PR 77-004

RECLAMATION PLAN
for the
WALTON OPERATIONS

Minerals &
Manufacturing
Group

DRESSER

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PR77-004

RECLAMATION PLAN

FOR THE

WALTON OPERATIONS

Prepared and presented by the
Safety and Environmental Dept.
Minerals and Manufacturing Group
Dresser Industries, Inc.

December 20, 1977

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Introduction

The Walton barite mining and milling operation of Dresser Minerals, a division of Dresser Industries, Incorporated, respectfully submits this reclamation plan to, and at the request of, the Nova Scotia Department of the Environment and the Environmental Protection Service of Environment Canada in conjunction with the Nova Scotia Department of Mines. With the consent of these Departments this carefully thought out plan shall be followed by Dresser personnel at Walton and shall be completed within a reasonable period of time following the official date of closure which is currently scheduled for October, 1978. The plan was written by the Environmental Control Department of the Minerals and Manufacturing Group of Dresser Industries and follows guidelines commonly accepted in reclamation techniques.

The only specific reclamation requirements for mine closure are found in Chapter 183 of the Metalliferous Mines and Quarries Regulation Act of 1967 (revised in 1976). Other requirements governing the restoration and reclamation of degraded or despoiled areas of the environment are found in the Environmental Protection Act, Chapter 6. In light of these requirements, mine reclamation specialists were sent to Walton in 1976 and 1977 to work with plant management in evaluating the economic and technical feasibility of reclamation at the mine. This plan was then developed following these considerations and is designed to reduce the short term and long term adverse environmental impacts of operation closure.

The mine is located approximately 2.5 miles southwest of Walton and is accessible by a road intersecting Provincial Highway 215. Descriptions of the property have been given in detail by Tenny (1951), Jewett (1957), Boyle (1972), and others (see figure 1). The area consisting of the mine and mill operation is a contiguous series of plots with a total area of approximately 285 acres. Company housing and export operations are located in Walton and situated on Company owned land.

Reclamation plans many times contain objectives other than revegetation, although the establishment of a self-regenerating plant cover is usually a major part of any plan (Dames & Moore, 1976). This plan includes other objectives such as artificial (man induced) establishment of vegetation on areas where natural succession does not immediately regenerate a groundcover. The ability of the stock piles and other disturbed areas to self-regenerate a plant cover is addressed in this report. The findings of the report indicate that a self-generating plant cover for the spoils area is already established as proven by vegetative analyses of those areas. Other objectives presented in this plan include plans for; disposal of buildings and equipment, contouring, sink hole correction, sulphide containment, safety precautions, and others.

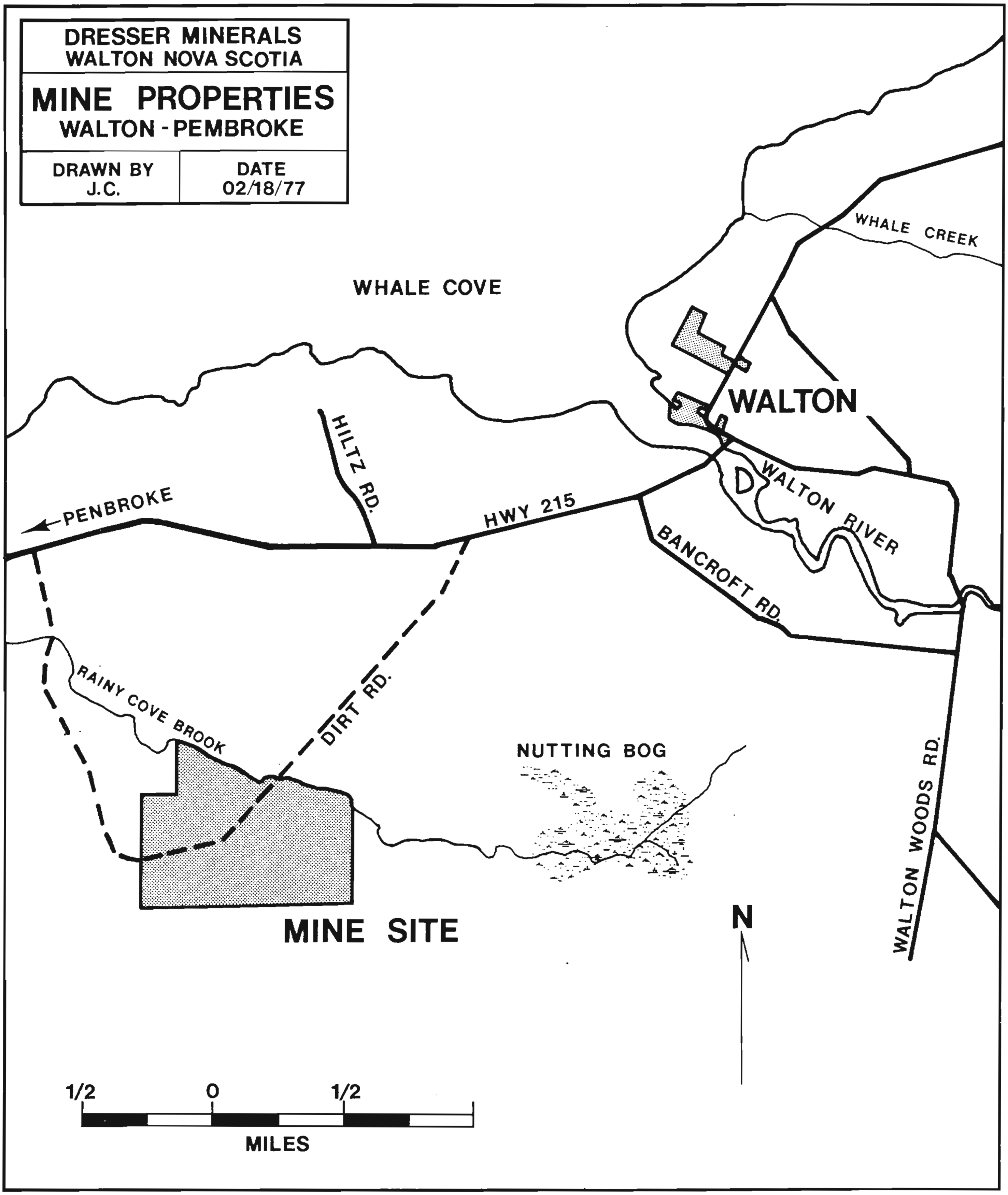


Figure 1. Mine and Townsite.

History

Detailed historical monographs of the Walton operation can be found in several widely published journals. From these publications it is apparent that the barite orebody was known as early as 1894 (Boyle, 1972) although no mining interest in the ore was expressed for years. In 1941, the Canadian Government asked all gold mining companies to prospect for badly needed minerals and metals (Gorman, 1949, and Tenny, 1951). Following this request, Springer Sturgeon Gold Mines Limited began an extensive drilling program which gave rise to the largest barite quarry and mine in Canada (Boyle, 1972). Although the mine was owned by the Springer Sturgeon Company, it was operated by a subsidiary, Canadian Industrial Minerals, Limited, until 1955. At that time the property was sold to Magnet Cove Barium Corporation, a subsidiary of Dresser Industries, Incorporated of Dallas, Texas. The mine has since been operated by Dresser Industries providing essential products to the Canadian oil and gas industry. The mine has employed from 260 full-time employees during peak production years to 55 employees during the recent final phase of operations.

