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IRRIGATION WITH SEWAGE EFFLUENT ON THE OLD GRANBY TAILINGS AT PRINCETON, B.C.

Paper presented jointly
by:

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INTRODUCTION AND BACKGROUND

During 1978, the Ministry of Energy, Mines and Petroleum Resources obtained funding under the Accelerated Mineral Development Program to revegetate mining areas that were not covered by present reclamation legislation. Under this program, several areas were treated. This talk discusses the program conducted on the old Granby Tailings at Princeton, B.C.

The tailings at Princeton were produced by the Allenby concentrator, which processed the ore mined at Copper Mountain. The mine was active intermittently from 1919 to 1957. The ore mined at Copper Mountain consisted of basaltic and andesitic breccia, which had been intensely altered by biotization, foliation and fracturing. Copper was removed from the ore as a concentrate by crushing and flotation methods. Total production from Copper Mountain was 39,774,902 tons of ore, which produced approximately 1,043,247 tons of concentrate that averaged 33% copper. Approximately 33,731,655 tons of tailings were produced, the majority of which were deposited in the tailings ponds adjacent to Princeton.

The main tailings pond covers approximately 300 acres and was purchased by the Village of Princeton when mining operations terminated at Copper Mountain. Dust from the pond is often a source of irritation to the residents of Princeton during the summer months. This dust nuisance has resulted in many attempts at revegetation during the past twenty years. Treatments over small portions of the pond have included disposal of woodwaste on the surface, surface dressing of a portion of the pond with gravel, planting of trees and seeding of grass. Although most of these treatments met with some success, the funding necessary for an overall reduction of dust has never been available.

In 1960, the Village of Princeton constructed a sewage disposal system which terminates in sewage lagoons located immediately adjacent to the Princeton tailings pond. With the opening of new primary industrial plants

in the area since 1960, the population has grown, with consequent increases in input to the Village's sewage system. The larger volume of effluent has decreased the efficiency of the lagoon system and eventually it may reach levels in the future which will not meet pollution control requirements.

Given the foregoing conditions, the Village of Princeton Council realized that proper use of the tailings pond might permit simultaneous abatement of the dust nuisance and provide low cost disposal of sewage lagoon effluent.

In 1976, the Village of Princeton commissioned Shultz International Ltd. to prepare a study on the feasibility of a sewage spray irrigation program on the tailings ponds. The report entitled "Revegetation of the Princeton Tailings Pond Using Sewage Lagoon Effluent for Spray Irrigation, 1976 Pilot Project", proved that:

1. Commercial species of legumes, cereals and grasses can be established as ground cover for control of dust and surface erosion.
2. The sewage lagoon effluent is a good source of irrigation water, but the quality and quantity of effluent are unknown for heavy demands.

With this information, the Ministry began its program to reclaim the tailings pond by engaging the professional services of R.A. Nelson, P. Eng., to design a pumping and irrigation system.

The sewage pumping records for Princeton indicated that the average availability of effluent was about 12,928,000 U.S. gallons per month (or about 300 U.S. gallons per minute). Soil samples of the tailings pond were taken across the field in a diagonal transect to determine the maximum water application rate for irrigation. The samples were sent to the Kelowna Soil Testing Laboratory for analysis.

The results of the soil tests showed that there was considerable variation in surface textures and variable contents of silts and clays in subsoil layers with very fine categories of sands. Tests also indicated a general absence of organic matter.

PROJECT DESIGN

On the basis of soil sample results and sewage effluent availability, 40 acres of the 70-acre lower tailings bench will be supplied with water by the irrigation system. Of these 40 acres, 33 acres are the main portion of the field, 2.5 acres the sloping embankment bordering the sewage lagoons, and 4.4 acres the elbow on the northeast end of the tailings pond. (Figure 1).

Site Preparation

The surface of the tailings pond was levelled with a 966 front-end loader and a grader equipped with front-mounted rippers.

After recontouring, a Ministry of Highways' survey crew surveyed the tailings pond to define the mainline layout and mark the 60-foot set intervals of the irrigation laterals.

Fencing was constructed, where necessary, around the tailings pond area and sewage lagoons, to prevent access by cattle, all terrain vehicles and snow mobiles. The non-irrigated portion of the tailings pond was included in the fenced area to enable future expansion of the irrigation system.

