MT. WASHINGTON MINE RECLAMATION PROJECT

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Ministry of Energy Mines and Petroleum Resources

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1. PROJECT HISTORY

The old Mt. Washington Copper Mine is located 25 km west of Courtenay, British Columbia (Figure 1(a), (b), and Figure 2). It operated for one year following its opening in 1965, and during this time two pits were created, only one of which - the most northerly - proved to generate acid. Copper has leached from this site since the late 1970's and has had a major negative impact on the fishery in the Tsolum River.

In 1987 a consultant's study recommended the following remedial work:

- collection of piles of waste rock in the pit area and placement on the two major dumps;
- covering of this with a blanket of compacted waste; and,
- construction of diversion ditches upslope of the dumps, and related work.

In 1988 the Ministry of Energy Mines and Petroleum Resources allocated funds for the project, and by the fall of 1989 the work was completed (Figures 3 and 4). Analysis of the results of the water quality program over the following winter showed that a major amount of acid and copper was being generated in the pit, with some groundwater draining downslope to the East Dump.

In 1990, 2500 square meters of the pit floor were cleaned of waste (shattered rock), by backhoe, and bedrock was cleaned with a firehose. It was not possible to place an impermeable cover over the stockpiled waste at that time. Results of the cleaning were ambivalent. Although acid generation was initially increased in groundwater downstream of the cleaning, an increase was noted in pH of water passing over the surface. The result was considered to be sufficiently successful to test over a larger scale, the presumption being that increased copper levels generated in the groundwater would be dissipated in the fall and spring freshet seasons.

2. 1991 PROGRAM

2.1 Objectives

The interagency Mt. Washington Project Committee recommended an expansion of the cleaning program in 1991, encapsulation of excavated waste and further testing of neutralization using calcium hydroxide and limestone. Work was proposed to be concentrated in the north half of the pit, which drains to the Lower Ditch. This was to provide a better comparison
of results between this half and the south half of the pit which drains to the Upper Diversion Ditch.

2.2 Work Details and Cost

The Ministry of Energy Mines and Petroleum Resources allocated $170,000 to the project for the 1991/92 fiscal year. Work began with snow plowing of Branch 126 Logging Road, to provide access to the discharge and water quality station at Pyrrhotite Creek. Work completed is shown in Figure 5, and Program costs are given in Table 1. It should be remembered that costs for a remote site and pilot work do not directly apply to other locations.

The unit cost of cleaning bedrock in 1991 was higher than in 1990 because of increased depth of waste encountered (estimated at 1.5 metres and 0.6 metres, respectively), and the generally flatter slope of the pit floor on which it lay (Table 2).

It was found to be feasible to contour and compact waste with a vibrating steel drum roller, and to place concrete to a depth which varied between 1.5" to 2". Concrete was reinforced with polyethylene fibres, included 30% flyash, and a retardant, and was transported to the site by transit mix trucks. It was chuted into place on slopes which varied from horizontal, to a maximum of 2.5 horizontal to 1 vertical. A slope of 3:1 was considered optimum for placement.

<table>
<thead>
<tr>
<th>TABLE 1 1991 SITE PROGRAM</th>
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<tbody>
<tr>
<td>1. Snowplowing and road construction: 1 km $12,000</td>
</tr>
<tr>
<td>2. Excavating and cleaning of bedrock: 0.28 ha 57,000</td>
</tr>
<tr>
<td>3. Contouring and compaction of waste: 0.22 ha 6,000</td>
</tr>
<tr>
<td>4. Concrete cover: 0.14 ha</td>
</tr>
<tr>
<td>materials - 70 cu.m. @ $189.46 = $13,262.20</td>
</tr>
<tr>
<td>labor - 3 persons = 6,208.70</td>
</tr>
<tr>
<td>testing = 800.00</td>
</tr>
<tr>
<td><strong>20,300</strong></td>
</tr>
<tr>
<td>5. Other cover tests:</td>
</tr>
<tr>
<td>Asphalt emulsion, compacted fines, asphalt emulsion impregnated geotextile cloth, polyurethane/geotextile membrane 13,900</td>
</tr>
</tbody>
</table>
6. Drainage control: 2,000
7. Neutralization tests: 9,700
   Calcium hydroxide, crushed limestone
8. Wetlands test: 2,000
   Raise water level of Br. 126 bog, 70 hay bales
9. Leach test pads: 2,500
10. Water quality and discharge monitoring:
    Samples, equipment, supplies, helicopter 10,800
11. Engineering (contract costs): 34,100
12. Other: 4,700
    Total: $ 175,000

