VEGETATIVE REHABILITATION OF WHITEHORSE COPPER MINE TAILINGS

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ARCTIC ENVIRONMENTAL STRATEGY

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PROJECT #4181-245

1. INTRODUCTION

Whitehorse Copper Mine, 10 kilometres south of the main part of Whitehorse, but within city limits, on the west side of the Yukon River valley, is a property of Hudson Bay Mining and Smelting Company Limited. The mine ceased operation in 1982 after almost 15 years of production and since that time the site has been a subject of environmental concern. The geological setting is a metamorphic contact between Lewes River limestone and Cretaceous granodiorite of the Whitehorse Stock. Some 10 million tons of finely ground material - limestone, granodiorite and calc-silicate metamorphic rocks have been pumped into three tailings areas following the extraction of the valuable copper sulphides and gold. The largest of these areas is called the Old Pond, an area of 55 hectares adjacent to the Little Chief mine and the mill site.

This material is fairly benign compared with tailings from many other base metal mines. There are no specific, toxic chemicals present. Manganese, being slightly high, is mentioned in the Hudson Bay abandonment plan, presumably because it is the only metal which is moderately above that in the environment. Rather than being acid generating, these tailings are strongly alkaline, having a pH in excess of 9.0 due to the presence of finely ground limestone. Thus alkalinity is one of the several factors, perhaps the most important one, which inhibit vegetative growth on the site. The fine material, fine sand or silt sized particles (minus 150 screen mesh or about minus 0.1 mm) is subject to wind erosion and deposition as illustrated (Appendix A, Photograph #1). On the windward side of a barrier fence, the fine sand has collected to a depth of 20 centimetres in the three months since the fence was built. The area is also subject to alkaline evaporite deposits where rain and snow melt percolate downward into the tailings, dissolved salts then rise by capillary action, evaporate and leave the salts as grey to white encrustations on the surface (Appendix A, Photograph #2). There has been negligible re-growth on these tailings after a minimum of 12 years even though other disturbed portions of the mine property,

especially the dykes of crushed rock, gravel and mineral soil support an impressive floral display of yarrow, lupin, fireweed, kinnikinnick, dandelion, rumex, shepherdia, etc. as well as willow and small spruce. Wind tailings build up as cones and sand or silt dunes around dandelion clumps - and the plants seem to thrive. Such hardly suggests the tailings to be toxic. Further, where the original surface is present, or is covered with only a thin skin of tailings, there is growth of aspen poplar, willow and other plants.

2. PURPOSE OF PROJECT

The purpose of the project is to revegetate a portion of the Old Pond tailings to make it a more attractive and productive site, especially for wildlife, even though deer, moose and bear presently use or cross the area. The specific site was deliberately chosen based on the Hudson Bay Abandonment Plan as an area subject to wind erosion.

We regard the project as reflecting in a tangible way some of the goals of the Yukon Conservation Strategy prepared by the Yukon Government in 1988 and 1989. The project is consistent with the statement on page 38 of the Strategy, "...establish well defined, site specific approaches for effective clean-up and reclamation of depleted or abandoned mining sites."

Optimistically, the project could serve as a model for the reclamation of other tailings areas in the Yukon or other sub-arctic settings. However, at present, the project is intended to stand on its own merits. For chemical/mineralogical reasons the Whitehorse Copper Mine tailings represent a less formidable problem than some of the other tailings sites. Anvil and Elsa tailings produce acid waters when leached by rain and snow melt and Venus tailings contain highly toxic arsenic as a basic part of the mineralogy (arsenopyrite).