Topography and Soils

A geological description of the orebody will not be included here although detailed monographs addressing the subject have more than adequately described the area. These monographs also detail the mining methods used in extracting the ore during the lifetime of the operation. One of the most recent descriptions can be found in Bulletin 166 written by R. W. Boyle of the Geological Survey of Canada published by the Department of Energy, Mines and Resources. This report also contains the barite and sulphide body production figures for the years 1941 through 1966 as found in the Annual Reports of the Nova Scotia Department of Mines.

The soil of the spoils piles has not been treated or changed in chemical composition. The soil is characterized as a red clay with varying degrees of rock content. The primary product, barite (barium sulfate), is an inert rock. Any residue left from the mining or milling process would therefore pose no threat of soil toxicosis.

Soil analysis of the spoils soil conducted by the Soils and Crops Branch of the Nova Scotia Department of Agriculture and Marketing indicate that the fertility of the soil is adequate to sustain a healthy plant community without fertilizing. The nitrogen level is low although the predominance of legumes in the early years will fix nitrogen into the soil. A sustained nitrogen content will be enhanced by natural nitrogen-fixing systems other than the legumes. The ability of other plants to fix nitrogen into the soil at a rate equal to or greater than the legumes is found in the association between obligately symbiotic actinomycetes (bacteria) and ligneous vegetation such as *Comptonia* and *Alnus* (Evans and Barber, 1977). Most of the nitrogen produced for forest and woodland maintenance is derived from a variety of non-leguminous associations and free living organisms (Evans and Barber, 1977). These two general associations indicate that nitrogen fixing systems will predominate throughout the changes in succession of the spoils piles without the aid of fertilization.

The fertility of the tailings pond soil has been analyzed by the Department of Agriculture. The soluble salts for the July 1976 sample are indicated by a solubridge reading of 92 mhos X 10^{-5} which is relatively high for sustaining plant growth although a soil leaching period of one year has transpired since that test. Another soil test will be conducted in 1977 and again in 1978 in order to determine the rate of leaching.

As a corrective treatment for the soil, efforts were made to leach the salts from the surface of the tailings ponds by draining rain-water run-off over the soil. This process was improved in June 1977 when some areas with standing water were forced to drain so dissolved salts would be carried from the soil. This method of leaching the salt is not only the simplest method but probably the only method applicable to this particular situation. The procedure was conducted at the recommendation of the Soils and Crops Branch of the Department of Agriculture and Marketing (1976).

The characteristics of soil solidity are dependent upon the settling rates of the tailings. The settling characteristics of the clays and sands in the Walton area are such that the surface is too weak to support heavy machinery. An application of fertile top soil to the surface of the tailings pond is therefore not technically practical. Similarly, discing the soil and incorporating organic material or planting and fertilizing is not practical either, which therefore poses a problem. The only currently visible means of solving this problem and seeding the tailings ponds will, therefore, be by hand which will be laborious as well as uneconomical (see chapter entitled "Revegetation"). → Send nutrient out with tailings.

Contouring will be required in several areas of the mine site. The focus of the contouring effort will be directed only at sharp ridges and peaks. Steeper slopes of the spoils piles give evidence that areas with a steeper grade develop a groundcover of shrubs and trees much more successfully. This statement is supported by the fact that shrubs are first found on areas supporting better drainage.

Climatic Considerations

No records were available to the author which indicate that any meteorological data have been collected for the immediate vicinity of Walton. The nearest meteorological data station to Walton which had compiled complete climatological data for at least thirty years was Truro, Nova Scotia, located approximately forty aeronautical miles east north-east of Walton. Truro is located more inland than Walton although, for the purpose of this study, the data collected at Truro can be used as a comparison to the Walton area. The following information was derived from these data collected at this station which is operated by the Atmospheric Environmental Service of Environment Canada (Atmospheric Environment Service, 1975).

The mean annual precipitation for Truro is 43.33 inches which contains a snow fraction of approximately 30% (see figure 2). A slightly wetter season extends from August through January composed of an average mean monthly precipitation rate varying between 3.08 inches in September to 4.38 inches in August. Slightly drier months vary from a low of 2.47 inches in June to a higher monthly mean of 3.39 inches in February. These data suggest that a true dry and wet season for the area is not indicated although the spring months are slightly drier than are the fall months.

The mean daily temperature for the year is 41.8^{o} F with the high monthly mean of 63.6^{o} F in July and the lowest monthly mean of 20.6^{o} F in February (see figure 3). The period between the first fall frost and the last spring frost is 104 days with the first frost occurring on September 17 and the last frost occurring on June 4. Wind data collected from 1955 through 1972 indicate a predominately westerly wind for every month with an increase of west south-westerly and southwesterly winds from June through August. Northerly winds increase during March and April.

These data support the view that an adequate growing season prevails for the area with adequate precipitation and favorable weather conditions for life sustaining processes. Irrigation or other artificially induced weather changes are not necessary in this plan.

