

VEGETATIVE REHABILITATION OF WHITEHORSE

COPPER MINE TAILINGS,

REPORT NUMBER 2

BY

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ROTARY CLUB OF WHITEHORSE

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CANADA/YUKON ECONOMIC DEVELOPMENT AGREEMENT

HUDSON BAY MINING AND SMELTING COMPANY LIMITED

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1. INTRODUCTION

Whitehorse Copper Mines, 10 kilometers south of the main part of Whitehorse, but still within the city limits, 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. Some 10 million tons of finely ground material - limestone, granodiorite and calc-silicate metamorphic rock - have been pumped into three tailings areas following the extraction of the valuable copper sulphides and gold. The largest of these areas, the Old Pond, is 55 hectares in extent, adjacent to the Little Chief Mine and millsite and contains tailings ranging from zero to 20 meters in depth, depending on the topography onto which the tailings were pumped. The tailings are confined by dykes of crushed and broken rock.

There are no specific toxic chemicals present. From this point of view, then, the tailings can be considered rather benign. Snow melt ponds, right on the tailings, present from May to the end of July, are drunk from by humans and animals without apparent ill effects. The tailings are however, extremely alkaline, with a pH of greater than 9. This alkalinity is one of several factors, perhaps the most important one, which inhibits vegetative growth on the site. There has been negligible re-growth on these tailings after a minimum of twelve 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, dandelions, rumex, arabis, shepherdia, etc as well as willow and small spruce. Wind blown 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, willow and other plants.

A 0.9 hectare area on the east side of the Old Pond was selected in 1994 and isolated by a wind barrier fence constructed of plastic over metal or plastic chain link fencing. This area was identified in the Hudson Bay Mining and Smelting Company Limited reports as being an area of wind erosion and tailings dust

transport. This 0.9 hectare was divided into plots and treated with applications of organic material (compost) and commercial fertilizer, rototilled to 15 centimeters depth and seeded with a recommended mixture of grasses (Figure 1). Details of this project are provided in the 1994 Report, Vegetative Rehabilitation of Whitehorse Copper Mine Tailings.

A total of 75 trees, representing eleven species, ranging up to four meters in height, were transplanted by a tractor mounted, hydraulic tree spade from the forested area at the margin of the tailings to immediately inside the barrier fence. Trees were set at three meter intervals. The intention is that these trees, once established, will take over the wind barrier duties from the plastic fence, partially sheltering the enclosed, revegetated area from the prevailing winds and their burden of transported tailings.

2. PURPOSE OF PROJECT

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

The purpose of the 1995 work was to install and operate a sprinkler irrigation system on the site treated and seeded in 1994.

3. ACTION PLAN IMPLEMENTATION

The 1995 mine tailings revegetation program consisted of assembling and operating a sprinkler irrigation system. The specifications for the waterline, spacing of lateral lines and spacing of sprinklers along the laterals were based on advice from International Plastics Ltd., irrigation specialists of Kelowna, British Columbia. System components were purchased from the Kelowna firm and from several Yukon industrial supply firms. Totaltrac of Whitehorse, supplied the pump.

Equipment consisted of a Kubota Model KVP-20S high pressure pump (65 meters head) having a four centimeter discharge expanded to five centimeters diameter with 450 meters of 5 centimeter diameter delivery hose extending from the water source, a snow melt pond, to the reclamation site. The delivery hose was then connected to the sprinkler irrigation system. This system consists of rigid plastic pipe five centimeters in diameter arranged with a transverse feeder line connected to three, parallel sprinkler lines 17 meters apart. Each lateral was arranged with a tee and gate valve such that each line could be operated independently - the usual mode of operation. The plastic pipe was buried 10 to 15

centimeters deep with 30 centimeter risers, 20 millimeters in diameter at 20 meter intervals (Figure 2). Deschampsia (Bering Sea hairgrass), an alkaline tolerant species of grass, was planted along the site of the buried pipe.

Irrigation was typically 0.5 to 0.75 hours per day for each lateral or approximately two hours pumping per day at 300 liters per minute. The site was irrigated for 34 of the 45 days from 9 June when pumping started until 25 July when the water supply was exhausted, providing abundant water for the main growing season, a total of roughly one million liters. The pump was set up on a daily basis.

Additionally, material for further compost production, largely grass cuttings and yard waste, were added at the east side as available, to act as a wind break and snow catchment ridge.