3. ACTION PLAN IMPLEMENTATION

Of the various aspects, factors or problems which inhibit plant growth, the following are considered to be the most important:

a. pH: As mentioned, unlike the spoil or waste from so many base metal and coal mines which produce acid water when oxidized and leached by snow melt and rain, the pH of these tailings is approximately 9.3 (highly alkaline), too high for the growth of all but the most alkaline tolerant plants.

b. Soil Nutrients: Since the tailings consist of finely ground rock, nitrogen, a major, essential plant nutrient is lacking and growth would not be

expected. However, phosphorous, potassium, and sulphur are all present in adequate amounts, although they may not be available to plants for other reasons. They are also lacking in organic material and normal soil organisms.

c. Evaporites: On some parts of the tailings, water, having moved downward, dissolves salts and then percolates upward to the surface by capillary action and evaporates, leaving a light grey to white, hard encrustation, largely calcium carbonate and strongly alkaline. This, both texturally and compositionally, is a poor growth medium.

d. Texture: The tailings, thought of as a soil, consist of fine sand to silt sized particles (minus 150 screen mesh or about 0.1 mm) are dense, tightly compact and non-cohesive. In their undisturbed state, they do not contain air.

e. Wind Erosion: The wind removes silt from some areas and deposits it in others, in some cases, to almost one meter depth. Both removal and deposition would inhibit plant growth. Flying sharp fragments could damage germinating plants at a vulnerable stage.

f. Water: Water seems to be deficient in the top few centimetres. The tailings are moist at greater depth. Movement of water may not be satisfactory, but genuine lack is probably not a strongly inhibitory factor in this setting.

Measures taken to cope with each of the factors listed are as follows:

a. pH: Most of the effort has gone towards combating what is seen as a crippling pH. All of the organic material - bark, shavings, and sawdust, as well as the more conventional compost material - garden waste, grass cuttings and horse manure, are acidic upon decomposition. This material should shift the pH toward neutral, hopefully an amount adequate to allow plant growth. Further, ammonium sulphate commercial fertilizer should correct the pH in the short term.

Also, of the suite of grass seeds sown, *Deschampsia*, an alkaline tolerant species, is to be used as part of the seed mix.

b. Soil Nutrients: These are contributed by the compost and wood waste, as well as the commercial fertilizer 150kg./hectare 34-0-0 plus 11% sulphur and 150 kg./hectare 0-0-60.

c,d. Evaporites and Texture: The tilling, to introduce air and reduce

compaction should reduce evaporation. Also, the organic material should both absorb water to reduce evaporation and improve the friability and other textural characteristics.

e. Wind Erosion: A 1.2 meter wind fence, consisting of chain link with 6 mil. construction plastic folded over the fencing blocks the wind, especially on the west side of the area. In the three months the fence has been in place, some 10-25 cm. of sand and silt have accumulated on the windward side, blocked from the test area by the fence but indicative of the rate of transport of the unanchored tailings.

f. Water: A 1,300 meter water tank has been placed on a seven meter tower on the outer dyke. During the 1995 growing season (May to August) water will be pumped from snow melt ponds elsewhere on the tailings area and used to irrigate the growing plants.

The area, 180 meters from north to south and 50 meters from east to west, is on the east side of the Old Pond, the eastern boundary being the retaining dyke. The surface is gently undulating, having three meters of local relief. It includes a part subject to wind erosion and a low part where evaporites form. It would seem that most of the conditions of the entire tailings are present in this smaller test site. The test site was divided into five strips or panels extending from east to west. The treatment of the panels, successively from the north is as follows:

1. Grass thatchings. 12-15 cm thick, rototilled into the upper 12 cm of tailings.

2. Barren tailings, rototilled 15-20 cm, essentially as a control on the organic treatment of the other panels.

3. Spruce/pine sawdust 5-10 cm rototilled into the upper 12 cm of the tailings.

4. Spruce/pine sawdust, 5-10 cm, grass cuttings 10-15 cm rototilled into the top 10 cm of tailings.

5. Compost, consisting of horse manure, grass cuttings wood shavings and vegetable wilt 10-15 cm, rototilled into the top 10 cm of tailings.

On a time basis, 2000 hours labour, including 650 hours of volunteer time have been put into the project as well as 150 hours of tractor time - hauling trailers of organic material, use of front end loader and rototiller.

There were little in the way of setbacks. A shortage of water from mid-August on slowed the composting process. Thus, much of the grass cuttings are not decomposed. This material will contribute to textural improvement but probably not to the nutrient supply until well into the 1995 growing season.