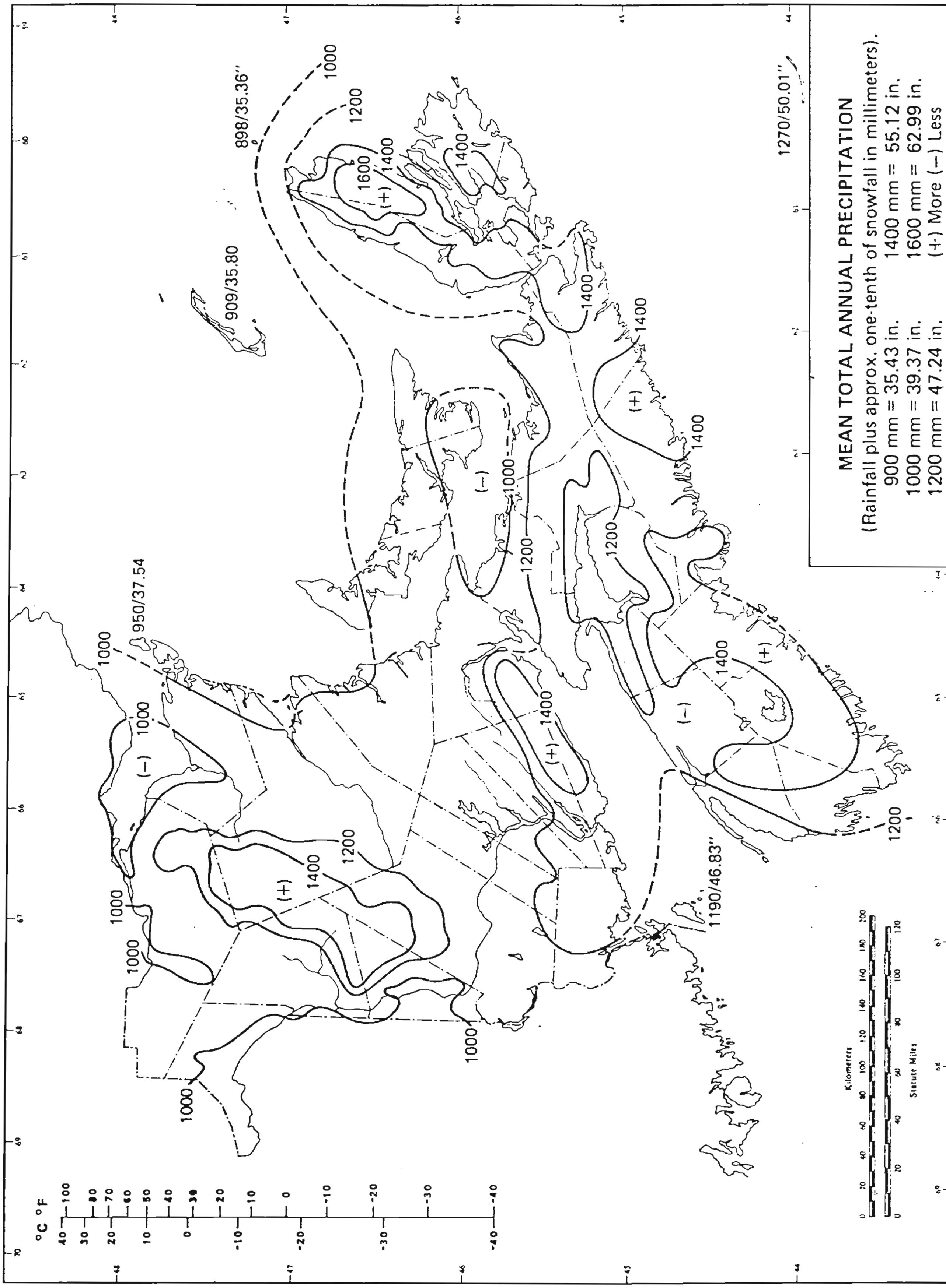


Figure 2. Mean Total Annual Precipitation (Taken from Gates, 1975).

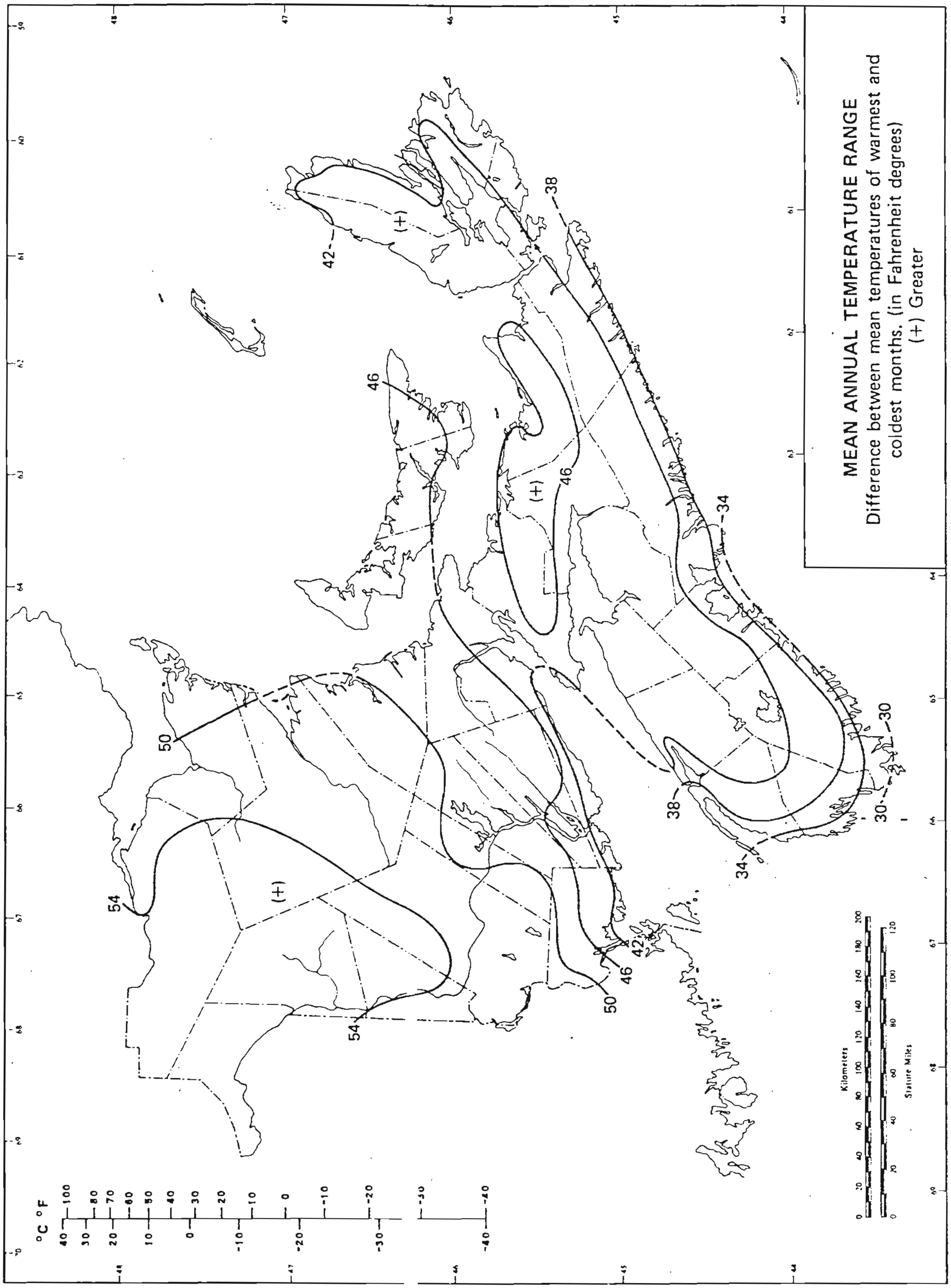


Figure 3. Mean Annual Temperature (Taken from Gates, 1975).

Ecological Considerations

The Walton area is included in the hemlock - white pine northern hardwood region of North America (Nichols, 1935). The dominant trees of the region are hemlock, sugar-maple, beech, yellow birch, white and red pine, white ash, red and white spruce, balsam fir, and red maple (Roland and Smith, 1969). Aerial photographs indicate that areas adjacent to the Dresser mine and mill property have had the timber cut and the forest cleared as recently as the mid-1950's. The current forest surrounding the property does conform to the description given above although an increased abundance of invaders such as tamarack and shrubby species are still co-dominants with the indicator species. Knowledge of the surrounding vegetation is important when describing the existing vegetation on the spoils and estimating its ability to reestablish itself. With this knowledge, the ability of the vegetation to recover was based on the age of the spoils piles in comparison to the stage of succession found for the currently existing vegetation.

Primary invading species on denuded spoils include plants found commonly in Nova Scotia such as Kentucky Bluegrass, Legumes, Field Horsetail, Coltsfoot and Black Medic. Following this invasion many areas experience a co-dominance or dominance of Hawkweeds, Wild Carot, or Brambles. By far the most abundant species on the spoils are Kentucky Bluegrass and Hawkweed although it should be noted that dominants vary to some extent with the changes in seasonal flora. No plants rare to the area were found and those plants found were all noted in "The Flora of Nova Scotia" as appearing commonly, or at least occasionally to the area. The appearance of shrubs and trees and their successional development will be addressed in the following text.