Spruce and pine seedlings, 10 to 30 centimeters in height, were planted along the perimeter fence, to augment the large, tree spade transplants in forming the future wind break.

At the end of the season the delivery hoses were taken up and stored for the winter. The risers and sprinkler heads of the irrigation system were removed, the pipes drained and plastic plugs placed in the lateral lines at the sprinkler sites. The plugs prevent the entry of either snow or dirt which could freeze and damage the pipes. The buried distribution system remains in the ground for the next year's irrigation program.

A large water tank and seven 45 gallon barrels used primarily for watering the trees prior to installing the irrigation system were removed permanently at the end of the season.

4. RESULTS

The growth characteristics of the suite of grasses on the five different plots were striking. All were treated with commercial fertilizer (150 kg/Ha 34-0-0 + 11% S, 150 kg/Ha 0-0-60), rototilled and planted the same. Irrigation was the same on all plots. There is some variation within the tailings themselves especially between silty areas of wind deposition and areas of crusted, alkaline evaporite. This site is largely protected from the wind deposition as evidenced by a ridge of fine sand up to 25 centimeters deep on the outside of the fence, formed since the fence was erected in July of 1994. Further, a belt of crusted evaporites did extend throughout the reclamation site. It is prominent just north of the site. Treatment and results for each plot follow.

Plot 1:

Grass cuttings and old landscaping wastes were partially composted early in the season. These were added and rototilled into the top upper 15 centimeters of tailings. There is non uniform, modest growth of grass on this plot. Striking is the abundant growth of grass surrounding the shepherdia transplanted by tree spade. However, this growth persists in the tailings one to two meters from the transplant, well beyond the topsoil brought in with the root ball. It is here attributed to the nitrogen fixing bacterial nodules present on the shepherdia rootlets.

Plot 2:

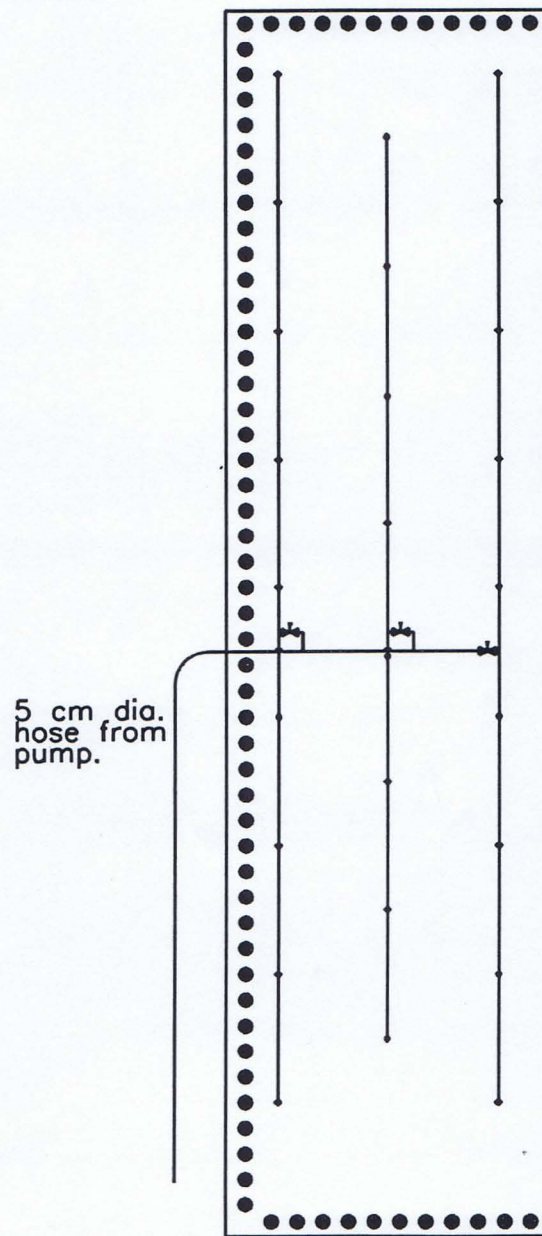
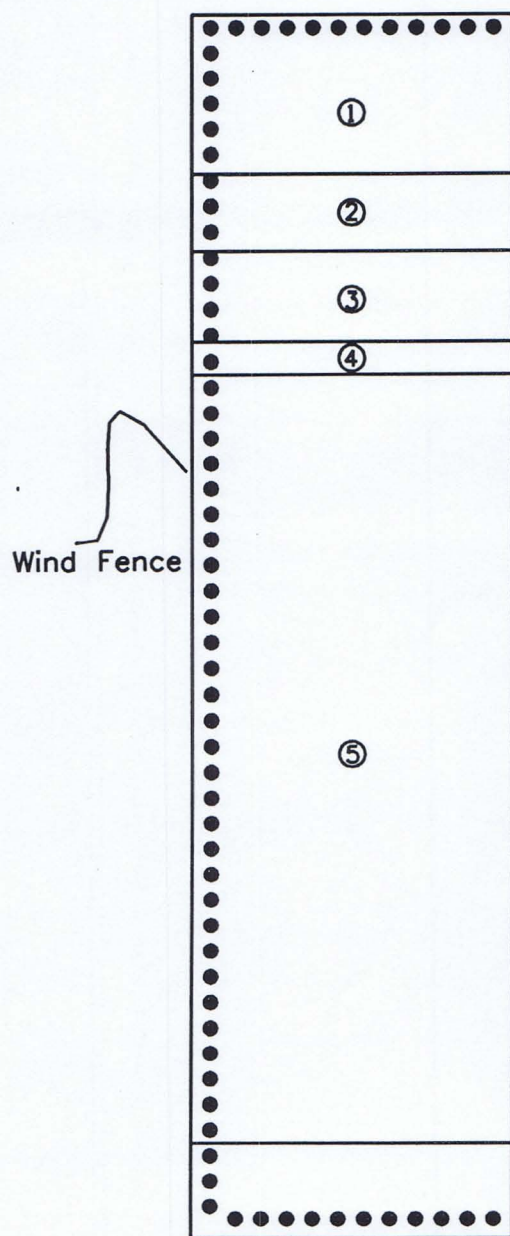
This plot is regarded as the control plot. No organic enhancement was made. In spite of seed, fertilizer, tilling and irrigation there was zero growth on this plot. By spring, 1995 compaction was such that the tailings appeared to be the same as in the spring of 1994, before any reclamation efforts had been made. Crusted evaporites developed and cracks, many centimeters in length, formed similar to evaporite zones outside the reclamation site. Irrigation water drained down the cracks.