The largest factor in the whole project is that, as conducted, it was highly labour intensive. The strategy was to have a successful technique and then mechanize the actual work. Although trucks, trailers, loader and tractor were all used regularly the amount of hand work was such that any further reclamation work of this or other sites will be more mechanized.

4. RESULTS

a. An area of tailings, 0.9 hectares in extent, which has been completely barren of growth since it was deposited as part of a standard mining-milling industrial process has had a variety of organic materials tilled and mixed into the upper 12 centimetres of these tailings. The tailings are not covered over with soil: they are an important part of what is seen as a new, developing topsoil.

b. The area has been fertilized uniformly with a commercial fertilizer in an amount and of a type recommended by a landscaper experienced with respect to Yukon soils and plants. Differences in growth of the various test plots can then be attributed to the different organic treatment each received.

c. The area has been planted with a locally developed suite of grasses, specially selected for revegetating disturbed areas in this climatic region, but which have not been used previously on mine tailings.

d. A variety of shrubs indigenous to the area, or similar to local species - willow, raspberry, - have been planted to eventually provide a hedge.

e. A wind fence has been constructed on three sides of the project site to provide the growing grasses with wind erosion protection from the prevailing wind directions.

f. Since the project involves vegetative growth, a growing season, 1995, will be required to assess the longer term success of the project. In fact, several growing seasons will be required to provide a clear appraisal of a project such as this.

5. CONCLUSION

Acknowledging outcome of "f" above, the character of rather desolate areas, disturbed by mining can be made attractive and productive by determined effort, reasonable understanding of environmental conditions and processes and application of modest technology.

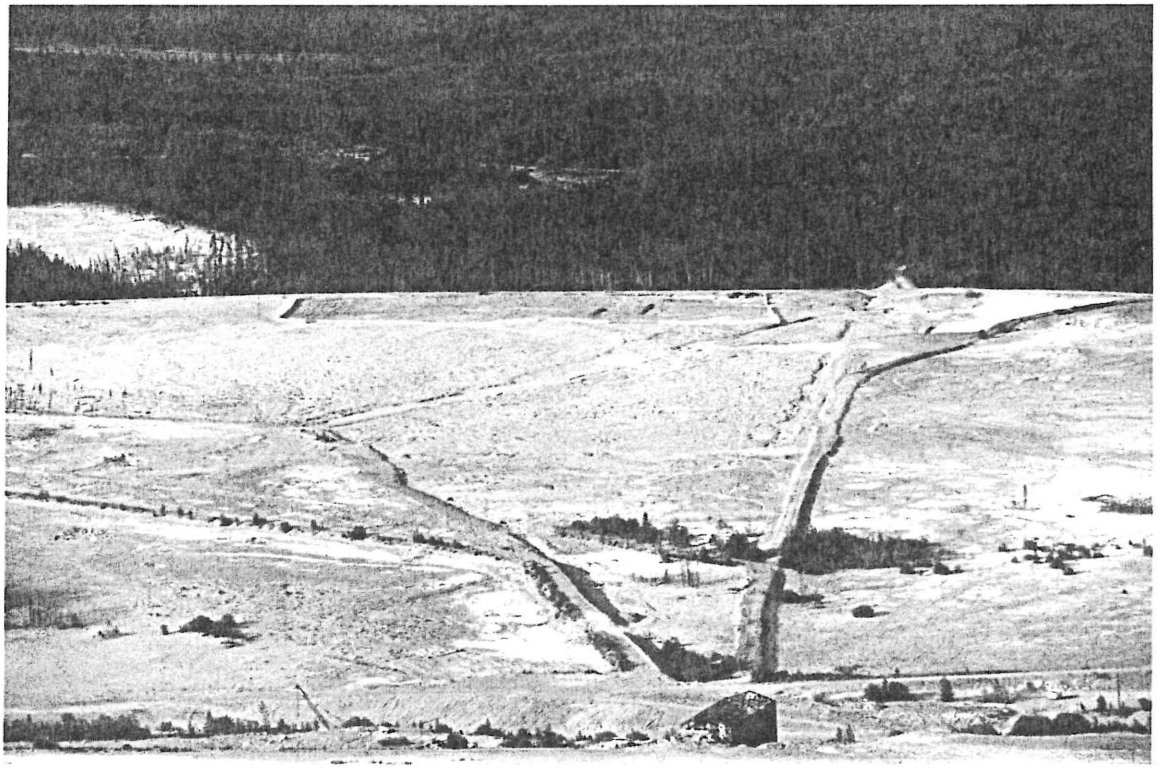
6. RECOMMENDATIONS

It is recommended that:

a. The Chamber of Mines reclamation site be monitored for growth of the grasses planted and that this growth be scientifically related (samples clipped and weighed) to the treatment that each test panel or strip received.