Chart quadrats of two areas were recorded (see figures 5, 6) and are included to give a visual reference to groundcover. One quadrat taken on a spoils deposit five years old gives an aerial view of the exact location of each plant located within an area measuring one square meter. The location of the quadrat was carefully selected in an effort to avoid gross bias which could occur if the quadrat were laid over an area very dense in vegetation or one with relatively little vegetation. A similar procedure was applied to an area twenty years old and the resulting chart is indicated by figure 6. These quadrats indicate an increase in both species diversity as well as density with an increase in time. An estimate of the total groundcover calculated for the quadrat containing the five year growth is 50% whereas the estimate for the area containing the twenty year growth is 88%. The estimate was derived by use of a listing ruler in measuring those areas without vegetation. Associations containing ligneous vegetation were avoided for the purpose of these quadrats.

Spoils piles which have been undisturbed for twenty years support areas of vegetation which give evidence that reforestation will develop under conditions of primary succession. Most of the dominant species given in the previous description for the northern hardwood region of North America

1 m² Chart Quadrant of Five Year Growth on Spoils

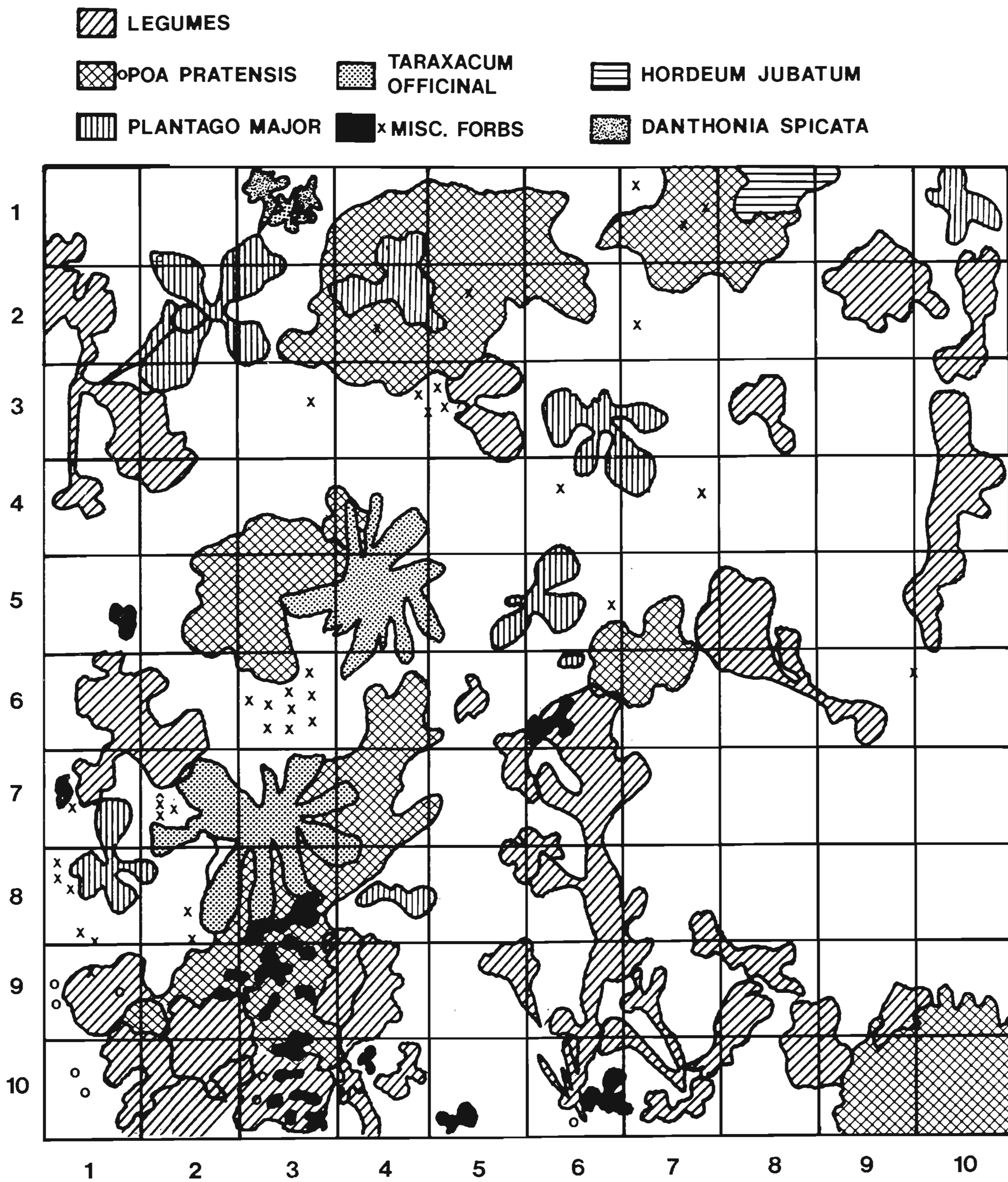
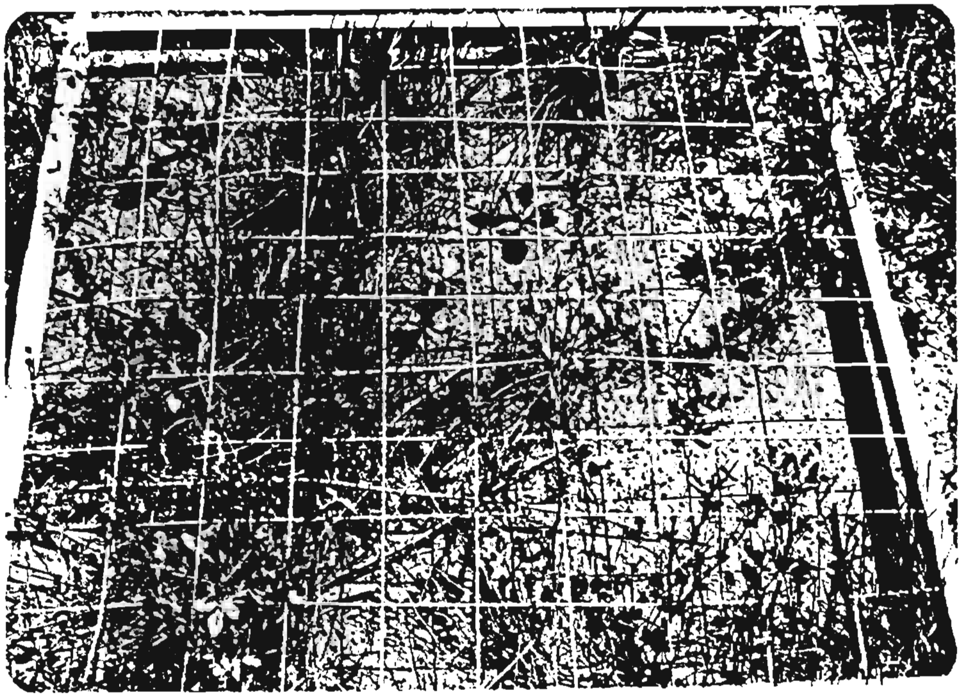


