIES</u>	<u>BOARD FEET</u>	<u>PRICE/THOUSAND</u>	<u>VALUE</u>
Hard Maple	884	\$ 70.00	\$ 59.08
Red Oak	665	70.00	46.55
American Basswood	555	60.00	33.30
White Birch	325	40.00	13.00
American Elm	176	55.00	9.68
White & Black Ash	120	45.00	5.40
Red Maple	150	50.00	7.50
Red & White Pine	200	65.00	13.00
Hemlock	0	15.00	0.00
Yellow Birch	0	85.00	0.00
Misc. Species	210	30.00	6.30
TOTAL	3,245		\$ 193.81

VALUATION SUMMARY:

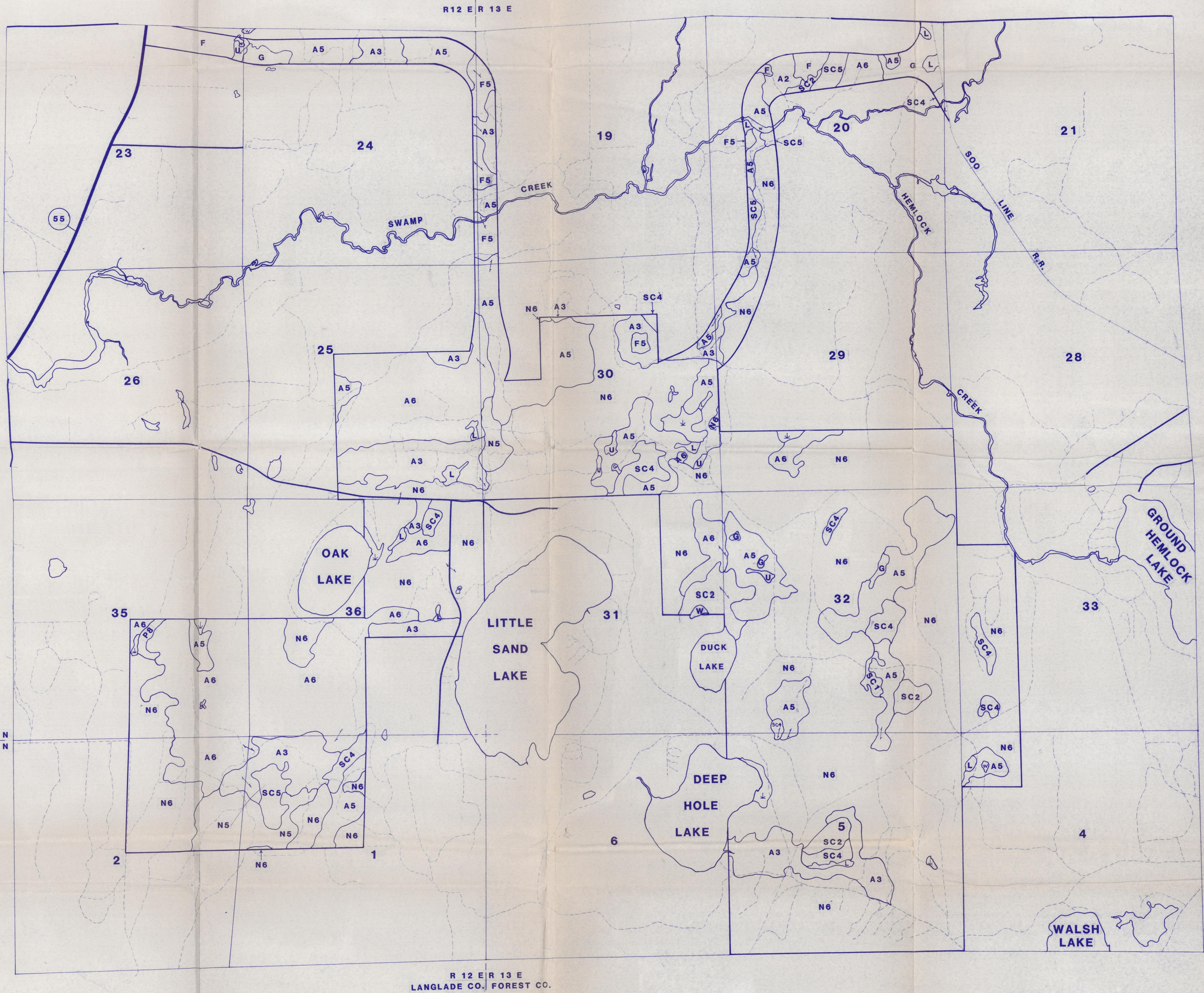
Pulpwood.....	\$ 582.70
Sawtimber.....	\$ 193.81
Total	\$ 776.51

