

RECLAMATION AT NEWMONT MINES, PRINCETON, B.C.

Paper presented

by:

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INTRODUCTION AND BACKGROUND

Mining commenced at the Newmont property near Princeton, in December, 1970, in the Ingerbelle pit, with the first concentrate production in early 1972. Present planning foresees production until the late 1990's.

For open pit mining, disturbance of the original surface is necessary to extract the metallic content of the ore body. To date, at Newmont's Ingerbelle pit, about 1.8 pounds (0.8 kilogram) of copper have been recovered for every ton (0.9 tonnes) of rock removed. In other words, about 0.09% of the material removed has value. This waste material consists of about 34% finely ground rock or tailings from which about 7 pounds (3.2 kilograms) of copper per ton is recovered, the remaining 66% is waste rock ranging from fine to very coarse material that has to be removed to get at the ore.

This waste material is stored on nearby areas giving a new surface configuration that has to be reclaimed to a useful, stable state. Tailings and waste rock each offer a slightly different reclamation challenge.

Climate

Climatic conditions control growth and determine the scope of the reclamation that can be expected.

Near Princeton, the following weather data summary is for the last 10 years:

Precipitation:	35 centimetres average, with extremes of 20 to 46 centimetres
Snowfall:	62% average of precipitation, with extremes of 36 to 81%
Temperature:	Mean 5°, extremes of +38 to -41°C

The climate is semi-arid with wide ranging variations.

Chemical and Physical Environment

Vegetation requires a limiting minimum of moisture, nutrients, microorganisms, and pH range for germination and self-sustaining growth.

In the Ingerbelle mine area, humus derived soil ranges from an inch (2 centimetres) or so to being entirely absent. Glacial sand and gravel alluvium covers some of the rock surface. Testing of the rock and alluvium materials show that they are sterile, non-phytotoxic, contain no available nitrogen or potash, and have a minute trace of phosphorus, possibly from apatite. The pH averages about 8.4.

Physically, the sizes of material range from sand to very coarse. The tops of waste dumps usually develop a fairly fine surface material due to preparation, and operation of the haul trucks. Roughening of the harder packed portions can be done prior to seeding.

RECLAMATION OBJECTIVES

Given the relatively restrictive conditions of the area, the reclamation program had to be directed to revitalizing the new host surface, and, using the existing climate, setting an eventual target of self-sustaining perpetual, useful growth. Experimentation with grass seed types, inoculated legumes, and varying fertilizer nutrients was essential.

Experimental Test Plot

In 1971, a one acre (0.4 hectare) level test plot was constructed with pit waste rock. As only limited amounts of alluvium would be available, only half of the plot surface was covered with alluvium. While irrigation would obviously have advantages in accelerating growth, natural precipitation would be the norm, hence only half of each of the above areas were set up for irrigation. Two seed mixtures were used, with one to take advantage of the irrigation. One hundred

each of four types of coniferous seedlings were planted—because the surface was difficult to dig, a tank drill with a large bit was used to prepare the seedling holes.

This plot was maintained and studied until October, 1972, when production requirements turned it into part of a large waste dump. The test was valuable by showing that, while alluvium cover and irrigation aided more rapid growth, satisfactory seed growth progressed on both the alluvium and waste rock without irrigation. The seedling test was not conclusive but indicated that tree growth could be a problem.

Highway Safety Berm

A decision was made to place a protective barrier beside the newly constructed highway to prevent any future dump waste rock from reaching the highway and to provide a "greenbelt" along this publicly prominent portion of the operation. This berm is about 4000 feet (1200 metres) long, up to 100 feet (30 metres) wide at the top, some 15 feet (5 metres) above the highway surface, and contains over two million tons of waste rock.

As the objective was to obtain rapid growth, the berm was coated with alluvium and the top surface covered with a layer of imported "soil" that turned out to be predominately sand. An irrigation system was installed. Seeding, fertilizing, and the planting of 4600 mixed deciduous and coniferous seedlings was done in 1972, with good growth apparent in the fall of 1972.

The winter of 1972-73 "graciously" provided one of the infrequent "winterkill" conditions and less than 10% of the Green Ash and Siberian Elm were the only partial survivors. Some sprouted from their base in 1973; at present, there are only a few Siberian Elms remaining from this original planting. The grass and legumes survived the winter satisfactorily.