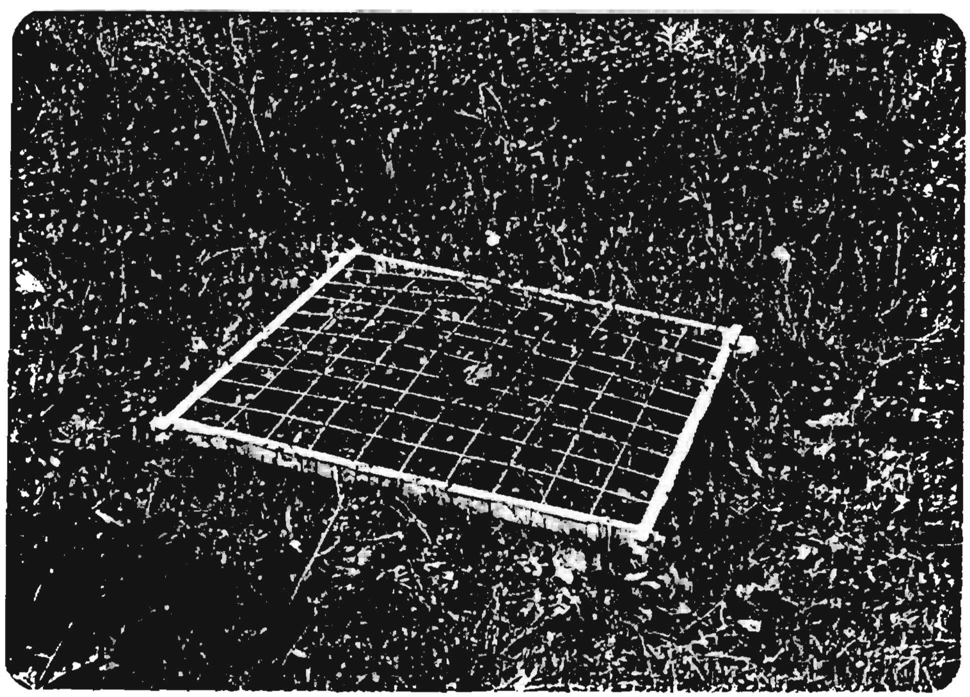
Figure 5

¼ m^2 Chart Quadrant of 20 yr. Growth on Spoils

Figure 6



Photograph of the $1m^2$ quadrat from which the chart in figure 4 was derived.



Photograph of the quadrat from which the $\frac{1}{4}m^2$ chart quadrat in figure 6 was derived.

A shrubby stand forming the early establishment of ligneous vegetation on the spoils piles.

currently exist on the spoils piles although their density is variable and none are expressed as dominants thus far. This situation is due to, and possibly only to, the fact that not enough time has elapsed for forest development. Pre-climax ligneous species are found in established stands on the northern, eastern and western slopes of the overburden pile located east of the quarry as well as the east slope of the tailings dump located north of the main road.

The areas described above characterized by a primary shrubby complex composed of brambles, sweet-fern, and beaked willow in which each may vary greatly in density. Following the emergence of the willows (although sometimes appearing simultaneously and usually in association with them) are tolerant (able to compete with an overstory) trees such as balsam fir, yellow birch, and red maple with intolerant species such as trembling aspen, large toothed poplar, and paper birch. Although the red maple is considered a primary invader on disturbed soils (Roland and Smith, 1969) it appears as a subordinate or at most a co-dominant in this situation. Other species occurring less commonly on the spoils or tailings dumps as well as near the quarry include red spruce, tamarack, and pussy willow.

On either side of the road leading to the quarry are stands of aspen comprising the early development of an overstory. A cross section of one of the largest trees in the stand revealed that the stand began to establish itself twenty years ago. One possible explanation for quick establishment may have been the influence of a concentrated seed dispersion from an undisturbed area supporting established trees located on the north side of the road. In association with the aspen is an underdeveloped midstory composed primarily of beaked willow with the occasional appearance of immature trees such as balsam fir and paper birch. The groundcover is composed predominantly of field horsetail and mosses.

These stages of succession indicate a definite trend of progressing primary plant succession for revegetation on the spoils piles and tailings dumps. The emergence of a disclimax forest appears unlikely except, of course, in the quarry. The spoils piles and other disturbed areas will probably give rise to climax vegetation even though the diversity and density of tolerant trees are presently indicative of an early subclimax community.

The development of these associations presently suggests that efforts to revegetate the area would be of no value in developing a mature forest cover. The woody vegetation on the spoils piles has undergone natural steps of succession to the eighth of ten stages commonly accepted and described (Spur and Barnes, 1973) for mesarch succession in forest ecology. To revegetate these areas would obviously deter development of the community for approximately the equivalent time required for the stages of succession to have progressed to their present stage without interference.

Two stands of aspen growing on spoils piles situated either side of the road leading into the quarry.

Checklist of the Vascular Flora

The following list of taxa were collected from spoils piles or tailings deposits from the Dresser Minerals barite mine area. The taxa are listed in alphabetical order first by family, then by genus and species. The nomenclature is in accordance with "The Flora of Nova Scotia."

Aceraceae	
Acer rubrum L.	Red Maple
Caprifoliaceae	
Diervilla lonicera Mill.	Bush Honey-suckle
Viburnum cassinoides L.	Viburnum
Compositae	
Achillea lanulosa Nutl.	Yarrow
Anaphalis margaritacea (L.) C.B. Clarke var. intercedens Hara	Pearly Everlasting
Antennaria neodioca Greene	Everlasting
Aster spp.	Asters
Centaurea nigra L.	Knapweed
Chrysanthemum lencanthemum L.	Ox-Eye Daisy
Cirsium arvense (L.) Scop.	Canada Thistle
Cirsium vulgare (Savi) Tenore	Ball Thistle
Hieracium aurantiacum L.	Devil's Paint Brush
Hieracium caespitosum Dumort	Hawkweed
Hieracium floribundum Wimm. & Grab.	King-devil
Hieracium pilosella L.	Mouse-ear Hawkweed
Solidago rugosa Ait.	Rough Goldenrod
Solidago sp.	Goldenrod
Sonchus sp.	Sow Thistle
Taraxacum officinale Weber	Dandelion
Tussilago farfara L.	Coltsfoot
Corylaceae	
Betula alleghaniensis Britt.	Yellow Birch
Betula populifera Marsh.	Gray Birch
Cruciferae	
Sisymbrium officinale (L.) Scop.	Hedge Mustard
Cyperaceae	
Carex spp.	Sedges
Equisitaceae	
Equisetum arvense L.	Field Horsetail

Gramineae	
Agropyron repens (L.) Beauv.	Couch grass
Danthonia spicata (L.) Beauv.	Wire grass
Festuca ovina L.	Sheep Fescue
Hordeum jubatum L.	Fox-tail Barley
Phleum pratense L.	Timothy
Poa pratensis L.	Kentucky Bluegrass
Hypericaceae	
Hypericum perforatum L.	Common St. John's Wort
Iridaceae	
Sisyrinchium montanum Greene, var. crebrum Fern.	Blue-Eyed Grass
Juncaceae	
Juncus Gerardi Loisel	Rush
Juncus sp.	Rush
Leguminosae	
Medicago lupulina L.	Black Medic
Melilotus alba Desr.	White Sweet Clover
Melilotus altissima Thuill.	Sweet Clover
Melilotus officinalis (L.) Lam.	Yellow Sweet Clover
Trifolium pratense L.	Red Clover
Trifolium repens L.	Creeping White Clover
Vicia Cracca L.	Vetch
Myricaceae	
Comptonia peregrina (L.) Coult	Sweet Fern
Onagraceae	
Oenothera sp.	Prim-rose
Pinaceae	
Abies balsamea (L.) Mill	Balsam Fir
Larix laricina (Du Roi) K. Koch.	Tamarack
Picea glauca (Moench) Voss	White Spruce
Picea rubens Sarg.	Red Spruce
Picea strobus L.	White Pine
Plantaginaceae	
Plantago major L.	Plantain
Polygonaceae	
Polygonum sp.	Knotweed
Rumex acetosella L.	Sheep-sorrel
Rumex sp.	Dock
Ranunculaceae	
Ranunculus Gmelini D.C. var. Hookeri (D. Don) Benson	Buttercup
Rosaceae	
Fragaria virginiana Duchesne	Wild Strawberry
Prunus virginiana L.	Choke Cherry
Rosa cinnamomea L.	Cinnamon Rose
Rubus sp.	Bramble
Salicaceae	
Populus grandidentata Michx.	Large Toothed Poplar
Populus tremuloides Michx.	Trembling Aspen
Salix Bebbiana Sarg.	Beaked Willow
Salix discolor Muhl.	Pussy Willow

