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VEGETATION TYPES AND FOREST PRODUCTIVITY, WEST PART OF SYNCRUDE'S LEASE 17, ALBERTA

FOREWORD

Syncrude Canada Ltd. is producing synthetic crude oil from a surface mine on the eastern portion of Crown Lease 17. Western Ecological Services Ltd. was commissioned to map vegetation types and to assess forest productivity on the undeveloped western portion of the lease in order to add to Syncrude's knowledge of the entire area within the lease boundaries. The information on productivity is especially useful for setting reclamation objectives, and for assessing long-term environmental impacts.

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ABSTRACT

This monograph describes the vegetation that existed in August 1977 on the western half of Syncrude's Lease 17 near Fort McMurray, Alberta. Eight vegetation types were identified and are mapped in this monograph at a scale of 1:24,000. Black Spruce - Labrador Tea was the dominant vegetation type, making up 35.0% of the 9,250 hectare study area. The second most abundant vegetation type was Aspen - White Spruce (26.0%) and the third was White Spruce - Aspen (18.0%). The remaining 21.0% of the area was occupied by the Aspen - Birch vegetation type (7.5%), Balsam Poplar - Alder (6.0%) along the McKay River, Sedge - Reed Grass (4.0%) mainly around bodies of standing water created by beaver dams, Willow - Reed Grass (3.0%) along stream courses, and Black Spruce - Feathermoss (0.5%). The White Spruce - Aspen type is best developed in the southern part of the lease where there have been no major fires for 80 or more years. It is the only vegetation type that contains some white spruce stands approaching the present lower limits of merchantable forest in Alberta. The most productive stand sampled in the White Spruce - Aspen type had a gross volume of 324.5 m^3/ha and a merchantable spruce volume of 226.7 m^3/ha; site index for spruce in this stand was 22 m (72 ft) at age 70 years. The Aspen - White Spruce type was less productive, with an aspen site index averaging 16 m (52 ft) at age 50 years. In terms of mean annual increment and site index, the two vegetation types with the greatest potential for fibre production (White Spruce - Aspen and Aspen - White Spruce types) are of average or below average productivity when compared to data from similar stands elsewhere in Alberta and Saskatchewan.

KEYWORDS: Aspen, Floristic composition, Forest productivity, Spruce, Tar sands, Vegetation map

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1. INTRODUCTION

1.1 Objectives of this study

The purpose of this study was to obtain baseline information concerning present vegetation on about 9,250 hectares of the west half of Syncrude's Lease 17, near Fort McMurray, Alberta. The study area is on the west side of the Athabasca River, in the vicinity of latitude 57° 00' N and longitude 111° 40' W (Figure 1).

Specific objectives were to: (i) classify the vegetation, on the basis of floristic composition, into reasonably uniform mappable units; (ii) describe the identified vegetation units according to tree, shrub, herb and moss layers; (iii) map the described vegetation units at a scale of 1:24,000; (iv) calculate the area, in hectares, occupied by each mapped vegetation unit; and (v) interpret and quantify forest productivity of each vegetation unit in terms of potential wood fiber production in accordance with methods used by the Canadian Land Inventory system.

The emphasis in this study was upon floristic classification and estimation of capabilities for wood fiber production, omitting integration with data from separate 1977 studies of soil capability and wildlife productivity. Floristic classification was only to a level of detail that resulted in units that would be recognizable on aerial photographs and mappable at a scale of 1:24,000. Phytosociological differences that were not associated with distinct aerial photograph patterns, for example ecologically distinct micro-sites involving different species of *Sphagnum* or different species of *Carex*, were not documented in this study.

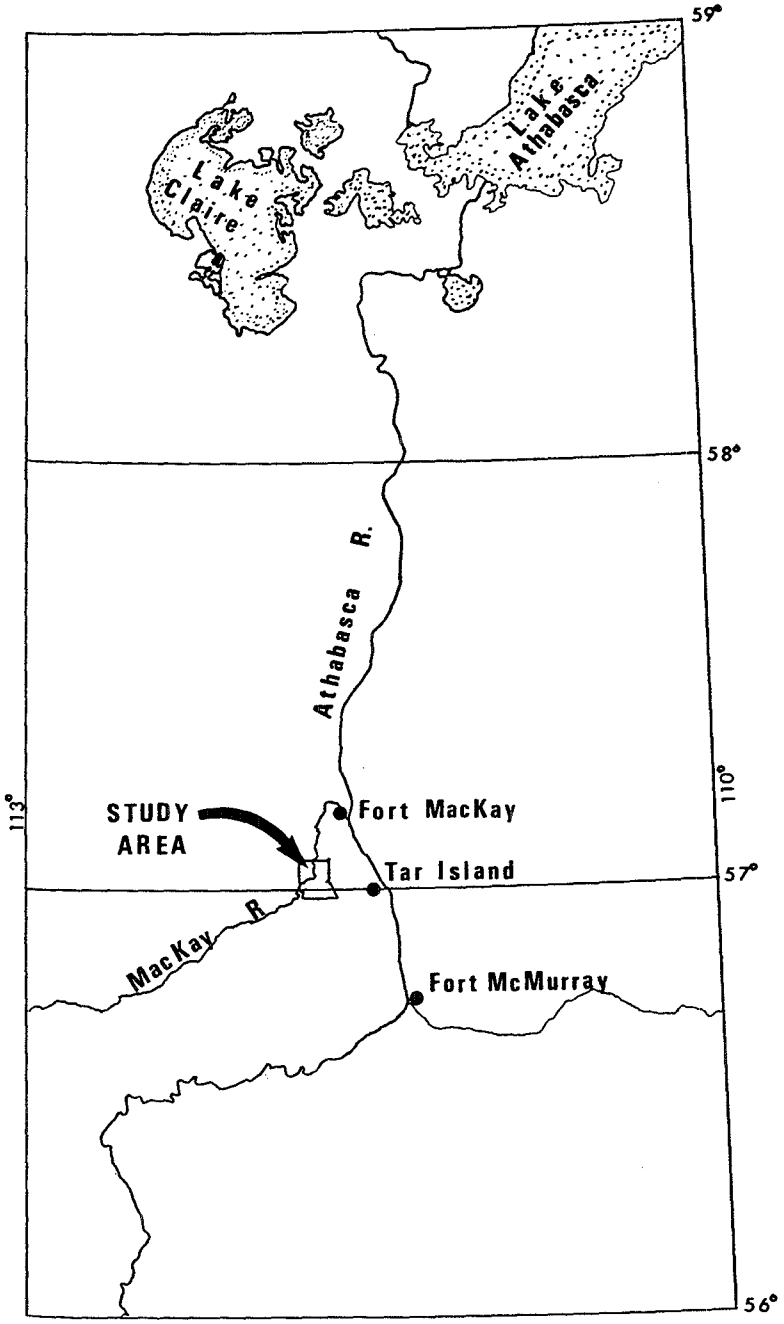

FIGURE 1. Location of study area along MacKay River near Fort McMurray, Alberta.

2. METHODOLOGY

2.1 Preliminary identification of vegetation types

The three most obvious sources of information on vegetation types are aerial photographs, direct field examination and other published accounts. All of these sources were used in the preliminary phases of this study.

It was not the purpose of this study to conduct a thorough review of literature dealing with boreal vegetation, but several references were examined in detail to aid the prediction of vegetation types before ground checking in the Lease 17 study area. The most informative reference was the preliminary vegetation description of the Alberta Oil Sands Environmental Research Program study area by Stringer (1976). Other references consulted for specific information on vegetation types were Kabzems, Kosowan and Harris (1976), Lewis, Dowding and Moss (1928), Moss (1953), Rowe (1961), and Syncrude Canada Ltd. (1975).

Ground truthing of aerial photographs of the west half of Lease 17 took place on 6 and 7 June 1977. From this first field reconnaissance it was possible to list the main vegetation units, compile preliminary species lists for each unit, and prepare a preliminary map by aerial photographic interpretation. The latter step is described in the next section. Additional ground checking and revisions of the preliminary map took place during field work in late July and early August 1977.

2.2 Photogrammetry

Photographic interpretation was performed primarily at

the Alberta Remote Sensing Centre. A Carl Zeiss Interpretoskop was used to delineate vegetation boundaries. For detailed analysis of vegetation types, panchromatic black and white, 1:16,000 scale photography was used. These photographs were obtained from flights in April and May 1977 by Northwest Survey Corporation (Yukon) Ltd. In addition, a 1973 false colour infrared negative, at a scale of 1:73,000, was obtained from the National Air Photo Library. The latter was a valuable complementary source of information on vegetation types of the study area.

Information obtained from stereograms was initially transferred to a 1:25,000 scale orthophoto map produced by Northwest Survey Corporation (Yukon) Ltd. and the Surveys and Property Branch of Alberta Transportation. This orthophoto map, containing preliminary vegetation type boundaries, was used during the June and August ground truthing. Finally, a Bausch and Lomb Zoom Transferscope was used to transfer delineated types from the rectified orthophoto map to a Syncrude base map at a scale of 1:24,000.

2.3 Field description of floristic composition

Photogrammetric analyses and ground surveys led to the delineation of eight vegetation types. A total of 27 sampling locations were examined, with at least three within each vegetation type. The main selection criteria for sampling locations were that the site be relatively homogeneous and that it be within, rather than on the edge of, a vegetation type recognizable on aerial photographs. Locations of the 27 sampling sites are shown on the 1:24,000 vegetation map that accompanies this report.

Permanent sample plots were not established for either floristic analyses or mensurational data. Species lists and estimates of species significance were obtained from an indefinite area around a temporary sampling point. The main requirement was that floristic data be obtained from an area that fell within one recognizable vegetation type. For dominant and conspicuous species, estimates of species significance were recorded for the radius readily visible to an observer standing at the temporary sampling point, without actually delineating a specific plot area by survey or string boundaries. For species that were sparsely present, species significance ratings were obtained by walking through a broader zone away from the central sampling point but still within the mensurational sampling radius defined by prism selection of sample trees.