Seeding Program

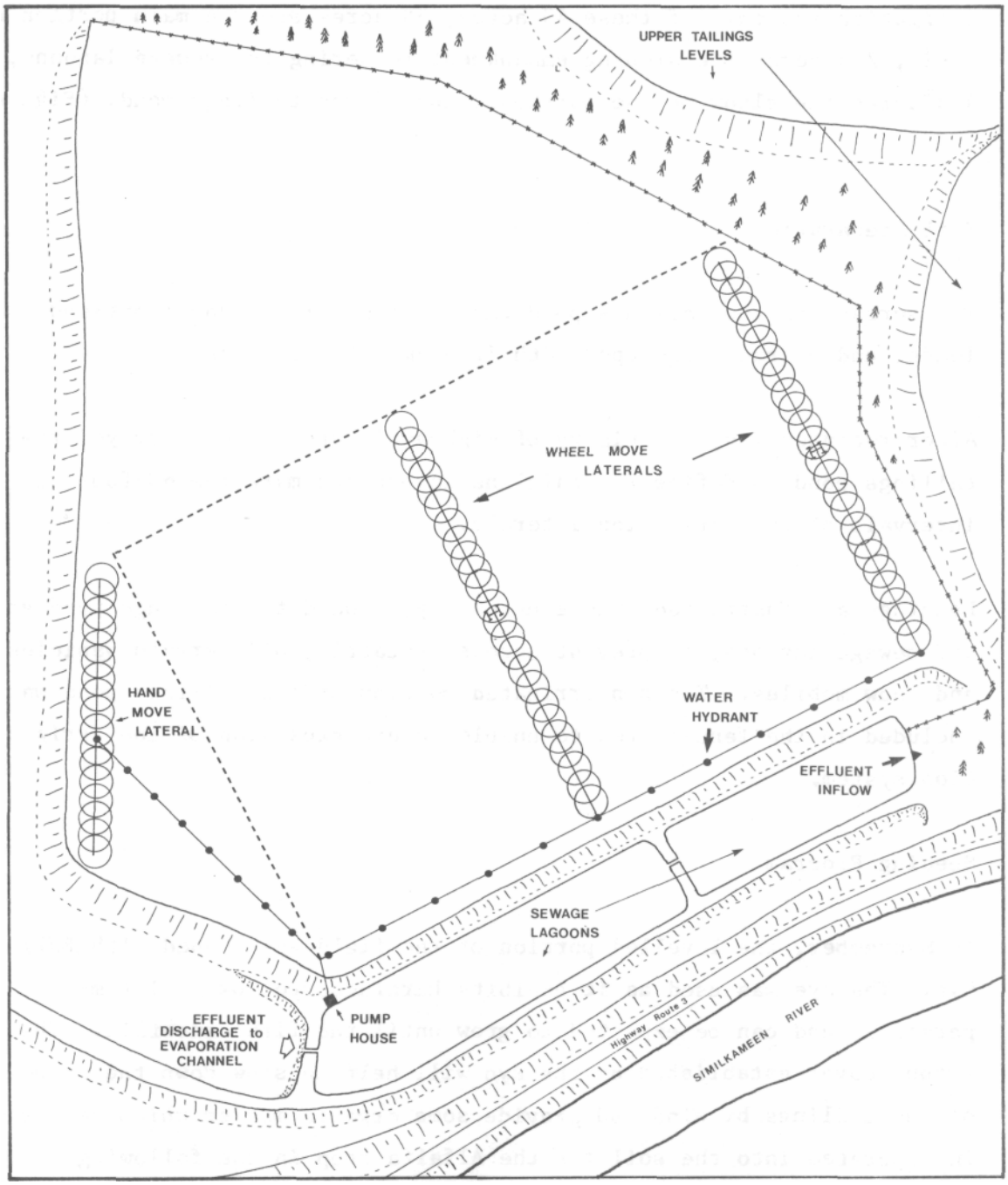
In September, the levelled portion of the field was seeded with Fall Rye. The Rye was used as it exhibits hardiness to low fall tem-5 peratures and can be expected to grow until the first snowfall. The ground cover established by the Rye will help to slow down the movement of the tailings by wind and provide some organic matter which can be incorporated into the soil for the Alfalfa crop in the following spring.