Based on the above analysis, the forest resources on the mine/mill site would have a market value of \$780.00.

**LEGEND**

FOREST COVER TYPE	DESCRIPTION
N5	Medium stocked northern hardwood pole timber with merchantable volume in the 7-15 cord per acre range.
N6	Well stocked northern hardwood pole timber in excess of 15 cords per acre.
A6	Well stocked aspen and white birch, with smaller amounts of northern hardwoods. Volume is in excess of 15 cords per acre.
A5	Medium stocked aspen and northern hardwoods with a volume range of 7-15 cords per acre.
A3	Well stocked aspen saplings regenerating after previous clear cutting. The young saplings are in excess of 700 stems per acre.
A2	Medium stocked aspen saplings with 300-700 stems per acre.
F5	Balsam fir, spruce, and mixed hardwood poles in the 7-15 cord per acre range.
P8	Medium stocked red pine, white pine and hemlock saw timber in the volume range of 5,000 to 10,000 board feet per acre.
SC5	Medium stocked swamp conifers (black spruce, balsam, cedar, tamarack) in the 7-15 cord per acre range.
SC4	Poorly stocked swamp conifer and lowland hardwood pole timber with 3-7 cords per acre.
SC2	Swamp conifer saplings with 300-700 stems per acre.
SC1	Poorly stocked swamp conifer saplings with a stocking less than 300 stems per acre.

NONFOREST TYPES	DESCRIPTION
ROW	Right of way for roads, utilities, and easements.
F	Field areas which are suitable for agriculture.
+	Marsh composed primarily of sedges and bog species.
L	Lowland brush composed of alder and willow.
U	Upland brush species invading previously open grass and field.
G	Grass and open areas.
W	Open bodies of water, including lakes, ponds, and streams.



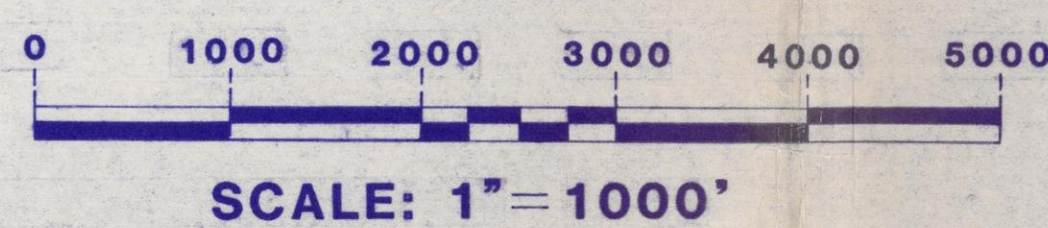
FOREST CO. T 35 N  
LANGLADE CO. T 34 N

T 35 N  
T 34 N

R 12 E R 13 E  
LANGLADE CO. FOREST CO.



EDWARD STEIGERWALDT & SONS  
CONSULTANT FORESTERS INC.



EXXON MINERALS COMPANY CRANDON PROJECT			
TITLE <b>FOREST TYPE MAP OF THE CRANDON PROJECT AREA (JULY 1982)</b>			
SCALE	STATE WISCONSIN	COUNTY	FOREST
DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
DRAWING NO.	SHEET OF		REVISION NO.
<b>FIGURE 3</b>			

UW-STEVENS POINT



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