Data were recorded according to four basic vegetational layers, as listed below, with subdivision of the A and B layers where necessary.

A layer: A_1 dominant and codominant trees;
A_2 intermediate and suppressed trees;

B layer: B_1 saplings and shrubs, 2 to 9 m;
B_2 shrubs and woody plants, 15 cm to 2 m;

C layer: small woody plants less than 15 cm tall and all herbaceous plants;

D layer: bryophytes and lichens.

A species list was prepared for each of the 27 sampling sites. All vascular plants and the dominant ground lichens and bryophytes were listed. Epiphytic mosses and lichens were not listed.

To each species was assigned a species significance value. The species significance scale is a combined rating of abundance and dominance based on the Domin-Krajina scale (Brooke, Peterson and Krajina 1970) as follows:

+	Species very sparse, dominance very small
1	Sparsely present, dominance small
2	Very scattered, dominance small
3	Scattered to plentiful, dominance less than 1/20 of area visible to observer
4	Often present, dominance 1/20 to 1/10
5	Often present, dominance 1/10 to 1/4
6	Any number of individuals, dominance 1/4 to 1/3
7	Any number of individuals, dominance 1/3 to 1/2
8	Any number of individuals, dominance 1/2 to 3/4
9	Any number of individuals, dominance over 3/4

Two additional notations were made for tree species: the symbol "*" denoted tree species present as seedlings only, as in the case of *Abies balsamea*; the letter "V" denoted a tree species present as a veteran, as in the case of *Pinus banksiana* at some locations.

Species and their species significance values are summarized in Appendix I. This Appendix identifies plots on which each species occurs, according to five layers: trees; saplings, shrubs; herbs and dwarf woody plants; and lichens and bryophytes. Within each layer species are listed in descending order of species significance ratings. Thus, a user of Appendix I can identify the most characteristic species of a given vegetation type by scanning the first few species listed for each of the five layers. Some of the tree species were listed in more than one layer because they sometimes were of a height to coincide with the tree and shrub (sapling) layers or were also present as seedlings.

An alphabetical listing of all vascular plants is provided in Appendix II. This list includes a number of species that were observed during field work but which were not present at the 27 sampling locations and which were therefore not in Appendix I. However, the species mentioned in Appendix II should not be taken as a complete list of vascular plants present in the west part of Lease 17 because this study did not set out to prepare an exhaustive compilation of the area's flora.

2.4 Mensuration

Mensurational data were obtained at 15 of the 27 sampling locations which had tree cover of sufficient size and density to warrant measurement. Basal area estimates were obtained by use of wedge prism rather than by tree measurements on a given plot area. For all stands in the White Spruce-Aspen type a prism with a basal area factor of 20 was used; for other vegetation types, with generally smaller stem diameters, a prism with a basal area factor of 10 was used. Prisms were calibrated in ft^2/acre and these data were later converted to metric units. All living trees, regardless of species or size, were tallied if stem overlap was evident when the tree was viewed through a prism from a temporary sampling point that served as an imaginary "plot centre". For each tallied tree, the species, diameter at breast height, and height were recorded. Representative dominant and codominant trees were bored to determine stand age. Spruce and pine cores were aged directly in the field; aspen cores were stored for later checking in the office. Alberta Forest Service map information on dates of fires in the study area also served as an approximate guide to stand ages.

Basal areas were calculated for the coniferous, deciduous and total tree cover by using the appropriate basal area factor provided with each prism, according to the following formula:

$$\text{Basal area, } ft^2/ac = \frac{\text{No. of trees tallied by prism count}}{\text{No. of sampling sites (plots)}} \times \text{Basal Area Factor}$$

The above formula may be used for single sampling sites (plots) or for estimation of basal area for a vegetation type.

Volumes were calculated for individual trees by formulas and regression coefficients derived by Honer (1967), as modified by the Alberta Forest Service. Gross and merchantable volumes calculated from these equations were in Imperial units of measure which were later converted to metric units for purposes of this study.

The basic formula for gross volume of individual trees is provided in Table 1 of Honer (1967):

$$\text{Gross volume, } ft^3 = \frac{D^2}{a+b/H}$$

Where: D = diameter at breast height, ouside bark, inches
H = total tree height, feet
a,b = regression coefficients for each species established by Honer (1967)

To calculate volume directly on an area basis a modification of the above formula, as developed by the Alberta Forest Service, was used:

$$\text{Gross volume, } ft^3/acre = \frac{D^2}{a+b/h} \times \frac{\text{Basal Area Factor}}{.005454\ D^2}$$

Merchantable volume was calculated by the method used in the Alberta Forest Service, using a stump height of 1 foot and a top diameter, inside bark, of 3.0 inches for all trees over 3.6 inches d.b.h. outside bark. No estimates of cull due to stem decay were deducted in the conversion of gross volume to merchantable volume, other than those included in the regression coefficients of the formula below:

Merchantable volume, ft^3/acre =

gross volume, ft^3/acre $[a+b\{d^2/D^2(1+h/H)\}+c\{(d^2/D^2)(1+h/H)\}^2]$

Where: d = top diameter, inside bark, inches
D = diameter at breast height, outside bark, inches
h = stump height, feet
H = total tree height, feet
a,b,c = regression coefficients for each species as established by Honer (1967).

For those sample locations that contained dominant or codominant white spruce, site indices were calculated using a formula developed by Kirby (1975):

$$\text{White spruce site index} = \frac{H}{\text{H/SI ratio @ age}}$$

Where: site index = total height of dominant and codominant trees at a selected index age of 70 yr taken at 1 ft above the ground
H = total height of tree, feet
H/SI = ratio determined from Figure 3 of Kirby (1975)

For those sample locations with dominant and codominant aspen, site indices were determined using a graph prepared by MacLeod (1950) from aspen data in northern

Alberta. Height and age data of dominant and codominant aspen on Lease 17 were also compared to site classes defined by Kirby, Bailey and Gilmour (1957) for aspen stands in Saskatchewan, but the Alberta site indices developed by MacLeod were considered to be geographically more applicable to the Lease 17 study area.

2.5 Map production

The classification system for mapping of vegetation units of Lease 17 was based predominantly on patterns revealed on aerial photographs. Vegetation types were classified at a level that could be mapped at 1:24,000. No climatic, edaphic or physiographic features were considered in the classification, other than as expressed by the vegetation present. Vegetation units that displayed a more or less homogeneous pattern on aerial photographs were delineated by marking preliminary boundaries on an orthophoto map, with further revisions as a result of field checking.

Recognizable vegetation units that were homogeneous but too small to map at 1:24,000 were handled in one of two ways. If several small vegetation types occurred in association with each other to form a recurring vegetation pattern this group of associated vegetation types was mapped as one unit. An example is the Aspen - Birch vegetation type which is made up of small areas of aspen, small patches of black spruce and other areas of birch or willow cover, none of which, by themselves, are large enough to map at 1:24,000.

A different approach was used for homogeneous, but small, vegetation units that existed only as isolated occurrences within larger vegetation types. For example, throughout the study area there are pockets of willow

dispersed through most of the other vegetation types. Only the largest of these willow areas could be mapped as a distinct type on a 1:24,000 map. Where they occurred as isolated patches within other vegetation types, such occurrences were considered to be anomalies and were simply not mapped. On the vegetation map that accompanies this monograph, the smallest mapped vegetation unit is about 0.2 hectares.

The area of each mapped vegetation unit was measured with a Neumonics Graphic Calculator at the Alberta Remote Sensing Centre. This instrument was calibrated for read-out in acres. These measured areas, converted to hectares, were superimposed on a copy of the 1:24,000 vegetation map, along with locations of the 27 sampling locations. Aggregate areas of each of the eight vegetation types were computed and are presented in Table 2 in a later section of this monograph.

3. RESULTS

3.1 Vegetation types of west part of lease 17

Aerial photographic interpretation and field work on 6 and 7 June and 25 July to 10 August resulted in the delineation of eight vegetation types. Brief floristic descriptions of these mapped units are given below and photographs of the eight vegetation types appear in Appendix III. Species names in this section follow Moss (1959) for vascular plants, Bird (1973) for bryophytes and Hale (1969) for lichens.

3.1.1 SEDGE - REED GRASS

(*Carex* spp - *Calamagrostis canadensis*)

This type is characterized by a variety of wetland species, predominantly *Carex aquatilis* and *Carex lasiocarpa* on the very wet sites and marsh reed grass (*Calamagrostis canadensis*) on the slightly drier sites and around the perimeters of fens. The intermittent, sparse shrub layer is composed primarily of willows (*Salix* spp). In association with the sedges are *Galium labradoricum*, *Polygonum amphibium*, *Scutellaria galericulata*, *Rumex occidentalis* and *Typha latifolia*. Forming a mat around the stems and roots of the herbaceous cover are several species of moss, with *Drepanocladus aduncus* dominant.

Including the open water which is often present at the centre of fens, this type occupies approximately 367 hectares (4%) of the study area.