Scrophulariaceae	
Veronica officinalis L.	Common Speedwell
Typhaceae	
Typha latifolia L.	Broad Leaved Cat-tail
Umbelliferae	
Daucus carota L.	Wild Carot
Carum Carvi L.	Caraway

Line Transect Data - June, 1977

These data indicate the number of plants to intersect a 50 foot tape given as the % of the total plants to intercept the line.

Taxa	Line Number 1	2	3	4	5	Total No. of Intercepts	% of Total Intercepts
Aceraceae							
Acer rubrum	1					1	.0658
Caprifoliaceae							
Diervilla lonicera							
Viburnum cassinoides	8				2	10	.6583
Compositae							
Achillea lanulosa			4	14		18	1.1850
Anaphalis prargaritacea var intercedens			11			11	.7242
Antennaria neodioca							
Aster spp.							
Centaurea nigra							
Chrysanthemum leucanthemum	5			5	3	13	.8558
Cirsium arvense			2			2	.1317
Cirsium vulgare			1			1	.0658
Hieracium aurantiacum					2	2	.1317
Hieracium caespitosum							
Hieracium floribundum				3	13	16	1.0533
Hieracium pilosella	6		447	15	80	548	36.0764
Solidago rugosa	3		5			8	.5267
Solidago sp.	10		3	11	2	26	1.7112
Sonchus sp.		9				9	.5925
Taraxacum officinale			1	5	6	12	.7900
Tussilago farfara	3	11		15		29	1.9092
Corylaceae							
Betula alleghaniensis							
Betula populifera	3					3	.1975
Cruciferae							
Sisymbrium officinale							
Cyperaceae							
Carex spp.							
Equisitaceae							
Equisetum arvense	1			4	44	49	3.2258
Gramineae							
Agropyron repens		4				4	.2633
Festuca ovina							
Hordeum jubatum							
Danthonia spicata	1	7	10			18	1.1850
Phleum pratense				1		1	.0658
Poa pratensis	44		119	143	171	477	31.4022

Taxa	Line Number 1	2	3	4	5	Total No. of Intercepts	% of Total Intercepts
Hypericaceae							
Hypericum perforatum				5		5	.3292
Iridaceae							
Sisyrinchium montanum var crebrum							
Juncaceae							
Juncus Gerardi							
Juncus sp.							
Leguminosae							
Medicago lupulina	54	1		19		74	4.8716
Melilotus alba							
Melilotus altissima							
Melilotus officinalis							
Trifolium pratense	8	1		17	21	47	3.0941
Trifolium repens							
Vicia Cracca							
Sp.	1	11	8	11		31	2.0408
Myricaceae							
Comptonia peregrina	7					7	.4608
Onagraceae							
Oenothera sp.	1	1		2	2	6	.3950
Pinaceae							
Abies balsamifera	2				1	3	.1975
Larix laricina							
Picea glauca							
Picea rubens							
Picea strobus							
Plantaginaceae							
Plantago major							
Polygonaceae							
Polygonum sp.							
Rumex acetosella							
Rumex sp.							
Ranunculaceae							
Ranunculus Gmelini var. Hookeri							
Rosaceae							
Fragaria virginiana							
Prunus virginiana			9			9	.5925
Rosa cinnamomea							
Rubus sp.			6	6		12	.7900
Salicaceae							
Populus grandidentata	1					1	.0658
Populus tremuloides	1					1	.0658
Salix Bebbiana	1				1	2	.1317
Salix discolor	1					1	.0658

Taxa	Line Number 1	2	3	4	5	Total No. of Intercepts	% of Total Intercepts
Scrophulariaceae							
Veronica officinalis							
Typhaceae							
Typha latifolia							
Umbelliferae							
Daucus carota	22	11	20	5	7	65	4.2790
Carum Carvi	1					1	.0658

Revegetation

The tailings ponds will require revegetating with consideration given to soil salinity and surface solidity. The primary objectives with artificial revegetation are erosion control and soil development. Although natural revegetation will eventually cover and protect the area from erosion, the actual time involved for this process to develop could be longer than currently desired. Revegetating the tailings ponds requires a study of the plants readily available to Dresser personnel to determine which are the most tolerant for this particular soil yet available at feed stores.

Test plots were planted on the tailings ponds during the summer of 1976 although the plots were either washed out or the sprigs died out. During the last week of May, 1977, ten test plots were once again hand planted in order to determine which grass and legume species common to the area would be most successful (figure 7). The site selection for the plots was meant to include a variety of situations and each plot measured approximately 50 feet square. Timothy and Red Clover were expected to be successful largely due to their ability to naturally reestablish themselves on surrounding spoils areas. Care was taken to ensure that the plots were handled in the same manner as the entire reseeding operation would be handled. That is, excessive amounts of seed or additions of fertilizers were omitted so the results would indicate those similar to the actual planting. From these plots it is apparent that the most successful seed germination tests for this soil includes a mixture of Timothy and Red Clover. The plots were planted with varying combinations

Tailings pond soil leaching process.

Two test plots established on tailings soil.

Figure 7. Test plot quadrat data. Individual quadrats composed of one square decimeter.

Test Plot No.	Species Planted		Count & Rating/Quadrat			
			grass	rating	legume	rating
1	Timothy		114	VA		
			103	VA		
			144	VA		
			44	A		
			69	A		
		total	474			
2	Timothy					
	Red Clover		4	R	7	I
			12	I	51	A
			17	F	58	A
			8	I	21	F
			3	R	22	F
		total	44		159	
3	Bromegrass		0	R	2	R
	Alfalfa		0	R	1	R
			2	R	1	R
			0	R	0	R
			1	R	0	R
		total	3		4	
4	Timothy		0	R	8	I
	Alsike Clover		1	R	4	R
	Alfalfa		0	R	2	R
			0	R	0	R
			0	R	1	R
		total	1		15	
5	Timothy		8	I	3	R
	Alsike Clover		8	I	13	I
	Alfalfa		13	I	2	R
			11	I	8	I
			16	F	11	I
		total	56		59	