Plot 3:

Spruce and pine sawdust, a five centimeter layer, rototilled in produced some but poor growth. Perhaps five percent germination of stunted grasses to 10 centimeters high would be a reasonable description. However, that textural change was brought about was apparent from the more crumbly, rather than the caked character of the tailings. Strikingly, there were no cracks developed and presumably more irrigation water was retained in the upper few centimeters where it would be available to plants. Possibly in another year the slowly decomposing sawdust will make a more significant contribution.

Plot 4:

Spruce and pine sawdust, a five centimeter layer, and grass clippings, a 10 centimeter layer, were rototilled into the tailings. This grew reasonably well, with plants in the range of 15 to 25 centimeters in height. Texture of the upper material, although hardly a soil, is more like soil in terms of friability than is the barren tailings.



Scale: 1cm = 12 m

Figure 1:
Test Plots

Figure 2:
Irrigation System

Plot 5:

Horse manure, grass cuttings, vegetable waste, coffee grounds from government offices, bark and wood shavings were stacked and carefully put through the composting process by moistening and turning or re-stacking for several weeks. In this process various bacterial strains multiply and raise the temperature 20 to 50 degrees Celsius above ambient temperature. The process converts the source material into a nutrient rich soil conditioner. The compost was spread over the plot in a 10 to 15 centimeter layer, largely by front end loader with missed patches completed by hand, and rototilled into the tailings.

This plot, representing 70 percent of the site, experienced luxuriant growth over 80 percent of the plot. The poorer growth on the northern edge of this plot was directly related to the thinner layer of compost that was tilled into the tailings there. The planted seed produced dense growth to 60 centimeters height and a series of seeds, brought in with the compost material, also germinated and complemented the grasses with fireweed, dandelions, lamb's quarters and clover. See Appendix B for all identified plants on site.