3.1.2 WILLOW - REED GRASS

(*Salix* spp - *Calamagrostis canadensis*)

Although only about 271 hectares (3% of the study area) were mapped as the Willow - Reed Grass type, it

is prevalent over much of the study area in units that are too small to map at a scale of 1:24,000. It exists in close association with the Sedge - Reed Grass fens, and is the dominant vegetation type in minor drainage channels and depressions with impeded drainage. Narrow bands of Willow - Reed Grass may be observed in other vegetation types, but often they are evident only in the understory. *Alnus crispa, Betula pumila, Cornus stolonifera,* and juvenile *Populus tremuloides* and *Betula papyrifera* compete with *Salix* spp. for dominance. The herb stratum is varied, with only *Calamagrostis canadensis* being consistently prominent. Among the wide diversity of accompanying herbs and dwarf woody plants, common species are *Equisetum arvense, Rubus acaulis, Vaccinium vitis-idaea, Linnaea borealis, Petasites Palmatus, Goodyera repens,* and *Parnassia palustris.* The moss layer was discontinuous, but dense in some places, consisting primarily of *Sphagnum* spp. and *Aulacomnium palustre.*

3.1.3 BLACK SPRUCE - LABRADOR TEA
(*Picea mariana - Ledum groenlandicum*)

Treed muskeg covers approximately 3232 hectares (35%) of the study area. The tree cover is generally sparse and consists primarily of stunted *Picea mariana* with occasional *Pinus banksiana* and *Populus tremuloides.*

The medium to low shrub layer is completely dominated by *Ledum groenlandicum* with a few individuals of *Betula pumila. Kalmia polifolia* was present, but rare. *Vaccinium vitis-idaea* dominates the dwarf shrub-herb layer. *Oxycoccus microcarpus, Eriophorum vaginatum* and *Rubus chamaemorus* grow in association with a dense mat of mosses and lichens, primarily composed of *Sphagnum* spp., *Polytrichum juniperinum, Cladina mitis, Cladina arbuscula, Cladina alpestris* and *Cladonia* spp.

In small depressions with impeded drainage, *Carex aquatilis* and *Carex lasiocarpa* provide the major cover. These sedge areas may be observed on black and white aerial photographs as white patches on the black spruce muskeg. These areas may be left over from the natural succession from fen to bog (Lewis, Dowding and Moss 1928) or may merely be a reflection of an environmental moisture gradient (Stringer 1976).

A variant of the Black Spruce - Labrador Tea vegetation type occurred where a deciduous cover of aspen, willows, and a few other large shrubs was underlain by plant species typical of treed muskeg. These variants may be the result of a light fire disturbance as suggested by Rowe (1953).

3.1.4 ASPEN - BIRCH

(*Populus tremuloides - Betula papyrifera*)

This type is characterized by its lack of homogeneity, and can best be described as an association of several small vegetation types. The primary components, which are too small to map at 1:24,000, consist of *Picea mariana* muskeg areas dispersed in a mixture of *Populus tremuloides* and *Betula papyrifera*, with a wide variety of shrubs underneath. This type appears to be primarily transitional between the Black Spruce - Labrador Tea vegetation type and the Aspen - White Spruce stands. Further variability within this vegetation type arises along narrow drainage channels where the Willow - Reed Grass type occurs.

The dominant cover on most sites of this type is aspen and white birch. The middle shrub layer, which often merges with the tree layer, is composed of juvenile *Populus tremuloides, Populus balsamifera, Salix* spp., *Alnus crispa* and, on some sites, *Shepherdia canadensis. Lonicera dioica, Cornus stolonifera, Ribes oxyacanthoides, Betula*

pumila and *Lonicera involucrata* are present in lesser amounts. A few sites had *Picea glauca* and *Picea mariana* seedlings.

In the lower shrub layer, *Ledum groenlandicum* was present in varying amounts on all sites, and *Vaccinium myrtilloides* showed vigorous growth on a few sites.

The dwarf shrub/herb layer was highly variable. Some sites supported little herbaceous cover with the dominant species being *Cornus canadensis, Arctostaphylos uva-ursi, Vaccinium vitis-idaea, Castilleja miniata,* and *Lycopodium clavatum.* Other sites had dense herbaceous cover with a wide species diversity, of which *Calamagrostis canadensis, Geocaulon lividum, Petasites palmatus, Bromus ciliatus, Linnaea borealis* and *Epilobium angustifolium* were dominant. *Sphagnum* spp and *Aulacomnium palustre* were dominant in the moss layer.

There were no commercial size trees in this vegetation type and tree vigour was generally poor. This type occupies approximately 702 hectares (7.5%) of the study area.

3.1.5 ASPEN - WHITE SPRUCE

(*Populus tremuloides - Picea glauca*)

Many sites in the study area support vigorous *Populus tremuloides* with varying amounts and sizes of *Picea glauca* in the understory. Stands in this vegetation type varied from dense stands of juvenile aspen to better established mixed stands of aspen and spruce, with aspen always as the dominant cover species. On some sites, primarily at the north end of Lease 17, white spruce is approaching co-dominance.

In the shrub layer, *Rosa acicularis, Salix* spp. *Shepherdia canadensis* and *Alnus crispa* compete vigorously with the emerging spruce.

The ground vegetation is characterized by *Cornus canadensis, Equisetum arvense* and *Anemone canadensis*, with lesser amounts of *Calamagrostis canadensis, Galium boreale, Fragaria vesca,* and *Lathyrus ochroleucus*. There are very few mosses or lichens present.

Total stem volume for aspen and white spruce ranged from 72 to 195 m^3/ha but mean merchantable volume was only about 50 m^3/ha (Table 1). This type occupies approximately 2,405 hectares (26%) of the study area. It is the second most common vegetation type on the study area after the Black Spruce - Labrador Tea type.

3.1.6 WHITE SPRUCE - ASPEN
(*Picea glauca - Populus tremuloides*)

Mixed stands of *Picea glauca* and *Populus tremuloides*, in varying proportions, occupy approximately 1,650 hectares (18%) of the study area. They are the oldest stands in the area and this vegetation type supports the greatest volume of standing timber of all types mapped on Lease 17. Most areas have not been burned since the 1860's or 1880's, although small areas of more recent burn, (30 to 50 years ago) were observed. In addition to the codominant *Picea glauca* and *Populus tremuloides*, there are scattered old *Pinus banksiana* present.

Typical of these sites is a sparse shrub layer consisting of *Rosa acicularis, Shepherdia canadensis, Alnus crispa,* and *Vaccinium myrtilloides*. The ground vegetation is characterized by *Cornus canadensis, Linnaea borealis, Vaccinium vitis-idaea, Anemone canadensis* and a dense mat of feathermosses, primarily *Pleurozium schreberi, Hylocomium splendens* and *Ptilium crista-castrensis*. Seedlings of *Abies balsamea* were observed but no trees of this species were present at the sampling locations.

Field sampling in this vegetation type revealed *Picea glauca* with a stem diameter at breast height as great as 53.3 cm (21 in). Although a gross timber volume of 325 m^3/ha was measured, the actual merchantable volume is highly dependent on the softwood to hardwood ratio. The most productive site produced about 227 m^3/ha of merchantable coniferous wood, but the mean for the type was 147 m^3/ha merchantable coniferous timber (Table 1). The mean annual increment of the spruce component of this vegetation type ranged from an estimated 1.2 to 2.5 m^3/ha/yr (17.3 to 36.2 ft^3/acre/yr).

3.1.7 BLACK SPRUCE - FEATHERMOSS

(*Picea mariana - Pleurozium schreberi*)

Stands of relatively tall *Picea mariana* are not abundant on the west part of Lease 17. They cover only approximately 55 hectares (0.5%) of the study area. The tree cover is almost entirely black spruce with only the occasional *Larix laricina*.

Ground vegetation is characterized by the dominant feathermosses with little other vegetation. Mosses comprising this carpet are mainly *Pleurozium schreberi, Hylocomium splendens* and *Ptilium crista-castrensis*. *Ledum groenlandicum, Cornus canadensis, Equisetum arvense, Vaccinium vitis-idaea, Arctostaphylos rubra* and *Linnaea borealis* are the most conspicuous vascular plants.

These stands are generally low in forest productivity with merchantable volumes ranging from 42 to 74 m^3/ha (Table 1).

3.1.8 BALSAM POPLAR - ALDER

(*Populus balsamifera - Alnus tenuifolia*)

This vegetation type occupies most of the McKay River valley, and makes up about 6% (573 hectares)

of the study area. The overstory is primarily *Populus balsamifera* with very vigorously growing *Alnus tenuifolia* often co-dominant with the dense young balsam poplar.

Shrubs are not abundant, with *Rosa acicularis* being the dominant species in association with *Cornus stolonifera, Ribes triste* and *Ribes oxyacanthoides.*

The most abundant species in the herbaceous layer is *Equisetum arvense* associated with *Rubus acaulis, Maianthemum canadense, Actaea rubra* and *Epilobium angustifolium.* In addition, the herbaceous layer supported many species not common elsewhere. Among these were two species of fern (*Athyrium filix-femina* and *Gymnocarpium dryopteris*) and a stinging nettle (*Urtica gracilis*), which were not recorded directly at the three sampling sites within this vegetation type but were nearby on a west-facing slope of the McKay River valley.

The mean gross volume for this vegetation type is 139 m^3/ha with no coniferous component. No *Picea glauca* occur in the Lease 17 portion of the McKay River valley, but this is thought to be a result of fire history and availability of seed trees rather than any limitation of this valley as a productive site for *Picea.*

3.2 Forest productivity of west part of Lease 17

If forest productivity is viewed narrowly as present standing crop of merchantable coniferous timber, then only the White Spruce - Aspen type would appear to be significant on the west part of Lease 17, averaging 147.82 m^3/ha at the five locations sampled in 1977 (Table 1). Only one of these

sample locations had a merchantable coniferous volume approaching the present lower limit for commercial timber production in Alberta (about 245 m^3/ha). The White Spruce - Aspen type is best developed on the south side of Lease 17, south of the 24th Base Line, where there have been no major fires for 80 or more years.

Table 1 summarizes basal area, gross volume and merchantable volume data for the four vegetation types that have the greatest potential for production of commercial size white or black spruce (the White Spruce - Aspen, Aspen - White Spruce, Black Spruce - Feathermoss and Balsam Poplar - Alder types). At present there is virtually no merchantable spruce on the Aspen - White Spruce vegetation type. Of four sample locations in this type, only one had merchantable spruce volume and that was only 13.15 m^3/ha. The Black Spruce - Feathermoss type averaged 60.64 m^3/ha of merchantable black spruce timber (Table 1). No spruce was present in the Balsam Poplar - Alder type along the McKay River.