Irrigation ceased after the 1974 growing season and resulted in a change in the growth patterns. The drought resistant plant types became predominant while moisture dependent types receded. Numerous transplantings of indigenous seedlings were carried out, but none have survived—Forestry officials believe that the pH is too high for coniferous adaptation. In 1977, 600 Siberian Elm seedlings were planted and appeared to be doing well in 1978.

Some losses are expected from deer and elk stripping off the succulent small leaves.

Waste dumps against the berm are nearly completed. The "greenbelt" has been provided and results of this reclamation phase have been useful for other areas.

PROGRESS

Several other waste dump surfaces are being reclaimed without alluvium or irrigation. There are usually good patches of growth after the initial seeding and these spread to areas of poorer growth from natural reseeding. The slopes in front of the concentrator are irrigated to keep them green throughout most of the growing season. Each spring, there are sections here to re-do as the result of snow removal which usually dumps a new layer of road gravel on portions of the face.

Waste Dump Slopes

The main Ingerbelle waste dump is built up in a series of lifts ranging from 100 feet (30 metres) to 200 feet (60 metres) high. The toe of each lift is set back 100 (30 metres) to 150 (45 metres) feet from the crest of the lift upon which it is being built as a safety feature, resulting in an overall face slope of 26° or less. The actual face of each lift is sloped at the angle of repose—about 37°. As the waste rock is dumped over the face, it tends to segregate with finer material at the top to very coarse at the bottom. Because of this natural segregation, most of the face has fairly coarse rock that is not

suitable for seeding. To overcome this, alluvium from production or from stockpiles is dumped over the face from the top, filling in most of the spaces between the coarser rock, and providing a better surface upon which seed can take hold. The alluvium settles somewhat after placement and is usually left unseeded for a year.

Seeding and fertilizing is done with a special aircraft, as are all the larger areas. As with the flat dump surfaces, growth is preferential but spreads each year. Growth in other portions of the face is not as obvious, but sparse growth is evident over most of the faces. The areas of more concentrated growth are outlined in the snow as deer graze on these in the winter.

The dump slopes have remained stable with the lowest 180 foot high (55 metres) face now 6 years old. The first slope seeding was done in 1974.

Mine Tailings

The tailings dams are being constructed by a downstream method which adds new material each year, precluding any major reclamation until near the end of the property life.

In 1974, a test plot of tailings about 50 feet (15 metres) square and 3 feet (1 metre) deep was prepared and seeded. Analysis indicated that the tailings were similar to the waste rock in that it was sterile, non-phytotoxic, and lacking any available plant nutrients.

Good grass growth was immediate with legumes becoming apparent in 1977, and well established now. This plot was not irrigated, and was only refertilized in 1975 and 1976.

These results suggest eventual good growth potential for the tailings surface. Cattle have twice eaten the growth down to the surface on the plot.

Princeton Tailings

Newmont acquired some 70 acres (30 hectares) of old Granby tailings with its purchase of the Copper Mountain property in 1967. These are immediately west of the tailings owned by the Town of Princeton, where the Ministry of Mines is doing some experimental reclamation.

Early concern about the dust from these tailings resulted in some locally inspired small-scale experiments by Dr. L.H. Burr, a local medical practitioner, but these were abandoned. As a dust control measure, arrangements were made with Northwood Mills to dump wood waste materials on the tailings, which stopped the spreading of dust and helped to reduce the local smoke pollution.

In 1976, Newmont decided to seed these tailings. Unfortunately, a considerable number of waste logs were included with the wood waste cover so these had to be bulldozed into windrows before seeding, leaving a cover of fine wood waste on the tailings. The seeding has taken fairly well. Cattle got in and ate the first growth so the area has been fenced to permit the growth to become well established before allowing cattle to harvest the growth.

SEEDING AND FERTILIZATION

Seeding

Seed mixtures have been gradually modified from experience through a series of 12 combinations, mostly as a result of performance, but also due to the lack of availability of some seeds and excessive cost increases. All seed is minimum Canada No. 1 grade.