Before seeding the Rye,the field was fertilized with 300 pounds per acre of 13-16-10 and harrowed to a depth of one foot. The fertilizer

FIGURE 1

LAYOUT OF IRRIGATION SYSTEM

PRINCETON RECLAMATION PROJECT



was spread with a 10-foot fertilizer spreader and the field harrowed with a 10-foot vibra-shank cultivator. A 10-foot seed drill was used to seed the Fall Rye at a rate of 50 pounds per acre.

In the spring of 1979, the level area of the tailings pond will be seeded with Vernal Alfalfa at a rate of 30 pounds per acre. An additional fertilizer application will be made with 300 pounds per acre of 13-16-10 and 300 pounds per acre of 11-48-0.

In late September, the sloping embankment bordering the sewage lagoons was fertilized with 300 pounds per acre of 13-16-10 and seeded with 30 pounds per acre of the following seed mix:

Species	% of mix by weight
Creeping Red Fescue	20
Crested Wheatgrass	50
Drylander Alfalfa	15
Sainfoin	7
Sweet Clover	8

Both the seed and the fertilizer were spread, using a broadcasting unit mounted on the back of a tractor.

IRRIGATION SYSTEM

The main portion of the field will be irrigated with two 980-foot wheel-move lateral sprinkler systems, each with 24 5/32 inch x 3/32 inch sprinklers on a 40 foot x 60 foot spacing (Figure 1). The elbow on the northeast end of the tailings pond will be irrigated with a 640 foot hand-move lateral with 17 3/16 inch x 1/8 inch sprinklers mounted on 18-inch risers on a 40 foot x 60 foot spacing. The hand-move lateral is variable in length, due to the triangular shape of the elbow.

Irrigation on the sloping embankment bordering the sewage lagoons will be applied through a fixed system of twenty-four 75 foot x 3/4 inch diameter plastic pipes, each with two Rainbird #20 x 7.64 inch sprinklers mounted on stands with a sprinkler spacing of 40 foot x 60 foot. Water is supplied by one-inch gate valves that are attached to the hydrants supplying the wheel-move laterals.

The sewage effluent is pumped by a 25 horsepower vertical turbine with a pumping capacity of 300 U.S. gallons per minute. The water mainline is made from 20-foot sections of 6 inch diameter lightweight steel pipe coupled with victaulic fittings. Hydrants are spaced every 120 feet along the mainline supplying the wheel-move laterals and every 80 feet along the mainline supplying the hand-move lateral (Figure 1). The hydrants for the wheel-move laterals serve two successive settings through a 30-foot length of aluminum pipe and a 6-foot length of high pressure flex hose. The hand-move lateral has a centre connection to the hydrants which serve a single setting.

The pumping system has been designed for daily non-supervised pumping. There is a low pressure cut-out switch to prevent bank erosion by mainline pipe breaks, a high pressure cut-out switch to protect the motor from overloads arising from human error, and a liquid level regulator to prevent water from dropping to a level, in the lagoon, which could lower the effluent retention time to less than 30 days.

PROJECT COSTS

The total expenditure for the Princeton Reclamation Project was 52,000 dollars, creating a total of 1340 man-hours of employment. The cost per acre for the project was 1,300 dollars.

The largest portion of the cost is represented by irrigation which was 52% of the total (Figure 2). The rest of the cost was divided as follows: supervisory and professional services - 24%, seeding and fertilizing - 13%, fencing - 6%, and site preparation - 5%. The labour portion of each category represents a much smaller fraction of the cost than materials (Table 1).

OPERATIONAL ECONOMICS

The Ministry of Energy, Mines and Petroleum Resources will be signing ownership of the irrigation system over to the Village of Princeton, who have decided to lease the field to a local rancher. The rancher will be responsible for the care and harvesting of the crop. The Village will pay

FIGURE 2

COST BREAKDOWN OF B.C. M.E.M.P.R. RECLAMATION PROJECT ON THE PRINCETON TAILINGS POND.