In addition to these low standing crop values for conifers, the fact that 42% of the mapped area is occupied by non-forested vegetation types indicates that the west part of Lease 17, as a whole, is not of high potential for wood fibre production (Table 2). Three of the eight vegetation types were considered to have no ecological potential for production of commercial size trees: Sedge - Reed Grass; Willow - Reed Grass; and Black Spruce - Labrador Tea. The vegetation types considered to have potential for forest productivity are the four forested types for which mensurational data were gathered in 1977 (Table 1) plus the Aspen - Birch type. Most of the latter vegetation type occurs north of the 24th Base Line on land that has been burned relatively recently, much of it from 1940 to 1949.

TABLE 1

Basal area, gross volume and merchantable volume for 15 sample sites on 4 forested vegetation types of west half of Lease 17

Plot No.	Basal Area[a]						Gross Volume[b]						Merchantable Volume[c]					
	Deciduous		Coniferous		Total		Deciduous		Coniferous		Total		Deciduous		Coniferous		Total	
	ft^2/ acre	m^2/ ha	ft^2/ acre	m^2/ ha	ft^2/ acre	m^2/ ha	ft^3/ acre	m^3/ ha	ft^3/ acre	m^3/ ha	ft^3/ acre	m^3/ ha	ft^3/ acre	m^3/ ha	ft^3/ acre	m^3/ ha	ft^3/ acre	m^3/ ha.
	WHITE SPRUCE - ASPEN																	
1	40	9.18	160	36.73	200	45.91	682	47.72	3166	221.53	3848	269.25	615	43.03	2939	205.65	3554	248.68
2	--	--	100	22.96	100	22.96	--	--	2385	166.88	2385	166.88	--	--	2219	155.27	2219	155.27
3	100	22.96	20	4.59	120	27.55	2660	186.13	609	42.61	3269	228.74	2538	177.59	582	40.72	3120	218.31
6	40	9.18	140	32.14	180	41.32	971	67.94	3667	256.59	4638	324.53	912	63.82	3240	226.71	4152	290.53
7	60	13.77	80	18.39	140	32.14	1369	95.79	1836	128.47	3205	224.26	1106	77.39	1583	110.77	2689	188.16
Mean	48	11.02	100	22.96	148	33.98	1136	79.51	2333	163.22	3469	242.73	1034	72.37	2113	147.82	3147	220.19
	ASPEN - WHITE SPRUCE																	
5	80	18.39	--	--	80	18.39	1030	72.07	--	--	1030	72.07	000	000	--	--	000	000
11	60	13.77	30	6.89	90	20.66	1150	80.47	383	26.80	1533	107.27	677	47.37	188	13.15	865	60.53
12	150	34.44	--	--	150	34.44	2798	195.78	--	--	2798	195.78	1687	118.04	--	--	1687	118.04
13	130	29.84	--	--	130	29.84	1531	107.13	--	--	1531	107.13	259	18.12	--	--	259	18.12
Mean	105		7.5	1.72	112.5	25.83	1627	113.86	96	6.70	1723	120.56	656	45.88	47	3.29	703	49.17
	BLACK SPRUCE - FEATHERMOSS																	
24	--	--	100	22.96	100	22.96	--	--	1650	115.45	1650	115.45	--	--	1065	74.52	1065	74.52
26	--	--	80	18.39	80	18.39	--	--	1265	88.52	1265	88.52	--	--	611	42.75	611	42.75
27	--	--	60	13.77	60	13.77	--	--	1125	78.72	1125	78.72	--	--	924	64.65	924	64.65
Mean	--	--	80	18.39	80	18.39	--	--	1347	94.23	1347	94.23	--	--	867	60.64	867	60.64
	BALSAM POPLAR - ALDER																	
8	140	32.14	--	--	140	32.14	2590	181.23	--	--	2590	181.23	1925	134.70	--	--	1925	134.70
9	130	29.84	--	--	130	29.84	2167	151.63	--	--	2167	151.63	1428	99.92	--	--	1428	99.92
10	80	18.39	--	--	80	18.39	1225	85.72	--	--	1225	85.72	682	47.72	--	--	682	47.72
Mean	116.6	26.77	--	--	116.6	26.77	1994	139.53	--	--	1994	139.53	1345	94.11	--	--	1345	94.11

a. Measured in ft^2/acre by prism for all trees, then converted to metric units

b. Measured in ft^3/acre for all trees, then converted to metric units

c. Based on a stump height of 1 ft and a top diameter of 3 inches inside bark for all trees with d.b.h. greater than 3.6 inches

TABLE 2

Areas occupied by each of eight vegetation types on west part of Lease 17

VEGETATION TYPE	AREA Hectares	AREA Acres	APPROX. % OF TOTAL MAP AREA
I Vegetation types with no potential for forest productivity			
A. Sedge - Reed Grass	367	906	4.0
B. Willow - Reed Grass	271	671	3.0
C. Black Spruce - Labrador tea	3,232	7,986	35.0
SUB-TOTAL	3,870	9,563	42.0
II Vegetation types with potential for forest productivity			
D. Aspen - Birch	702	1,735	7.5
E. Aspen - White Spruce	2,405	5,943	26.0
F. White Spruce - Aspen	1,650	4,076	18.0
G. Black Spruce - Feathermoss	55	135	0.5
H. Balsam Poplar - Alder	573	1,417	6.0
SUB-TOTAL	5,385	13,306	58.0
TOTAL	9,255	22,869	100.0

Because detailed stem analysis data are not available for aspen and black spruce in northern Alberta, mean annual increment was estimated only for white spruce. For the Lease 17 area, data compiled by MacLeod and Blyth (1955) were considered to be the most suitable for this purpose and their data were used to estimate mean annual increment for two sites within the White Spruce - Aspen vegetation type, as discussed later in this section. Although there was very little white spruce present at the sample locations within the Aspen - White Spruce type, potential productivity for spruce within this type was estimated from similar sites that have been documented in detail by Kabzems, Kosowan and Harris (1976). Thus, some indication of forest productivity was possible for both the White Spruce - Aspen and Aspen - White Spruce types which make up about 76% of the area occupied by the five types thought to have potential for forest productivity (Table 1).

No measurable white spruce were encountered in the Aspen - Birch type to allow productivity estimates for this type. The presence of a muskeg understory, characterized by Labrador tea and bog cranberry, in much of the Aspen - Birch type is an indication that the 7.5% of Lease 17 occupied by this type would have a very low forest productivity rating. Although no strictly comparable vegetation type is described in the Saskatchewan work by Kabzems, Kosowan and Harris (1976), sites on which they found Labrador tea to be abundant generally had a mean annual increment of 1.4 m^3/ha or less. Estimates of mean annual increment for the Black Spruce - Feathermoss type were not attempted in this study because stem analyses data are not available for northern Alberta black spruce and because this type occupies such a small portion of Lease 17

(0.5%). Absence of white spruce in the Balsam Poplar - Alder type prevented direct estimation of mean annual increment and directly comparable vegetation types are not included in the mean annual increment data of Kirby, Bailey and Gilmour (1975) or Kabzems, Kosowan and Harris (1976). It is possible only to speculate that the moist, but well-drained, slopes and valley bottom along the McKay River would have a productivity rating at least as high as that in well-drained White Spruce - Aspen stands.

Site index calculations for white spruce and aspen on the two main forested vegetation types are summarized in Table 3. Site indices for the least productive (sample location 1) and the most productive (sample location 6) sites of the White Spruce - Aspen type were used to estimate mean annual increment. Rounded off to a site index of 50, the 90-year-old stand of location 1 would have a mean annual increment of 1.2 m^3/ha according to data in Table 8 of MacLeod and Blyth (1955); the 100-year-old stand at location 6, with a site index rounded off to 70 (from Table 3), would have a mean annual increment of 2.5 m^3/ha. Aspen-dominated vegetation types described by Kabzems, Kosowan and Harris (1976) with floristic similarities to the Aspen - White Spruce type described in this monograph had mean annual increments ranging from 1.3 m^3/ha on sites with very rapid drainage to 3.7 m^3/ha on moderately well drained sites. From this it is reasonable to estimate that mean annual increment for the Aspen - White Spruce type on Lease 17 would be in the same general productivity class as estimated for the White Spruce - Aspen type (1.2 to 2.5 m^3/ha/yr).

TABLE 3

White spruce and aspen site indices for nine sample locations on west part of Lease 17

Sample Location Number	Species	Height in Feet	Age in Years	White Spruce Site Index[a]	Aspen Site Index[b]
White Spruce - Aspen					
1	White Spruce	57	88	48	--
2	White Spruce	42	53	56	--
3	White Spruce	69	98	53	--
6	White Spruce	98	104	72	--
7	White Spruce	95	115	65	--
Mean				58.8	
Aspen - White Spruce					
5	Aspen	30	25	--	50
11	Aspen	51	40	--	55
12	Aspen	47	40	--	55
13	Aspen	41	40	--	50
Mean					52.5

a. Height of dominant and codominant spruce, feet, at age 70, calculated from data in Kirby (1975)

b. Height of dominant and codominant aspen, feet, at age 50, calculated from data in MacLeod (1950)

4. DISCUSSION

4.1 Vegetation types

The description of eight vegetation types, list of 115 vascular plant species observed, and the vegetation map contained in this monograph are a record of vegetation conditions that existed in 1977. Considered together with other data on soils and wildlife habitat, this information can serve both as a baseline account of pre-mining conditions and as a guide to land-use planning for the west part of Lease 17.