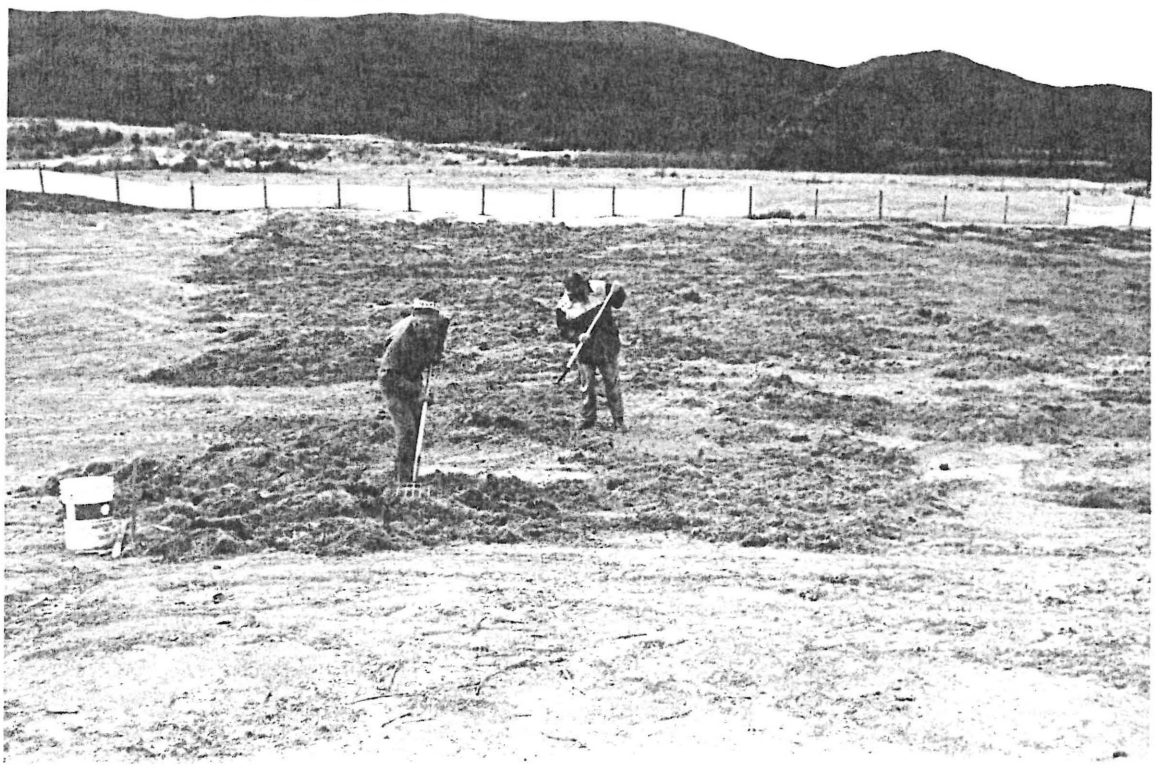
b. The site be made part of regular field trips by school classes for the environmental education benefits of having a mine tailings area and test reclamation site readily accessible within the city.