The belt of trees, planted as a wind break, survived the transplant and put out new growth. The aspen and willow were not as fully leafed out or as robust appearing as those off the tailings which were not disturbed, but such is to be expected in the first year. The conifers, both spruce and pine, put out new leaders for 1995 and most of the pines set cones. Again these were not as vigorous as the undisturbed trees, but fully acceptable. Only one tree, of 75 which were moved, perished. Also notable is what is here called "by catch". When the tree spade extracts a tree with a 70 centimeter diameter rootball, it also moves the grasses and forbs living around the base of the tree. Thus hundreds of plants, representing about 20 species, were also transplanted, but with their own soil environment. Thus each transplanted tree and the plants associated with it forms an oasis on the tailings. The plants in these oases have flourished and are extending gingerly out from the root ball perimeter to start the vegetative colonization of the tailings.

Finally, if the efforts to date have concentrated on the re-establishment of flora, the fauna are not far behind. Killdeer swoop and land in the reclaimed area and field mice are nesting in the grasses.

5. CONCLUSIONS

Based on the evidence to date, the project has been a success. A portion of Whitehorse Copper Mine tailings has been revegetated. The preferential growth on the different test plots is clearly the result of different amounts and quality of organic material, with the plots receiving abundant, well composted material showing by far the most abundant growth.

The role of the material is at least five fold:

1. Bark, sawdust, shavings and vegetable compost are all acidic upon decomposition. They should move the pH from the present highly alkaline condition towards an only mildly alkaline state.

2. It will foster a better tilth or texture than the finely ground rock texture of the tailings, which have no fibre or organic material.

3. It enhances the retention of snow melt, rain and irrigation water.

4. Upon decomposition the compost will provide plant nutrients, especially nitrogen, totally lacking in barren tailings. Further the organic material is probably less vulnerable to rapid leaching of nutrients than is the commercial, inorganic fertilizer.

5. It will provide a habitat for soil organisms to develop in. Soil bacteria, actinomycetes, fungus, mites, insects, worms and other microscopic and macroscopic organisms assist in soil health and soil building.

Indigenous floral species, soil bacteria, actinomycetes, fungus and other soil microorganisms, many from the immediately surrounding natural habitat, are well represented in the revegetation suite. It is reasonable to expect that such will continue to grow on the site and may well come to dominate in a few years.

The animal population, modest at present, will be in a symbiotic relationship with the flora. The mice will eat the plants, their burrowings will enhance the soil aeration and fecal material will provide plant nutrients.

One growing season, however successful, is too short a time to predict long term results. Succeeding seasons, especially the next two, should validate, (or negate) the promising results of 1995.

6. RECOMMENDATIONS

It is recommended that:

1. The reclamation site described in this report be irrigated during the 1996 growing season from mid May to late July by the same system and technique installed and applied during the 1995 season. Snow melt appears to be an adequate water source for this area. It is hoped that by the end of 1997, the plants will be well enough established that irrigation of the site will no longer be required.

2. The site be used for school field trips in 1996, as it was in

1994 and 1995, for the environmental education benefits of having a mine tailings area and test reclamation project readily accessible within the city.

3. That, since the plot receiving compost exhibited by far the most abundant growth, an effort be made to continue gathering of organic material, composting and applying such to other parts of the site. It is here acknowledged that gathering and preparing compost is labour intensive. Further effort should be made to identify the minimum compost application which will support sustainable plant growth. Once started, the view is that plant growth and decay will provide the necessary soil nutrients for the continuation of growth. Thus the first growth is critical.

4. Further, although some effort is being made towards a community compost facility, most Whitehorse material - both food and yard waste - still goes to the city landfill. It is here suggested that an effort be made to re-direct a part of this stream to Whitehorse Copper Mines site reclamation. Such could be readily accommodated at the site.

5. Since a determined interest is being taken in Canada to reduce total greenhouse gases, especially carbon dioxide, and that one such technique is to put carbon back into the environment by enhanced vegetative growth, it is suggested that Whitehorse Copper Mine tailings be identified as a suitable site. The bulk of the area supports no growth, and could, by diligent effort, be brought to a state where it could remove a significant amount of carbon dioxide from the atmosphere.

7. APPENDICES

APPENDIX A

PHOTOGRAPHS

Photograph 1.

Outside reclamation site. Barren tailings, some of which have been wind transported. Reclamation area was similar to this before revegetation.

Photograph 2.

Promising growth of grasses on composted plot.

Photograph 3.