The value of these vegetation descriptions is further enhanced if the vegetation units can be related to those described in other technical reports from the oil sands region of Alberta. Table 4 indicates how the eight vegetation types identified in this study relate to those described by Syncrude Canada Ltd. (1975) and Stringer (1976). As expected, there is not a strict equivalence between vegetation units defined in these various studies. In the case of the previous study by Syncrude Canada Ltd. (1975), the emphasis was upon well-drained sites that would be more likely candidates for revegetation than would the poorly drained sites. Hence, the Willow - Reed Grass type differentiated along minor drainage channels was not recognized in the 1975 Syncrude report, nor did it distinguish between the Black Spruce - Labrador Tea type and the Black Spruce - Feathermoss type.

Compared to the more recent study by Stringer (1976), there is generally closer correspondence with two exceptions. The first involves willow vegetation types. Although Stringer defined three vegetation types dominated by willows (Sandbar Willow Scrub, Tall Willow - River Alder Scrub, and Tall Willow Scrub), they

TABLE 4

Vegetation types considered to be ecologically similar on basis of descriptions from the present study, Syncrude Canada Ltd. (1975) and Stringer (1976).

Vegetation types described on west part of Lease 17, 1977	Vegetation types described by Syncrude Canada Ltd. (1975)	Vegetation types described by Stringer (1976)
A Sedge-Reed Grass	(8) Sedge Fen	(A) Fine-leaved Sedge Fen
B Willow-Reed Grass	no equivalent	no equivalent
C Black Spruce-Labrador Tea	(7) Black Spruce	(J) Semiopen Black Spruce-Tamarack Bog Forest and Muskeg
D Aspen-Birch	(3) Aspen	no equivalent
E Aspen-White Spruce	(3) Aspen	(F & G) Upland Mixedwood and Deciduous Forest
F White Spruce-Aspen	(4) White Spruce-Aspen (5) White Spruce	(H) Upland White Spruce-Aspen Forest
G Black Spruce-Feathermoss	(7) Black Spruce	(I) Black Spruce Bog Forest
H Balsam Poplar-Alder	(6) Riverine	(E) Bottomland Balsam Poplar Forest

were predominantly associated with habitats along major rivers. The more confined Willow - Reed Grass type, occurring in narrow bands along streams in the west part of Lease 17, had a distinct understory of *Calamagrostis canadensis* that indicated ecologically different conditions than those encountered in the willow habitats of major river valleys.

The second difference between the present classification and Stringer's 1976 account is that the latter did not include a vegetation unit that would coincide with the Aspen - Birch type. The main reason for this difference is that Stringer's study focussed on mature vegetation and did not sample the large areas of well-drained upland sites that are in early stages of regeneration after fire. The Aspen - Birch type, along with the Aspen - White Spruce type, occupies much of the area in Lease 17 that was identified as Recent Burn and Old Burn habitat types in a previous report by Syncrude Canada Ltd. (1973). The 1973 report stressed that these burned habitats were actually mosaics of several plant communities, an observation verified by the floristic diversity evident within the Aspen - Birch vegetation type of the present study.

It was not the objective of this study to define the processes controlling vegetation patterns in the study area but it was readily evident that two major forces are fire history and surface accumulation of water as a result of beaver dams along small streams.

Fire-controlled vegetation patterns tend to occur at a relatively large scale. For example, a large portion of Lease 17 south of the 24th Base Line has a mature forest cover because there have been no major fires since the late 1800's. A distinct fire boundary passes from east to west through Sections 25, 30, 32 and 33 and north of this line much of the vegetation is a result of post-fire

succession since the 1940's. Within the Aspen - White Spruce type a fire history often offers an explanation of the variable age and distribution of the white spruce. For example, Rowe (1953) has suggested that severity of a burn can have a profound influence on subsequent stand composition. Light fires which do not completely remove the humus layer favour development of pure aspen stands with vigorous growth of minor species on the forest floor. Such sites are unfavourable for establishment of white spruce. However, white spruce will invade such stands after 20 or 30 years, provided a seed source is available (Rowe 1953). In contrast, severe fires will completely remove the humus layer, expose mineral soil, and allow the simultaneous establishment of white spruce and aspen (Kabzems, Kosowan and Harris 1976, Rowe 1953).

In the absence of standing water created by beaver dams, the Sedge - Reed Grass and Willow - Reed Grass vegetation types would be mainly restricted to stream courses and wet depressions. However, in many cases on the west part of Lease 17 the lateral spread of these two vegetation types has been increased by damming of streams by beavers. The extent to which these localized changes to surface drainage have influenced the water table and the floristic composition of adjacent upland habitats was not examined in this study.

The major controlling processes mentioned above, distribution of forest fires and distribution of standing water along small stream courses, are readily evident on aerial photographs and were therefore recognized within the vegetation mapping phases of this study. Other less evident controls over floristic composition or vegetation patterns would include factors such as recent surface disturbances other than fire, distance to coniferous seed sources, small-scale elevational differences such as

those associated with the raised bog area in Section 8 of the mapped area, or minerotrophic differences in non-forested wetlands. Although the ecological importance of such factors was recognized, the vegetation map prepared in this study was not sufficiently detailed to be based on such criteria.

4.2 Forest productivity

Stem analyses were not obtained in this study. Therefore, mean annual increment was estimated by relating calculated site indices and stand ages (Table 3) to other published data on mean annual increments of mixedwood stands.

Site indices recorded for the west part of Lease 17 fell within site class III as recorded by Kirby (1962) for a study area in Saskatchewan. Kirby's study recorded a mean annual increment of about 1.75 m^3/ha for site class III. The estimated mean annual increments of 1.2 and 2.5 m^3/ha for the least productive and most productive sites measured on the White Spruce - Aspen type of Lease 17 are of the same general magnitude as Kirby's data for site class III. Sites with this range of mean annual increments were rated as fair to poor in Kirby's evaluation of all sites studied.

Another comparison was possible from a more recent study by Kirby (1975) which provided additional data on white spruce site indices for Alberta. Figure 2 is a reproduction of the portions of Kirby's 1975 site indices which coincided with white spruce ages recorded in 1977 on the west part of Lease 17. Calculated site indices for plots 1, 2, 3, 6 and 7 (Table 3) are superimposed on the corresponding graphs of Kirby's 1975 data. Three of the Lease 17 sample locations (1, 2 and 3) had white spruce site indices at or below the mid-range of other Alberta data.

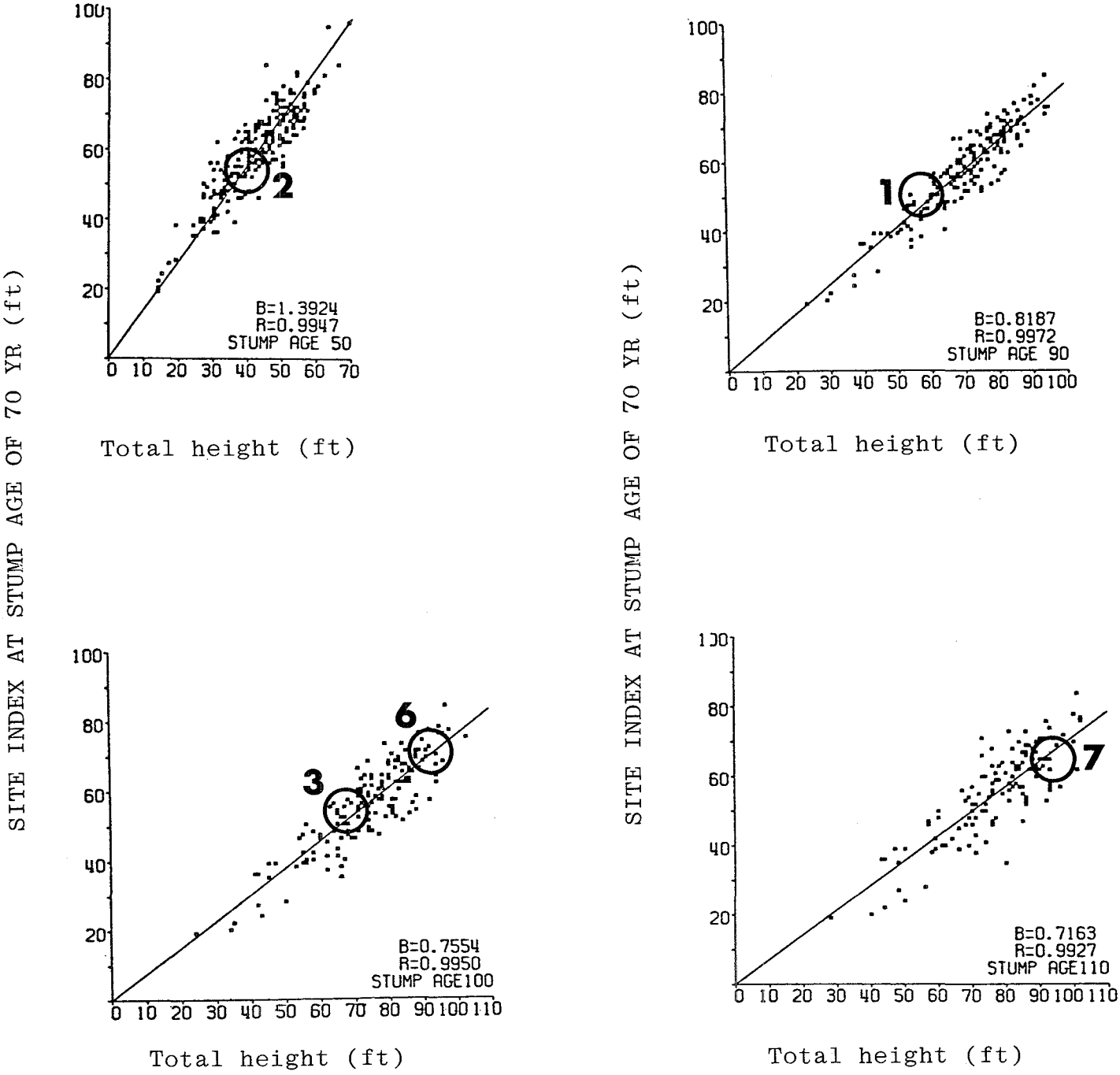

FIGURE 2. White spruce site index (total height of dominant and codominant trees at selected index age of 70 years taken at 1.0 ft above the ground) over dominant and codominant height at various stump ages (from Kirby 1975), with site indices superimposed for 6 sites in White Spruce - Aspen type, Lease 17

Two of the sample locations (6 and 7) had site indices nearer the upper range of Alberta white spruce site index.