1. Wind erosion. David Craig photograph



2. Old Pond showing fenced project site (middle of photograph) and evaporites (white areas). David Craig photograph

3. Sawdust (10 cm) on tailings. Diana Mullov photograph



4. Spreading compost on tailings. Joan Craig photograph

5. Equipment and temporary pond on tailings. David Craig photograph

6. Site preparation complete - organic material spread, surface rototilled and seeded; water tank, 1300 l, for composting and irrigation.
David Craig photograph

APPENDIX B

ACKNOWLEDGEMENTS

Financial sponsorship, making the carrying out of this project possible, was provided by:

Shell Environmental Fund
Hudson Bay Mining and Smelting Company Limited
Canada/Yukon Economic Development Agreement
Arctic Environmental Strategy

As well as nine paid, part time employees, many volunteer contributions were made by individuals and firms, largely in the collection of grass and other compostable materials and the collection of local seed for the revegetation. Among these are:

Landscapers

Decora
Adorna
Iditarod
Sourdough Sodbusters
Hotte Landscaping

Horse Owners

Lurina Mitchell
Joan Mackinnon
Allison Wiens
Joyce Scott
Darlene Richardson

Kelly Douglas provided several tons of wilted fruit and vegetables during the early months of the year.

The Slough Mill (Gunnar Nielson) provided 20 cubic meters of sawdust.

Volunteers

Jill Burger
Larry Carlyle
Diana Mulloy
Bill McLay
Ian Oostendie
Barbara Robertson
James Sumner
Scott Thompson

Officers of Yukon Agriculture visited the site, reviewed the work and provided appreciated encouragement and advice.

These efforts are acknowledged with appreciation.

APPENDIX C

PUBLICITY

The Whitehorse Copper Mines revegetation project has received considerable publicity. School tours were provided to approximately 100 students; 20 from the Science and Technology 11 class of Karen Leask of F.H. Collins Senior Secondary School and 80 students lead by Jeanne Burke from Porter Creek Junior Secondary School. The numerous visitors to receive a tour of the site included Audrey McLaughlin, Member of Parliament for the Yukon Territory and Jack Cable, Member of the Yukon Legislative Assembly. The Whitehorse Star newspaper provided front page coverage with photographs and write-up in the July 8, 1994 edition. Also, Whitehorse City Mayor, Bill Weigand, wrote a letter of appreciation to Hudson Bay Mining and Smelting Company Limited, the mine owners, for their reclamation efforts and partial sponsorship of this particular revegetation project. The mine property is within the city limits of Whitehorse.

CBC produced a radio spot on the project, after a visit to the property and interviews with several of the participants. This was aired several times. CHON-FM has produced TV coverage, still to be aired.

Scott Thompson produced a 10 minute video of the project activity which is on file at the Yukon Chamber of Mines office.

Finally, the trailer used to haul the organic material carried a prominent sign, identifying the project and sponsors.

APPENDIX E

SEED MIXTURE

The 0.9 hectare plot was seeded with the following:

50 pounds seed prepared by Arctic Alpine Seed Ltd. of Whitehorse for reclamation of disturbed sites in the sub arctic. Species and proportions are:

Violet Wheatgrass	(*Agropyron violaceum*)	20%
Slender Wheatgrass	(*Agropyron pauciflorum*)	20%
Alkali grass	(*Puccinella nuttaliana*)	35%
Bluegrass	(*Poa glanca*)	10%
Fescue	(*Festuea saximontana*)	5%
Awned Wheatgrass	(*Agropyron subsecundum*)	10%

Additionally, 5 pounds of hair grass (*Deschampsia*) seed is being obtained in Alaska, specially selected for tolerance to alkaline conditions.

Locally collected seed of lupin, mountain avens, dandelion, fireweed, and balsam poplar are also to be sown.

APPENDIX D

REVENUE AND COSTS

REVENUE		
Canada/Yukon Economic Development Agreement		$15,000
Hudson Bay Mining and Smelting Company Limited		$10,000
Arctic Environmental Strategy		$10,000
Shell Environmental Fund		$ 5,000
		40,000
COSTS		
Wages		19,500
Equipment Rental, Purchases, Workers Compensation Administration, etc.		21,000
	(40,461.04)	40,500

8. REFERENCES

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Kennedy, C. E., 1993, Guidelines for Reclamation/Revegetation in the Yukon.

Minnich, J., Hunt, M. and the Editors of Organic Gardening Magazine, 1979, The Rodale Guide to Composting.