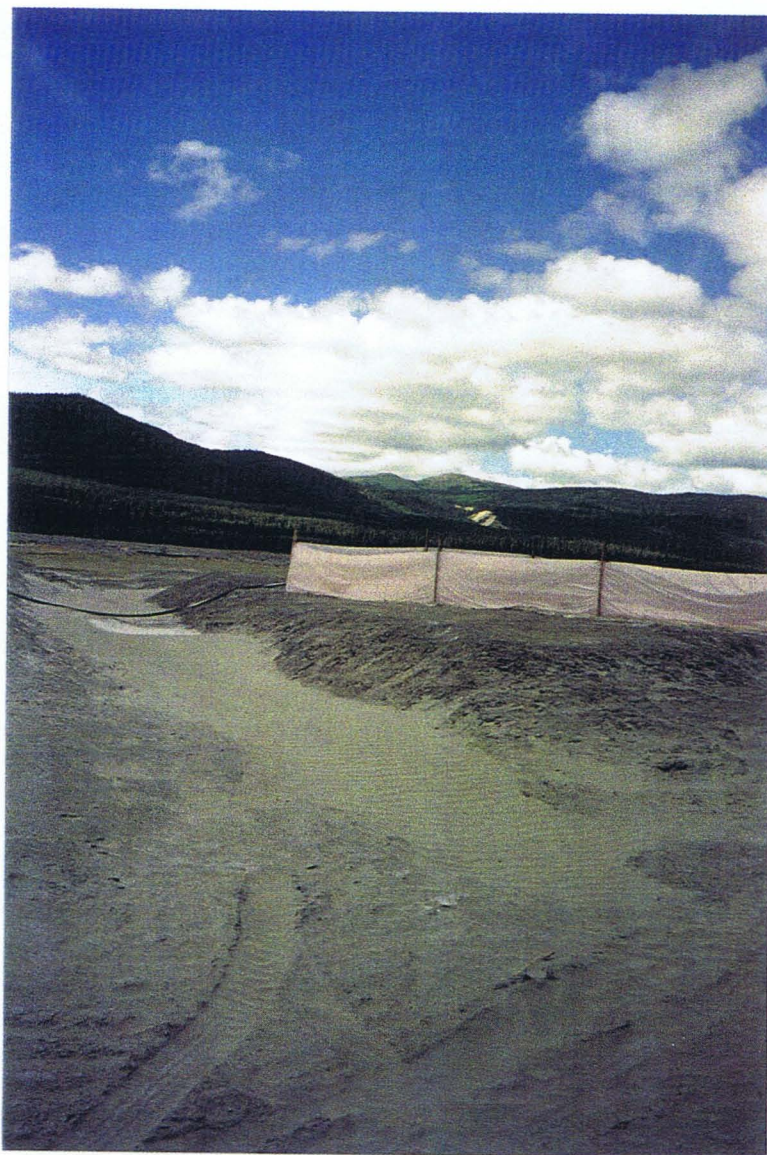
Grasses achieve dense growth to 60 centimeters height on best sites.

Photograph 4.

Perimeter trees provide a wind break; sprinkler system in action.

Photograph 5.

High pressure pump delivers 300 liters water per minute for irrigation.



Photograph 1.
Outside reclamation site. Barren tailings, some of which have been wind transported. Reclamation area was similar to this before revegetation.



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Promising growth of grasses on composted plot.



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Grasses achieve dense growth to 60 centimeters height on best sites.



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Perimeter trees provide a wind break; sprinkler system in action.



Photograph 5.
High pressure pump delivers 300 liters water per minute for
irrigation.

APPENDIX B

FLORA

Plants at Whitehorse Copper Mines Tailings Reclamation Site.

September 20, 1995

Joan Craig

Violet wheatgrass	(Agropyron violaceum)
Slender wheatgrass	(Agropyron pauciflorum)
Awned wheatgrass	(Agropyron subsecundum)
Alkali grass	(Puccinella nuttaliana)
Fescue	(Fescus saximontana)
Bluegrass	(Poa glauca)
Hair grass	(Deschampsia caespitosa)
Trembling aspen	(Populus tremuloides)
Balsam poplar	(Populus balsamifera)
Willow	(Salix)
Willow	(Salix)
White spruce	(Picea glauca)
Lodgepole pine	(Pinus contorta)
Wild rose	(Rosa acicularis)
Canadian buffalo-berry	(Shepherdia canadensis)
Common juniper	(Juniperus communis)
Alder	(Alnus crispa)
High bush cranberry	(Viburnum edula)
Low bush cranberry	(Vaccinium vitis-idaea)
Kinnikinnick	(Arctostaphylos uva-ursi)
Dandelion	(Taxacum officinale)
Groundsel	(Senecio lugens)?
Yarrow	(Achillea millefolium)
Hedysarum	(Hedysarum alpinum)
Sticky cranesbill	(Geranium erianthum)
Filaree, crane's bill	(Erodium cicutarium)
Fireweed	(Epilobium angustifolium)
Small fireweed	(Epilobium Hornemannii)
Bindweed	(Polygonum convolvulus)
Jacob's ladder	(Polemonium pulcherrimum)
Wild rhubarb, curly dock	(Rumex crispus)
Strawberry blite	(Chenopodium capitatum)
Goldenrod	(Solidago multiradiata)
Raspberry	(Ribes idaeus)
Raspberry	Domestic - Boyne
Stickseed	(Lappula redowski)
Lupin	(Lupinus Kuschei)
Pineapple plant	(Camomile ?)
Rock cress	(Arabis Drummondii)
Viola	
Pinks	(Diathus deltoides)
Pansy	