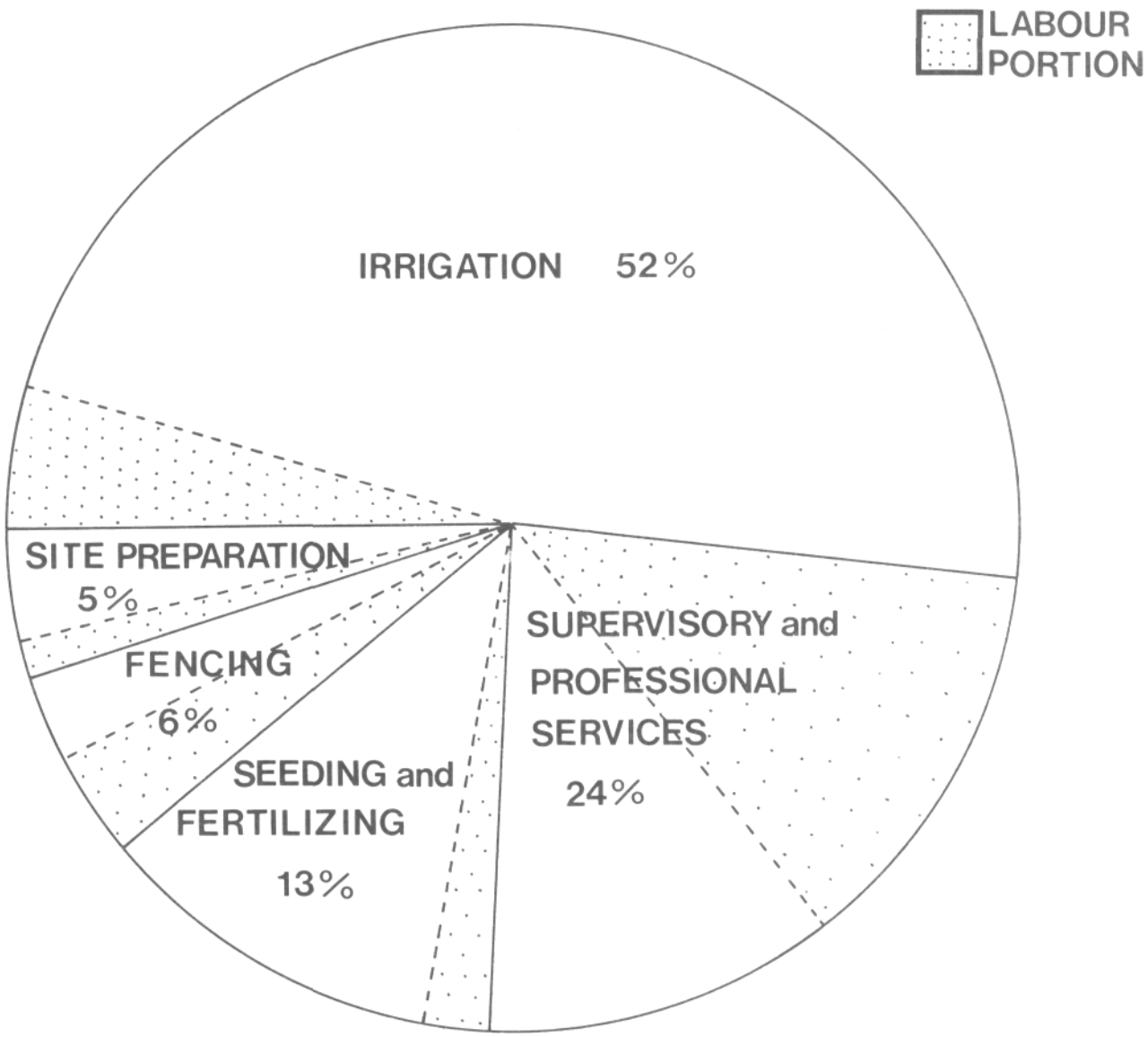


TABLE 1

BREAKDOWN OF TOTAL COSTS BY MATERIALS AND LABOUR

Description	Cost ($)	Cost ($)
Irrigation		26,603.23
Equipment	24294.03	
Labour	2309.20	
Supervisory and Professional Services		12,408.50
Expenses	5708.50	
Labour	6700.00	
Seeding and Fertilizing		6,531.71
Seed and Fertilizer	5531.71	
Labour	1000.00	
Fencing		2,992.10
Materials	1392.10	
Labour	1600.00	
Site Preparation		2,804.00
Equipment	2168.08	
Labour	635.92	
	Total Cost	51,339.54

power and maintenance and recover these costs by charging the rancher a fee on a per-ton-of-hay-produced basis.