Merchantable volumes obtained from 1977 measurements in the west part of Lease 17 were within the range of values reported from elsewhere for the mixedwood forest. For example, Kabzems, Kosowan and Harris (1976), in a study of Saskatchewan mixedwood forest types, found a mixed spruce-aspen stand on a well drained site to have a total volume of 216.3 m^3/ha. By comparison, on the west half of Lease 17, the mean total volume on the White Spruce - Aspen type was 242.7 m^3/ha. The most productive stand sampled in the White Spruce - Aspen type has a gross volume of 324.5 m^3/ha and a merchantable spruce volume of 226.7 m^3/ha. This was the only sample location with a merchantable coniferous volume approaching the present lower limit for commercial timber production in Alberta. Site index for white spruce in this stand was 22 m (72 ft) at age 70 years. Stands in the Aspen - White Spruce type appeared to be even less productive, with an aspen site index averaging 16 m (52 ft) at age 50 years (Table 3).

These comparisons with other published estimates of boreal mixedwood productivity and gross volume indicate that the White Spruce - Aspen and Aspen - White Spruce types of Lease 17 are of average or below average productivity when compared to white spruce - aspen stands elsewhere in Alberta or Saskatchewan. These vegetation types are the ones with the greatest potential for commercial wood fibre production on Lease 17, but they occupy only 44% of the study area.

5. SUMMARY

Analyses of 1977 panchromatic black and white photographs (1:16,000) and a 1973 false colour infrared negative (1:73,000) were combined with field observations in June, July and August, 1977 to prepare a vegetation map (1:24,000) for the western part of Syncrude's Lease 17. Field data were gathered on floristic composition of eight mapped vegetation units. A total of 115 species of vascular plant species were observed.

Three of the eight vegetation types (Sedge - Reed Grass, Willow - Reed Grass and Black Spruce - Labrador Tea) were non-forested. The other five vegetation types (Aspen - Birch, Aspen - White Spruce, White Spruce - Aspen, Black Spruce - Feathermoss, and Balsam Poplar - Alder) were considered to have potential for forest productivity.

Black Spruce - Labrador Tea was the dominant vegetation type, making up 35.0% of the 9,250 hectare study area. The second most abundant vegetation type was Aspen - White Spruce (26.0%) and the third was White Spruce - Aspen (18.0%). The remaining 21.0% of the area was occupied by the Aspen - Birch vegetation type (7.5%), Balsam Poplar - Alder (6.0%) along the McKay River, Sedge - Reed Grass (4.0%) mainly around bodies of standing water created by beaver dams, Willow - Reed Grass (3.0%) along stream courses, and Black Spruce - Feathermoss (0.5%). The White Spruce - Aspen type is best developed in the southern part of the lease where there have been no major fires for 80 or more years. It is the only vegetation type that contains some white spruce stands approaching the present lower limits of merchantable forest in Alberta. The most productive stand sampled in the White Spruce - Aspen

type had a gross volume of 324.5 m^3/ha and a merchantable spruce volume of 226.7 m^3/ha; site index for spruce in this stand was 22 m (72 ft) at age 70 years. The Aspen - White Spruce type was less productive, with an aspen site index averaging 16 m (52 ft) at age 50 years. In terms of mean annual increment and site index, the two vegetation types with the greatest potential for fibre production (White Spruce - Aspen and Aspen - White Spruce types) are of average or below average productivity when compared to data from similar stands elsewhere in Alberta and Saskatchewan.

The two major influences on floristic composition and vegetation patterns in the west part of Lease 17 are fire history and surface accumulation of water as a result of beaver dams along small streams.

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APPENDIX 1. Species significance ratings[a] for 27 sample plots in 8 vegetation types, west part of Syncrude Lease 17.

VEGETATION TYPE	SEDGE-REED GRASS	WILLOW-REED GRASS	BLACK SPRUCE-LABRADOR TEA	ASPEN-BIRCH	ASPEN-WHITE SPRUCE	WHITE SPRUCE-ASPEN	BLACK SPRUCE-FEATHER MOSS	BALSAM POPLAR-ALDER
PLOT	17 23 25	14 15 20	4 16 22	18 19 21	5 11 12 13	1 2 3 6 7	24 26 27	8 9 10
TREES								
Populus tremuloides		(2)		(6) (6)	(8) (7) (7) (8)	(5) (7) (5) (6) V + 1 + 1		
Picea glauca					7	(6) (5) (5) (7) 3 (4) 5 3 2		
Populus balsamifera				(1)	2	(1) 1		(9) (9) (9)
Picea mariana			(7) (4) (3)				(8) (7) (7)	
Betula papyrifera		(2) (1)		(5)	+	2		
Pinus banksiana			+ 1			V V		
Larix laricina							3 3	

[a] Species Significance Ratings

+ Very sparsely present, dominance very small
1 Sparsely present, dominance small
2 Very scattered, dominance small
3 Scattered to plentiful, dominance less than 1/20 of area visible to observer
4 Often present, dominance 1/20 to 1/10
5 Often present, dominance 1/10 to 1/4
6 Any number of individuals, dominance 1/4 to 1/3
7 Any number of individuals, dominance 1/3 to 1/2
8 Any number of individuals, dominance 1/2 to 3/4
9 Any number of individuals, dominance over 3/4
V Species present as veteran
* Species present as seedlings

(Some tree species are present in both A_1 and A_2 layers and some shrubs in both B_1 and B_2; A_1 and B_1 species significance ratings are in brackets)

APPENDIX 1. Species significance ratings for 27 sample plots in 8 vegetation types, west part of Syncrude Lease 17. (Continued)

VEGETATION TYPE	SEDGE-REED GRASS			WILLOW-REED GRASS			BLACK SPRUCE-LABRADOR TEA			ASPEN-BIRCH			ASPEN-WHITE SPRUCE				WHITE SPRUCE-ASPEN					BLACK SPRUCE-FEATHER MOSS			BALSAM POPLAR-ALDER		
PLOT	17	23	25	14	15	20	4	16	22	18	19	21	5	11	12	13	1	2	3	6	7	24	26	27	8	9	10
SAPLINGS																											
Populus tremuloides									+*	6*	4	(2)					(+) 2	(+) 3	1	(3)	+						
Picea glauca										(+)	1	2	2	2	(1) 1*		(+) 1*	(4) +	(3) 3*	*	(2) 3*						
Populus balsamifera										(2)	(3)	(3)										1					
Picea mariana							3	*				4										2	2	3			
Betula papryifera				2					(1)											(+)			*				
Pinus banksiana								*																			
Larix laricina																							*	*			
Abies balsamea																				*							
SHRUBS																											
Salix spp	1	4	3	7	8	7	+			4	4		(4)	2	(2) 1	(2) 2	(1)	2			1	1	(1)	2			
Ledum groenlandicum				7		3	7	7	5	6	2	4	3				2	1		6		3	7	5			
Rosa acicularis				1	2					1			3	5	2	4	2	3	3	3	4	1			5	5	5
Alnus crispa				(2) 2	(3) 2	2				+	1	(3)		(3) 1	(4) 2		(+) +		(6) 2	4							
Shepherdia canadensis				1							3	4	5	1	+	7	2	3	3		2						
Vaccinium myrtilloides								1		4	6		3	1		2	2	7		+				+			
Cornus stolonifera				1	1	2						3	1		1		+		4						5	+	2
Viburnum edule				2	2						1			2		6	1		4	1	2						
Ribes triste				1	1										2					1					2		2
Ribes oxyacanthoides				1	1							2			1				1						3	+	2
Amelanchier alnifolia																2		4	1								
Betula pumila				1					+		*	2															
Lonicera villosa				1	1									1						+							
Rubus strigosus						+									2										2	2	

APPENDIX 1. Species significance ratings for 27 sample plots in 8 vegetation types, west part of Syncrude Lease 17. (Continued)

VEGETATION TYPE	SEDGE-REED GRASS			WILLOW-REED GRASS			BLACK SPRUCE-LABRADOR TEA			ASPEN-BIRCH			ASPEN-WHITE SPRUCE				WHITE SPRUCE-ASPEN					BLACK SPRUCE-FEATHER MOSS			BALSAM POPLAR-ALDER		
PLOT	17	23	25	14	15	20	4	16	22	18	19	21	5	11	12	13	1	2	3	6	7	24	26	27	8	9	10
SHRUBS																											
Alnus tenuifolia																									6	9	6
Lonicera involucrata					1	2						2															
Lonicera dioica												4								1							
Symphoricarpos albus																										1	
Betula glandulosa									+																		
Vaccinium caespitosum										1	+																
Kalmia polifolia									1																		
HERBS & DWARF WOODY PLANTS																											
Cornus canadensis				3	1					5	5	2	6	4	7	6	3	5	3	4	5	3	1	+		3	
Equisetum arvense				3	1		3			2		2	3	1	2	2	2					3	6	6	7	6	7
Linnaea borealis				2	2					1	1	4	3	4		3	2	3	2	3	4	1	1	1			
Vaccinium vitis-idaea				6		2		7	7	4		2	7				3	+		6	3	2	4	4			
Anemone canadensis				2						2	2		4	4	4	3	2	3	+	2	1	2		4			
Rubus acaulis				2	2	+						2		3		2	1	1		1	1		1		2	3	3
Calamagrostis canadensis		8	5	5	6	7						4	2	3	3	3					3		2	2			
Epilobium angustifolium		1		2	3						2	3			1	5	+		2	1	4	2			4		
Maianthemum canadense								1			3	1		1		1	1	1	4	+	3				5		5
Galium boreale					1	1						1		2	3	2			3	1	2				2		
Fragaria vesca				3	1	1						1	1	2	4				1		3					1	
Vicia americana				1	1					1	1	1	1			3			3						1		
Achillea millefolium				1	+							1	1		1			+	1		+						
Mitella nuda				3		3						1			1				3		3		1	+			
Oxycoccus microcarpus						4	7	2	1			1											2				
Lathyrus ochroleucus										2	2		2		1	4	1		1								
Galium triflorum				1								+			1		1	2									