Shasta daisy	
Alaska daisy	
Swan River daisy	
Iceland poppy	
Delphinium	
Red clover	(Trifolium pratense)
White sweet clover	(Melilotus alba)
Alsike clover	(Trifolium hybridum)
Silverweed, Graceful cinquefoil	
	(Potentilla gracilus)
Silverweed	(Potentilla diversifolia)
Creeping Charlie	
Foxtail barley	(Hordeum jubatum)
Yellow locoweed	(Oxytropis spicata)
Alfalfa	(Trifolium ?)
Lamb's quarters	(Chenopodium alba)
Knotweed	(Polygonum ?)
Dogwood red osier	(Cornus stolonifera)
Chickweed	(Cerastium alpinum)
Shepherd's purse	(Capsella bursa-pastoris)
Butter and eggs	(Linaria vulgaris)
Pumpelly brome	(Bromus inermis)
Timothy	(Phleum pratense)
Hawkweed	(Hieracium umbellatum)
Stinkweed	(Thlaspi arvense)
Snap dragons	(Anterinum ?)
Bladder campion	(Molandria ?, Lychnis ?)
Lungwort	(Mertensia paniculata)
Wild parsley	()
Bisquit-root	(Lomatium ?)
Antennaria	(Antennaria subviscosa)
Moss	

APPENDIX C

PUBLICITY

Diana Watson assessed the activity and participated in the reclamation work, forming the basis of a report and photographic coverage as partial fulfillment of the requirements for a Master of Education degree at the University of Alaska.

The Whitehorse Garden Club made a tour of the site as one of the Club field trips.

Jeanne Burke, as part of her curriculum development project, Rock on Yukon, in partial fulfillment of a Doctor of Philosophy degree at the University of British Columbia, made visits to the site and organized select groups of teachers and students to tour with her there.

George Sinfield, President, Rotary Club of Whitehorse, toured the site and provided a write - up and photograph in the club newsletter, The Rotator. The Rotary Club of Whitehorse is the institution or society carrying out the 1995 reclamation.

The trailer used for transporting supplies for the project carries a prominent sign identifying the sponsors.

A permanent sign outlining the project and sponsors is to be erected on the site.

APPENDIX D

ACKNOWLEDGEMENTS

Appreciation is here expressed to the financial sponsors for making this project possible:

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

Tony Hill and Randy Lamb of Yukon Agriculture provided help with floral identification as well as technical advice. Their help and encouragement was much appreciated.

Rob Cordon and his staff from Hudson Bay Mining and Smelting Company Limited for friendly cooperation. Special thanks for taking down the water tower and tank.

Bob Studds and George Shaw, forestry officials for technical advice.

John Vanderkley for donation of seedling tree.

Whitehorse friends who made barnyard manure, straw and landscaping yard wastes available.

APPENDIX E

REVENUE AND COSTS

REVENUE

Arctic Environmental Strategy	\$6,000.00
Canada/Yukon Economic Development Agreement	\$6,000.00
Hudson Bay Mining and Smelting Company Limited	\$4,033.08

Total	\$16,033.08

COSTS

Wages	\$8,930.90
Equipment Rental	\$1,935.30
Equipment Purchase (Irrigation System)	\$2,886.96
Report Preparation	\$1,200.00
Covers/Laser Xerox	\$ 91.81
Management and Accounting (Rotary Club of Whitehorse)	\$1,000.00

Total	\$16,044.97
 Difference (Donated)	 \$ 11.89

8. REFERENCES

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