Because of their obviously' successful adaptability, five inoculated legumes are in the current seed mixes together with primarily drought resistant grasses, including short lived fast rooting types to give initial control of the surface. Sweet Clover is avoided because of the potential danger from its anti-coagulant properties.

Original seedings were at 80 pounds to the acre (90 kilograms per hectare) with a subsequent increase to 120 pounds to the acre (135 kilograms per hectare). Seeding is usually done in late summer or early fall.

Fertilization

Initially, the commercially available fertilizers contained about 40 to 50 units of usable plant nutrients. We now use specially prepared mixtures containing more than 60 units of nutrients, nutrient proportions being dependent on the growth stage at which the fertilizer is applied.

Nitro prills (blasting agent) were used in some spring fertilizing, but for a cost differential of about 1 cent a pound, fertilizers containing more available nitrogen as well as other nutrients can be used and nitro prills are no longer necessary. Application rates started at 300 pounds per acre (340 kilograms per hectare) but have been increased to 500 pounds per acre (550 kilograms per hectare) with initial seedings. Fertilizer application is planned for twice a year over three years by which time the areas are expected to become self-sustaining. The spring application is frequently done while snow remains on the ground to take advantage of the moisture it will provide.

Aircraft Application

In 1974, aerial application of seed and fertilizer was commenced as larger areas became available for reclamation. The specially adapted, single-seat, low-wing monoplane carries 1000 pounds (450 kilograms) of seed or fertilizer per trip in a bin located in the nose of the aircraft. Flying this aircraft is not for amateurs as very precise navigation is required at heights ranging from 50 to 150 feet (15 to 45 metres).

The bin in the aircraft is loaded with a special truck driven up to the aircraft. The aircraft bin has a spreader plate at its base which gives positive deposition in a 30 foot (9 metres) wide strip with

reduced deposition for 10 feet (3 metres) on either side so that full coverage requires careful overlapping of the flight strips. If a very precise limit to seeding is required, the spreader plate is removed and a tightly confined 25 foot (8 metres) strip can be placed. Seed application requires relatively calm conditions to accomplish the precision desired. Fertilizing is usually done at a greater height as precision is not quite so critical. The bin opening is varied to provide the rate of application requested.

Precision is excellent with an experienced pilot, and distribution is very uniform as indicated by one foot (0.3 metre) square heavily greased boards placed in an area being seeded.

The Princeton airport is used as a base for flying the nearby tailings and a good air strip has been prepared on the surface of a completed waste dump at the mine. Usually two days are sufficient for each application program.

Fertiliser placement costs about three times as much as seeding due to the heavier application rate. Current costs for 100 pounds of seed, 400 pounds of fertilizer, and placement is about 220 dollars per acre (494 dollars per hectare)

Arnot Bristly Locust

In 1971, Mr. Peck of the, then, Department of Mines suggested that the Arnot Bristly Locust had proven an excellent hardy bush for reclamation projects in parts of the U.S. and might be worth trying. Some seed was finally obtained and, in 1973, 5700 seedlings were planted on the property. To my knowledge, there were none left in 1978 because Princeton's climate is just too tough.

Hydroseeding

In 1975, a 10-acre (4-hectare) hydroseeding experiment was carried out on a dump face with the operator using his own formulation. Growth was

no more effective than with the aerial seeding and was excessively costly at 785 dollars per acre (1,900 dollars per hectare) compared to the total cost of aerial application at 135 dollars per acre (335 dollars per hectare) at that time. The cost comparison is undoubtedly biased by the size of the test, but even large area hydroseeding could not provide a satisfactory cost comparison.

PHOTOGRAPHS

A comprehensive photographic record has been kept throughout the program and, after considerable justifiable persuasion, photo targets were set up in 1977. These consisted of an angle-iron fence post with a permanent number. A company sign with the applicable date was placed on the post for identification on the photographs. The objective is to obtain "before and after" photos to record progress.

Only a very limited number of transparencies have been taken for slide projection.

CONCLUSIONS

Although growth can be sustained under almost any conditions with water and plant nutrients, the key to successful and economical reclamation is to develop, through experience, a program for the existing local conditions in order to reach self-sustaining growth as soon as possible.

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DISCUSSION RELATED TO JIM McCUE ' S PAPER

There was no discussion about this paper.