APPENDIX 1. Species significance ratings for 27 sample plots in 8 vegetation types, west part of Syncrude Lease 17. (Continued)

VEGETATION TYPE	SEDGE-REED GRASS			WILLOW-REED GRASS			BLACK SPRUCE-LABRADOR TEA			ASPEN-BIRCH			ASPEN-WHITE SPRUCE				WHITE SPRUCE-ASPEN					BLACK SPRUCE-FEATHER MOSS			BALSAM POPLAR-ALDER		
PLOT	17	23	25	14	15	20	4	16	22	18	19	21	5	11	12	13	1	2	3	6	7	24	26	27	8	9	10
HERBS & DWARF WOODY PLANTS																											
Trientalis borealis				1									1						1	1	1						
Parnassia palustris				2	1	1				1		1															
Carex capillaris			5			4			1														1	+			
Geocaulon lividum												3						1		+		1		1			
Castilleja miniata				3						3	+		+														
Goodyera repens				1	4					+										+							
Petasites palmatus					3	3						3											2				
Lycopodium annotinum																	1		1	5	2						
Carex aquatilis	8	4	7			6																					
Arctostaphylos rubra																						2	1	5			
Pyrola asarifolia												2				2											
Galium labradoricum	1	4	5																								
Elymus innovatus													1				+		3								
Bromus ciliatus				1	1							4															
Aralia nudicaulis					+											7		1			3						2
Pedicularis labradorica													2								2						
Hieracium canadense										+	+		1														2
Mertensia paniculata																			1		1				2		
Erigeron sp				1	+											1											
Actaea rubra																			1						2	3	2
Smilacina racemosa						2																	2			4	
Equisetum pratense																							3	4			
Carex disperma				1		1						1															
Carex lasiocarpa	8	4	8																								
Polygonum amphibium	+	2	2																								
Aster foliaceus												1						+			2						
Lycopus asper	1	1	+																								

APPENDIX 1. Species significance ratings for 27 sample plots in 8 vegetation types, west part of Syncrude Lease 17. (Continued)

VEGETATION TYPE	SEDGE-REED GRASS			WILLOW-REED GRASS			BLACK SPRUCE-LABRADOR TEA			ASPEN-BIRCH			ASPEN-WHITE SPRUCE				WHITE SPRUCE-ASPEN					BLACK SPRUCE-FEATHER MOSS			BALSAM POPLAR-ALDER		
PLOT	17	23	25	14	15	20	4	16	22	18	19	21	5	11	12	13	1	2	3	6	7	24	26	27	8	9	10
HERBS & DWARF WOODY PLANTS																											
Pyrola secunda					2												1										
Pyrola virens																		1						+			
Poa sp										1	2																
Eriophorum vaginatum							2	3																			
Potentilla palustris	2	2																									
Potentilla norvegica		2			3																						
Empetrum nigrum																						3		1			
Typha latifolia		2	1																								
Cicuta bulbifera		1	1																								
Scirpus microcarpus		2	3																								
Bidens cernua		3	+																								
Scutellaria galericulata		2	2																								
Rumex occidentalis		1	+																								
Arctostaphylos uva-ursi										2																	
Rubus chamaemorus							3	4																			
Agropyron trachycaulum												2															
Agrostis scabra										2																	
Glyceria grandis			+																								
Castilleja raupii												+															
Campanula rotundifolia													+														
Thalictrum sparsiflorum																									2		
Habenaria hyperborea							1																				
Petasites sagittatus																							3				
Lycopodium clavatum										1																	
Carex aurea		2																									
Carex rostrata			5																								
Carex gynocrates																								+			

APPENDIX 1. Species significance ratings for 27 sample plots in 8 vegetation types, west part of Syncrude Lease 17. (Continued)

VEGETATION TYPE	SEDGE-REED GRASS			WILLOW-REED GRASS			BLACK SPRUCE-LABRADOR TEA			ASPEN-BIRCH			ASPEN-WHITE SPRUCE				WHITE SPRUCE-ASPEN					BLACK SPRUCE-FEATHER MOSS			BALSAM POPLAR-ALDER		
PLOT	17	23	25	14	15	20	4	16	22	18	19	21	5	11	12	13	1	2	3	6	7	24	26	27	8	9	10
HERBS & DWARF WOODY PLANTS																											
Carex vaginata																								+			
Comandra pallida																	+		1								
Hippuris vulgaris	4																										
Potentilla tridentata										1																	
Caltha palustris						1																					
Impatiens capensis			+																								
Moneses uniflora																							1				
Aster ciliolatus																3											
Aster conspicuus				1																							
LICHENS & BRYOPHYTES																											
Pleurozium schreberi												1		4			8	8		7	7	8		7			
Sphagnum spp				5	7	7	4	9	9			2												5			
Peltigera aphthosa							1			2		1		2			1	3				2				1	
Hylocomium splendens														3			8	5		4	3	7		4			
Ptilium crista-castrensis							7												6		2	3		2			
Drepanocladus aduncus	3	3	5			5																					
Aulacomnium palustre				8	7							5															
Polytrichum juniperinum								2	5	3																	
Cladonia spp								3	4	3																	
Cladina arbuscula							8	3																			
Cladina alpestris																						2		2			
Cladina mitis								3																			
Icmadophila ericetorum							+	+	1																		

APPENDIX II

The following is an alphabetical listing of 115 vascular plants seen on the west half of Lease 17, Syncrude Canada Ltd., 1977. The nomenclature follows Moss (1959).

Abies balsamea (L.) Mill.	(Balsam fir)
Achillea millefolium L.	(Common yarrow)
Actaea rubra (Ait.) Willd.	(Red baneberry)
Agropyron trachycaulum (Link) Malte	(Slender wheat grass)
Agrostis scabra Willd.	(Hair grass)
Alnus crispa (Ait.) Pursh	(Green alder)
Alnus tenuifolia Nutt.	(River alder)
Amelanchier alnifolia Nutt.	(Saskatoon-berry)
Anemone canadensis L.	(Canada anemone)
Aralia nudicaulis L.	(Wild sarsaparilla)
Arctostaphylos rubra (Rehder & Wils.) Fern.	(Alpine bearberry)
Arctostaphylos uva-ursi (L.) Spreng.	(Common bearberry)
Aster ciliolatus Lindl.	(Lindley's aster)
Aster conspicuus Lindl.	(Showy aster)
Aster foliaceus Lindl.	-
Athyrium filix-femina (L.) Roth	(Lady fern)
Betula glandulosa Michx.	(Dwarf birch)
Betula papyrifera Marsh.	(White birch)
Betula pumila L. var. *glandulifera* Regel	(Swamp birch)
Bidens cernua L.	(Nodding beggar-ticks)
Bromus ciliatus L.	(Fringed brome)
Calamagrostis canadensis (Michx.) Beauv.	(Marsh reed grass)
Caltha palustris L.	(Marsh marigold)
Campanula rotundifolia L.	(Bluebell)
Carex aquatilis Wahlenb.	-
Carex aurea Nutt.	-
Carex capillaris L.	-

Carex diandra Schrank	-
Carex disperma Dewey	-
Carex gynocrates Wormsk.	-
Carex lasiocarpa Ehrh.	-
Carex rostrata Stokes	-
Carex vaginata Tausch	-
Castilleja miniata Dougl.	(Common red paint-brush)
Castilleja raupii Pennell	-
Cicuta bulbifera L.	(Water hemlock)
Cinna latifolia (Trev.) Griseb.	(Drooping wood reed)
Comandra pallida A. DC.	(Bastard toad-flax)
Cornus canadensis L.	(Bunchberry)
Cornus stolonifera Michx.	(Dogwood)
Elymus innovatus Beal	(Hairy wild rye)
Empetrum nigrum L.	(Crowberry)
Epilobium angustifolium L.	(Fireweed)
Equisetum arvense L.	(Field horsetail)
Equisetum pratense Ehrh.	-
Erigeron sp.	(Fleabane)
Eriophorum vaginatum L.	(Cotton grass)
Fragaria vesca L. var. *americana* Porter	(Woodland strawberry)
Galium boreale L.	(Northern bedstraw)
Galium labradoricum Wieg.	-
Galium triflorum Michx.	(Sweet-scented bedstraw)
Geocaulon lividum (Richards.) Fern.	(Bastard toad-flax)
Glyceria grandis S. Wats.	(Manna grass)
Goodyera repens (L.) R. Br.	(Rattlesnake plantain)
Gymnocarpium dryopteris (L.) Newm.	(Oak fern)
Habenaria hyperborea (L.) R. Br.	(Northern green orchid)
Hieracium canadense Michx.	(Canada hawkweed)
Hippuris vulgaris L.	(Mare's tail)
Impatiens capensis Meerb.	(Touch-me-not)
Kalmia polifolia (Wang.) var. *microphylla* (Hook.) Rehd.	(Mountain laurel)