Test Plot No.	Species Planted		Count & Rating/Quadrat			
			grass	rating	legume	rating
6	Timothy		102	VA	26	F
	Alsike Clover		148	VA	12	I
			35	F	1	R
			20	F	0	R
			4	R	31	F
		total	309		70	
7	Timothy		0	R	0	R
	Red Clover		0	R	0	R
			0	R	0	R
			0	R	0	R
			0	R	0	R
		total	0		0	
8	Bromegrass		0	R	0	R
	Alfalfa		0	R	0	R
			0	R	0	R
			0	R	0	R
			0	R	0	R
		total	0		0	
9	Timothy		8	I	7	I
	Red Clover		17	F	12	I
			8	I	5	R
			2	R	2	R
			0	R	3	R
		total	35		29	
10	Timothy		2	R	4	R
	Red Clover		18	F	26	F
	Alfalfa		13	I	9	I
			9	I	12	I
			7	I	13	I
		total	47		54	

of Red and Alsike Clovers, Alfalfa, Bromegrass, and Timothys in concentrations similar to, or greater than, those recommended by the Field and Crop Guide (Atlantic Field Crops Committee, 1976-1977). Although grasses as a whole deem greater erosion control characteristics than legumes, the legumes are desirable for their nitrogen fixing qualities although consideration was also given to the structure of the root system (figure 8). The nitrogen content of the soil is, of course, a primary macronutrient necessary for the success of the developing grass consociation as well as the desired invasion of native forbs, grasses and finally the ligneous vegetation. Developing an ecologically sound reclamation plan for the tailings ponds would not include maintaining an artificial ground cover but would be best suited by allowing natural steps of mesarch succession to transpire once a groundcover has been seeded. A healthier community can then develop at a much faster rate.

Hand sowing the seeds will be conducted in early June (according to meteorological data presented in the preceeding text) by broadcasting the mixed seed and using hand rakes to incorporate the seed and both shall be raked into the soil to a depth of approximately ½ inch. A dealer recommended inocculent will be applied to the legume seeds in order to ensure maximum nitrogen fixation. From meteorological information presented earlier, irrigation or other means of providing water to the seed should not be necessary.

The method employed for determining the seed sprout success for the tailings ponds was a basic procedure (Weaver and Clements, 1938) which

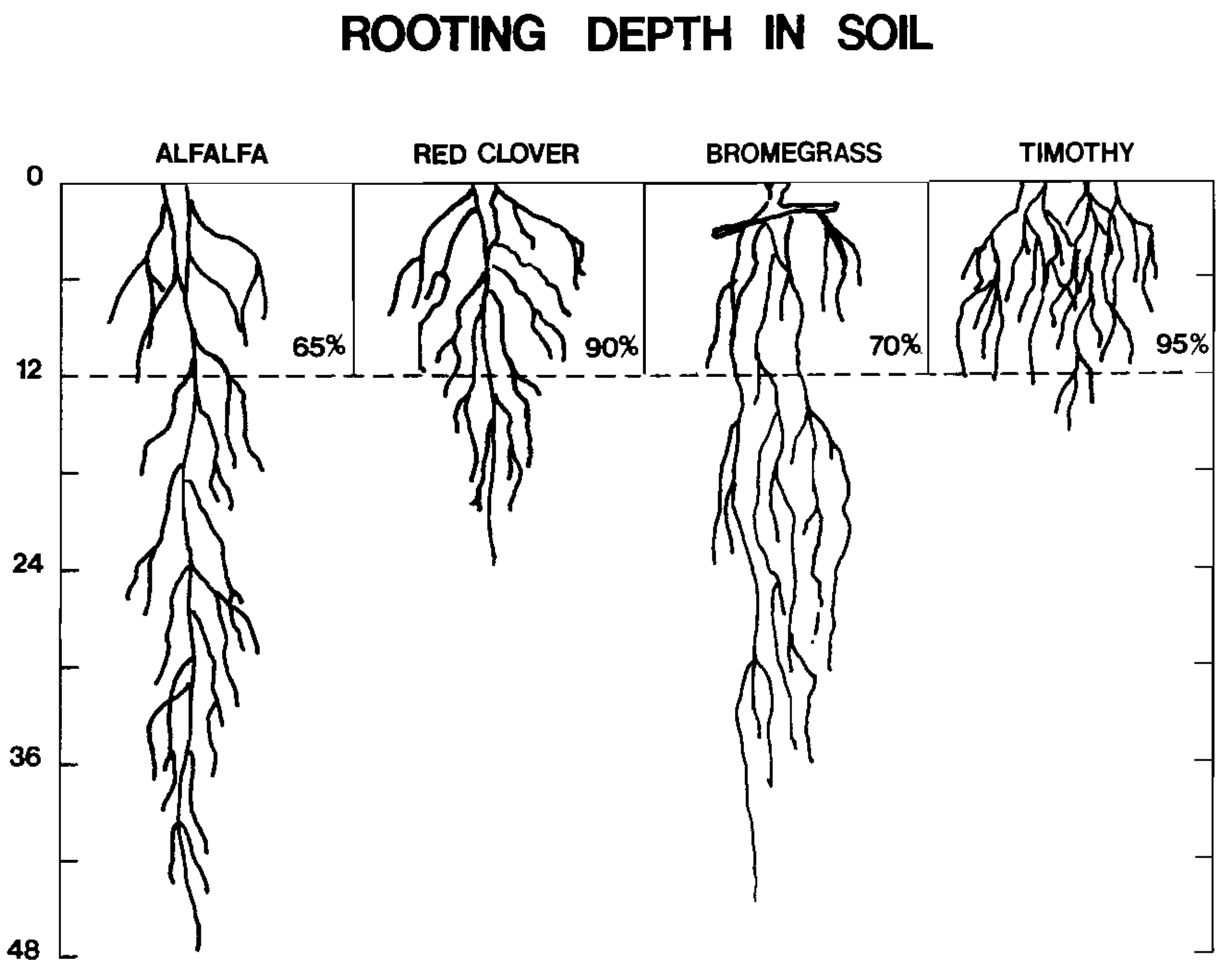


Figure 8. Rooting Depth in Soil. Red Clover and Timothy express greater erosion control properties than do Alfalfa and Bromegrass by providing a shallower root system to control the splash-wash effect of rainfall. (Taken from Atlantic Field Crops Committee, 1976-1977).

includes planting test plots and then determining the frequency - abundance by a series of quadrats. This method necessitates the use of several quadrats located equidistant and carefully placed in order to eliminate biased results. Frequency is expressed in percentage calculated by dividing the number of quadrats in which the species occurs by the total number of quadrats employed. Following this determination an estimate was made of the abundance of each species for each quadrat according to a convenient selected scale. In this case, the following scale was chosen: rare = 0 to 5 plants per quadrat, infrequent = 5 to 15, frequent = 16 to 40, abundant = 40 to 100 and very abundant = 100 to 150. A scale is then devised by substituting the first letter for an abundance value and selecting a numerical value for it as follows: R = 5, I = 15, F = 50, A = 100, VA = 150. Average abundance is then calculated for each species by adding the abundance values and dividing by the number of quadrats in which the species occurred. An index number of the frequency - abundance of each species on the test plot area is then secured by multiplying the frequency by the average abundance. Experimental bias could have occurred in the fact that several plots were partially washed out by rain-water run-off and two plots, numbers 7 and 8, were almost completely washed out, or at least never produced enough cotyledons for measure. This problem would not necessarily cause a measurement bias since natural conditions will in all probability cause the same problem when seeding the entire area actually occurs.