The power cost per year for the irrigation system has been estimated at 800 dollars. The maintenance cost may run as high as 1,100 dollars per year. Total yearly production of hay should be about 110 tons when the field becomes established. Using these figures, the Village of Princeton would charge 20 dollars per ton of hay.

Future expansion of the irrigation system on the tailings pond may be possible as the soil conditions in the irrigated area improve.

DISCUSSIONS RELATED TO D.P. LANE AND J.D. McDONALDS' PAPER

Garth Mayhew, University of Victoria. Could you explain a little more about the kind of effluent that is being used. Are you putting on raw sewage at Princeton or are you taking effluent from the treatment centre.

ANS. Well, Princeton doesn't have a treatment plant. They have an old type of system that was used by a lot of small towns starting in the 1960's. It is just a system of two lagoons that are essentailly settling ponds. The volume is worked out so that it takes about 30 days for water coming in at the inlet to get to the outlet and then into the evaporation channels. I might add that this type of lagoon system is rather old fashioned and I don't think they are permitted anymore. We are just taking water straight out of the lagoons.

Dave Bolster, Techman Ltd. What about heavy metal content in the effluent. I seem to recall reading that that might be a problem in the future.

ANS. That's right. There is no industrial effluent in the sewage lagoon, the effluent is strictly municipal. The system is set up and will be in operation, so we are going to have to test the vegetation over time to find out if there will be any future ill effects from heavy metal contamination.

Ross McDonald, University of Victoria. Can you tell me something about the bacteria counts.

ANS. Vernon has a large sewage irrigation project, and we discussed this with them. They assured us that there would be very little to worry about in terms of diseases when people handled the equipment. As a matter of fact, they said that they have found that personnel who presently handle the sewage equipment are much healthier than those who don't.

Tony Schori, Techman Ltd. Maybe there is no problem with sewage but what about contamination from the tailings. Is there any problem there in utilizing the Alfalfa grown for cattle feed. Has that been looked into. Generally when sewage is used it is put on natural soils.

ANS. Right. No, we didn't examine that but, once again, will look at that when we test the vegetation. You must remember that the tailings are quite old. They have been around now since 1957, and we hope that there has been enough time to wash out the heavy metals.

Terry Rollerson^ University of British Columbia. Did you do any analysis on these soils to test for the metal content.

ANS. No, we only did an analysis for growth potential. The system was going to go ahead anyhow and it was considered to be an added benefit if the Alfalfa could be used for a crop. As I mentioned before, there are three things involved: dust, getting rid of the sewage effluent, and producing a crop.

Terry Rollerson. University of British Columbia. What about the heavy metals.

ANS. Well, the tailings pond is not being used right now and it does present really bad dust nuisance. If you have ever driven through Princeton in the summer time when there is a heavy wind, it is like going through a snow storm. So even if all that is accomplished is getting rid of the dust problem and the sewage effluent, then our project has done its job.

John Railton, Calgary Power Ltd. Could you tell me about the parameters you used to measure growth potential, also what was the pH of your tailings material. If the pH was too high, it wouldn't leach out the heavy metals, and they would remain intact at higher alkaline pH's.

ANS. I don't remember exactly what the pH readings were, but I remember there were no severe restrictions from the soil analysis results, except for the lack of organic matter and of course water retention.

Stan Weston, Wesago. We have done some work on tailings of the new operations in that area. They are highly basic, and some run up to pH 8.7. We did run pH ' s on the Old Granby tailings pond in 1970 and we tested the sewage material. We were given a figure for a typical sewage outflow material of 45 parts per million of nitrogen and 25 parts per million of phosphate, and that is indicative of what we were looking at in 1970, but the tailings pond didn't belong to the mine at that time. It sounds like the Ministry of Mines has carried out an excellent program.