Larix laricina (Du Roi) K. Koch	(Tamarack)
Lathyrus ochroleucus Hook.	(Pea vine)
Ledum groenlandicum Oeder	(Common Labrador tea)
Linnaea borealis L. var. *americana* (Forbes) Rehd.	(Twin-flower)
Lonicera dioica L. var. *glaucescens* (Rydb.) Butters	(Twining honeysuckle)
Lonicera involucrata (Richards.) Banks	(Bracted honeysuckle)
Lonicera villosa (Michx.) R & S.	(Fly honeysuckle)
Lycopodium annotinum L.	(Stiff club-moss)
Lycopodium clavatum L.	(Common club-moss)
Lycopodium complanatum L.	(Ground cedar)
Lycopus asper Greene	(Water horehound)
Maianthemum canadense Desf. var. *interius* Fern.	(Wild lily-of-the-valley)
Mertensia paniculata (Ait.) G. Don	(Tall mertensia)
Mitella nuda L.	(Bishop's-cap)
Moneses uniflora (L.) A. Gray	(One-flowered wintergreen)
Oxycoccus microcarpus Turcz.	(Small bog cranberry)
Parnassia palustris L. var. *neogaea* Fern.	(Grass-of-Parnassus)
Pedicularis labradorica Wirsing	(Lousewort)
Petasites palmatus (Ait.) A. Gray	(Palmate-leaved coltsfoot)
Petasites sagittatus (Pursh) A. Gray	(Arrow-leaved coltsfoot)
Picea glauca (Moench) Voss var. *albertiana* (S. Brown) Sarg.	(White spruce)
Picea mariana (Mill.) BSP.	(Black spruce)
Pinus banksiana Lamb.	(Jack pine)
Poa sp.	(Bluegrass)
Polygonum amphibium L. var. *stipulaceum* (Coleman) Fern.	(Water smartweed)
Populus balsamifera L.	(Balsam poplar)
Populus tremuloides Michx.	(Aspen)
Potentilla norvegica L.	(Rough cinquefoil)
Potentilla palustris (L.) Scop.	(Marsh cinquefoil)
Potentilla tridentata Ait.	(Three-toothed cinquefoil)
Pyrola asarifolia Michx.	(Common pink wintergreen)
Pyrola secunda L.	(One-sided wintergreen)

Pyrola virens Schweigg.	(Greenish-flowered wintergreen)
Ribes oxyacanthoides L.	(Wild gooseberry)
Ribes triste Pall.	(Wild red currant)
Rosa acicularis Lindl.	(Prickly rose)
Rubus acaulis Michx.	(Dwarf raspberry)
Rubus chamaemorus L.	(Cloudberry)
Rubus strigosus Michx.	(Wild red raspberry)
Rumex occidentalis S. Wats. var. *fenestratus* (Greene) Le Page	(Western dock)
Salix spp.	(Willow)
Scirpus microcarpus Presl.	(Small-fruited bulrush)
Scutellaria galericulata L.	(Common skullcap)
Shepherdia canadensis (L.) Nutt.	(Canadian buffalo-berry)
Smilacina racemosa (L.) Desf. var. *amplexicaulis* (Nutt.) S. Wats.	(False Solomon's-seal)
Symphoricarpos albus (L.) Blake	(Snowberry)
Thalictrum sparsiflorum Turcz.	(Flat-fruited meadow rue)
Trientalis borealis Raf.	(Star-flower)
Typha latifolia L.	(Common cattail)
Urtica gracilis Ait.	(Common nettle)
Vaccinium caespitosum Michx.	(Dwarf bilberry)
Vaccinium myrtilloides Michx.	(Blueberry)
Vaccinium vitis-idaea L. var. *minus* Lodd.	(Bog cranberry)
Viburnum edule (Michx.) Raf.	(Low-bush cranberry)
Vicia americana Muhl.	(Wild vetch)

APPENDIX III

Photographs of eight mapped
vegetation types, west part
of Syncrude's Lease 17

FIGURE 3. Sedge — Reed Grass vegetation type which occupies 367 ha (4.0%) of study area in wet depressions and along streams.

FIGURE 4. Willow — Reed Grass vegetation type which occupies 271 ha (3.0%) of study area, mainly along streams.

FIGURE 5. Black Spruce — Labrador Tea vegetation type which occupies 3,232 ha (35.0%) of study area on poorly-drained sites, some of which are recently burned.

FIGURE 6. Aspen — Birch vegetation type which occupies 702 ha (7.5%) of study area on recently burned areas that range from well-drained to poorly-drained.

FIGURE 7. Aspen — White Spruce vegetation type which occupies 2,405 ha (26.0%) of study area on recently burned sites, most of which are well-drained.

FIGURE 8. White Spruce — Aspen vegetation type which occupies 1,650 ha (18.0%) of study area on well-drained upland sites.

FIGURE 9. Black Spruce — Feathermoss vegetation type which occupies only 55 ha (0.5%) of study area on edges of open muskeg.

FIGURE 10. Balsam Poplar — Alder vegetation type which occupies 573 ha (6.0%) of study area in valley of McKay River.

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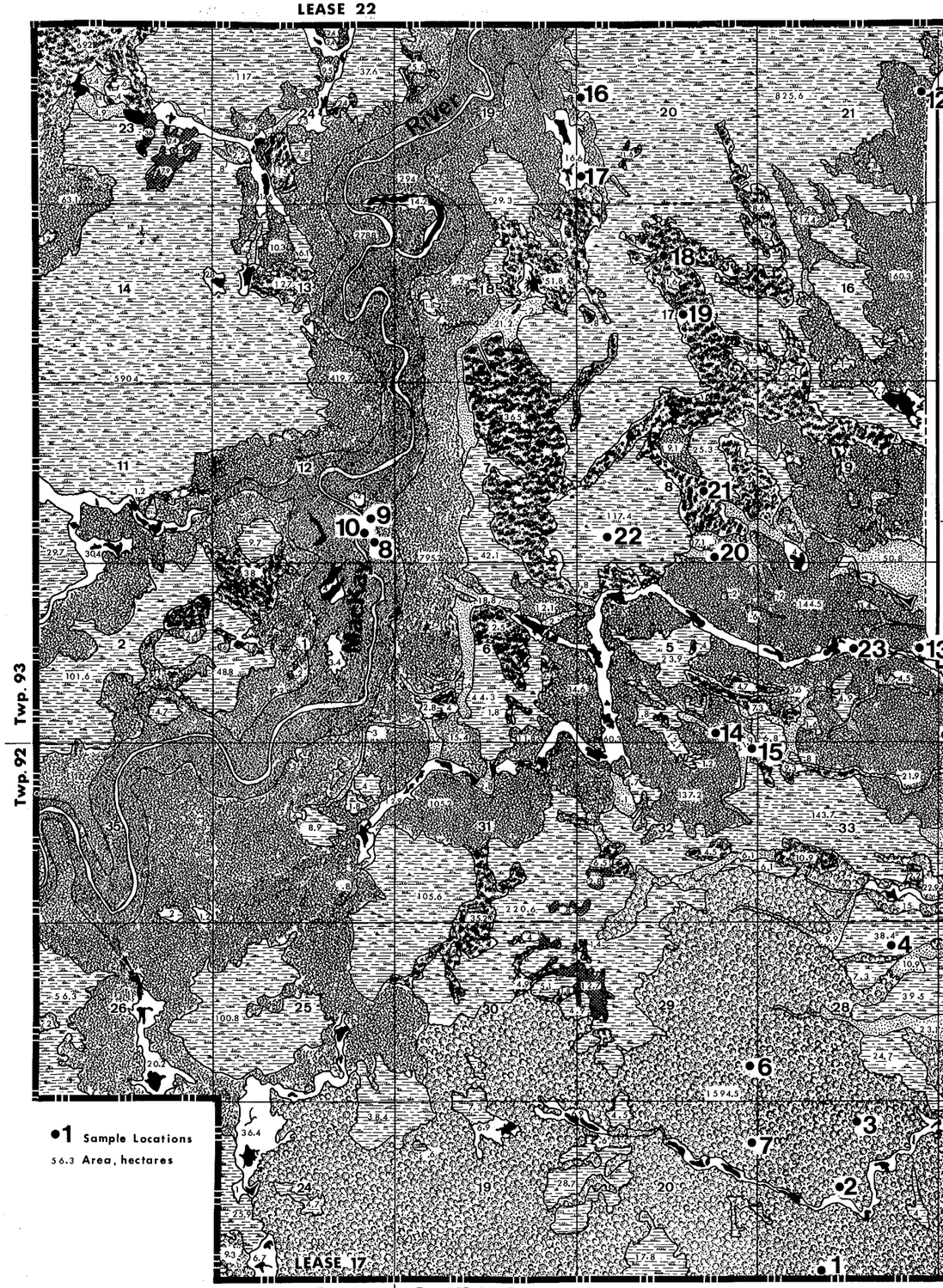

VEGETATION TYPE MAP,
WEST PART OF SYNCRUDE LEASE # 17
ALBERTA

- STANDING WATER
- SEDGE - REED GRASS
- WILLOW - REED GRASS
- BLACK SPRUCE - LABRADOR TEA
- ASPEN - BIRCH
- ASPEN - WHITE SPRUCE
- WHITE SPRUCE - ASPEN
- BLACK SPRUCE - FEATHERMOSS
- BALSAM POPLAR - ALDER

MAPPED IN AUGUST 1977
BY
WESTERN ECOLOGICAL SERVICES LTD.
EDMONTON
FOR
SYNCRUDE CANADA LTD.

0.5 1 mile
0.5 1 1.5 km

Twp. 93
Twp. 92
24th Base Line
Rge. 12 | Rge. 11, W. 4 mer.

Conditions of Use

Peterson, E.B. and A.G. Levinsohn, 1977. Vegetation types and forest productivity, west part of Syncrude's Lease 17, Alberta. Syncrude Canada Ltd., Edmonton, Alberta. Environmental Research Monograph 1977-6. 50 pp. plus map.