Species	Frequency	#Quadrats	Abundance Value	Abundance Average	Frequency-Abundance
Timothy	67%	35	1425	40	27
Bromegrass	20%	10	50	5	1
Red Clover	66%	10	365	37	24
Alfalfa	30%	10	90	9	3
Clover/Alfalfa	73%	15	105	7	5

Figure 9. Frequency-abundance chart for experimental seedling germination plots determined from data presented in figure 8.

According to figure 8, the best seed sprout success includes a mixture of Timothy and Red Clover. The success of the cotyledons to reach maturity was not measured here since this study establishes only seed sprout success. The percentage of groundcover cannot be determined thus far. The number of seeds planted for Timothy is approximately 2 times the amount suggested by the "Field and Crop Guide" (Atlantic Field Crops Committee, 1976-1977). The increase in the quantity of seed planting undoubtedly reflects an increase in the seed germination frequency-abundance calculation for Timothy. The frequency-abundance calculation for Timothy indicates that it would, however, greatly exceed the seed sprout success of Bromegrass.

Timothy is considered the basic grass for legume-grass mixtures in that it is widely adapted, easy to establish and maintain, has a shallow root system which is advantageous for erosion control as well as escaping lower saline soils, and it is compatible with all legumes (Atlantic Field and Crops Committee, 1966-67). These qualities in addition to the information presented in the experiment data suggest that Timothy should be the primary grass used in revegetation, depending upon the success of the cotyledons in reaching maturity on the tailings ponds.

Mine and Mill Structures

Reclamation objectives for mine and mill structures include leaving the areas as free from physical dangers as possible as well as aesthetically improving the operations site. The physical structures shall be discussed in the following text with consideration given to each.

Shafts: Dresser feels an obligation to adequately seal the shafts in a manner which would make injury virtually impossible. Fencing the shafts, as required by the Department of Mines, is believed to be an inadequate protective measure in this case since trespassers could conceivably climb over or through a fence and fall into an exposed shaft. Fencing is also undesirable due to expected vandalism or theft of the fence.

The ventilation shaft shall be filled with rock to the surface. The main shaft will have a two or three foot concrete slab poured at the ten foot level. The slab will be anchored to the shaft collars and rock will fill the opening to ground level. A concrete cap may be poured at surface level if later desired. This proposed method of shaft closure must be first approved by the Department of Mines.

Buildings: The headframe, hoist room and washplant are scheduled as saleable. Ancillary buildings are also expected to be sold locally for whatever building materials they may contain. If they are not sold within a reasonable period of time, they will be dismantled to the slab and the area shall be left free of debris (see figure 10).

Garbage Dump: Dresser Minerals has for years furnished the town of Walton and the surrounding community with a trash dump at absolutely no cost to the community or townspeople. The garbage has been buried regularly and the dump has been maintained odor free. Dresser does not wish to merely close the dump to local inhabitants without an alternative point of disposal for the community. Current plans consist of approaching the municipality and discussing the problem in order to develop an alternative garbage disposal site.

Quarry: Earthen embankments shall be constructed around all steep slopes of the quarry in an effort to prevent injury from trespassers. Because the quarry was developed prior to the promugation of reclamation requirements, the technological or economical feasibility of sloping the walls is impossible. If such a task were feasible, the resultant pit would be of such magnatude that the purpose of aesthetic improvement would be defeated.

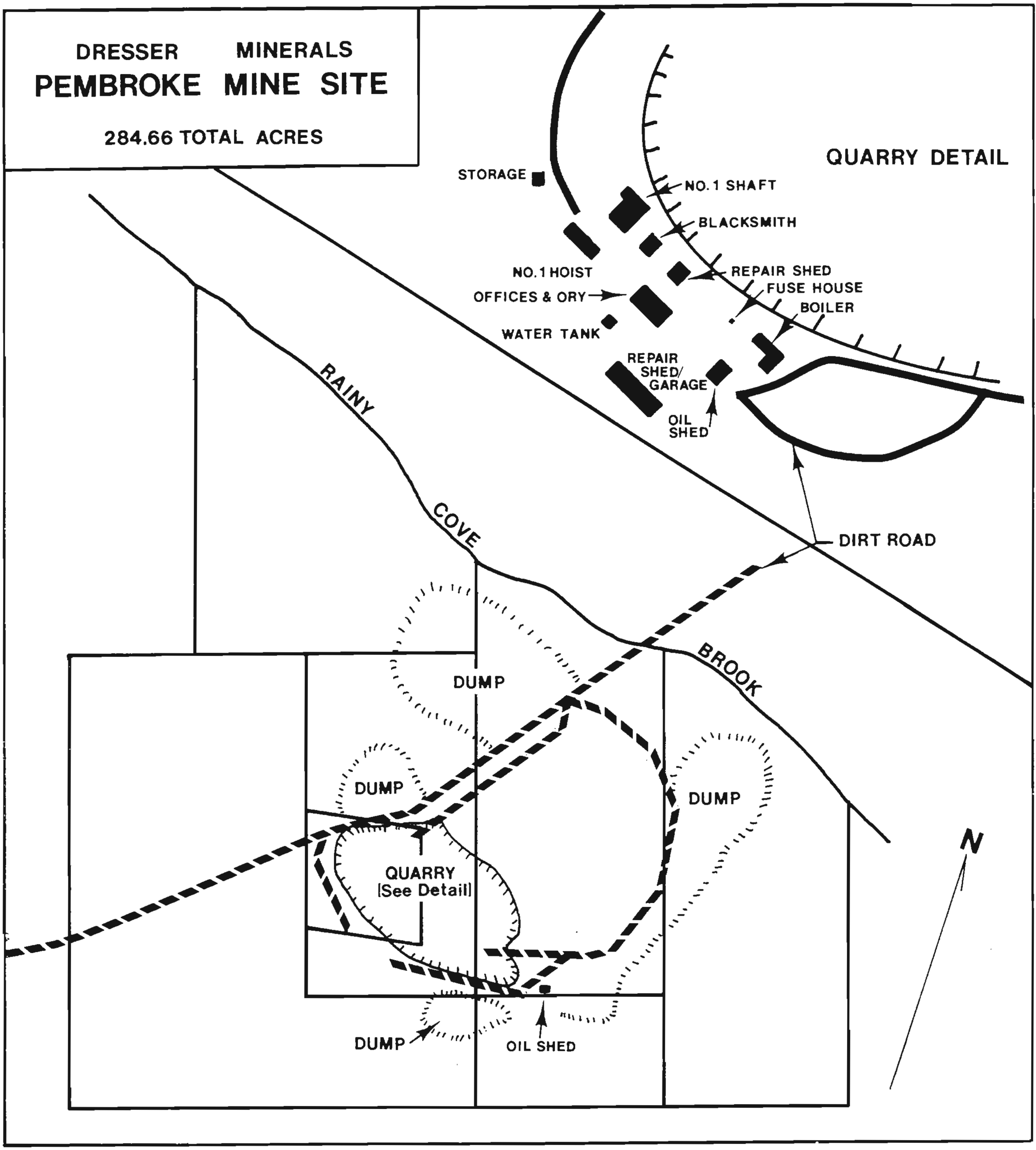


Figure 10. Aerial view of the mine site with a detail of the position of buildings and facilities.

Sulphide Pond: The sulphide tailings pond shall be covered with an adequate layer of settled tailings to prevent exposure of the sulphide materials. The surface of the sulphide pond will also be leached during the available time prior to closure and the surface planted in a procedure similar to that scheduled for the tailings ponds.

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