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**TABLE 2**

**COST TO CLEAN PIT FLOOR AND TO COVER WASTE**

Cost of work per square meter

<table>
<thead>
<tr>
<th>Clean to bedrock</th>
<th>Contour/compact</th>
<th>Cover with 2&quot; slab</th>
<th>*Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 20</td>
<td>$ 3</td>
<td>$ 15</td>
<td>$ 20</td>
</tr>
</tbody>
</table>

*Note: Total cost of control work is not the sum of unit costs above, as different work areas are involved. Also, although coverage with concrete appears to be the most attractive control alternative, it is best done in 'dry' areas of the pit floor, and those of relatively uniform depth of waste, due to concern for differential settlement and hydrostatic pressure.*
In the summer of 1991, asphalt emulsion (CRF-PM from Witco company), was tested as a waterproofing agent. When sprayed on to a geotextile cloth (Amoco Canada, product number 4551), it showed promise of being economical, strong and flexible in application. During the winter of 1991/92 several test panels were set up in Victoria and it was determined that applying 1.9 litres of asphalt emulsion per square metre yielded a waterproof sheet. A layer of sand and gravel is required over the surface of this sheeting to provide protection from traffic and the sun.

2.3 Monitoring and Results

Discharges were read and water quality samples were taken at the minesite during 1991, and in the spring of 1992, principally at Weirs #1, #2, #3, and #4, and at Branch 126 downstream of the site. Readings and samples were also taken at various points within the minesite to determine the nature of specific seepages and the effects of cleaning. Monitoring was assisted by the installation of several flat weirs.

During the winter of 1991/92 the water quality monitoring program was evaluated, and it was decided to install remote instrumentation at the site, as soon as possible in 1992, in order to properly document the discharge and copper loading regimes during the critical spring (and subsequently fall), freshets (Figure 6). Technical specifications are available on request.

A good appreciation of the general nature of copper leaching (loading) that takes place from the site can be obtained from Figure 7, which plots copper loading at Weirs #1, #2 and #3, against the sum of disharges at Weirs #1 and #2. These relationships are less proportional than individual loading/discharge curves, particularly for Weir #1, however a better appreciation of the total site condition is made possible.

In Figure 8, copper loading/discharge data obtained in the spring of 1992 is printed over that of previous years. A reduction in the marginal rate of copper loading is indicated at peak discharge time. Although this is encouraging, the data base is quite small, and this trend remains to be confirmed.

Data obtained in the spring of 1992 on copper loading from the washed area in the north half of the pit, and from the south half of the pit, indicates that the former contributes approximately 6% of loading at low discharge, and 12% at high discharge. The data base again is very small (2 samples each), and remains to be confirmed.
Information on the marginal rate of loading of copper from the toe of the East Dump shows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Rate (mg/litre)</th>
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<tbody>
<tr>
<td>1988</td>
<td>26.0</td>
</tr>
<tr>
<td>1989</td>
<td>8.5</td>
</tr>
<tr>
<td>1990</td>
<td>8.5</td>
</tr>
<tr>
<td>1991</td>
<td>19.2</td>
</tr>
<tr>
<td>1992 (spring)</td>
<td>23.1</td>
</tr>
</tbody>
</table>

The reason or reasons for the rate of copper loading to increase in drainage from the toe of the East Dump from 1998 to the present time are not known at this time with any certainty.

In summary, there are felt to be sufficient indications of improvement in the pattern of leaching of copper from the site to justify continuance of the general strategy of isolating waste from the action of surface and groundwater.

3. THE 1992 PROGRAM

3.1 Work Plan

The work plan in the pit for 1992 is partially based on the use of the asphalt emulsion impregnated geotextile (astex) cover. Its low cost (estimated at $ 5 per square metre for materials), allows larger areas of pit floor to be covered, and cleaning of bedrock to be limited to those locations at which groundwater and seepage must be exposed. A section illustrating the technique to be used in excavation and drainage is given in Figure 9.

3.2 Water Quality and Discharge Monitoring

A trailer unit has been outfitted with water quality testing supplies and equipment, and will be taken to the site to provide the quantity and quality of information, and the turn-around time required by this project. This is essential when dealing with a variety of seepages which vary significantly in pH, from 6 to 3.2, and whose copper contents show little relationship to pH.

3.3 Biological Treatment of Seepage Containing Copper

"Hot" seepages from under the astex cover will be conducted to biological treatment. Several pilot scale units are proposed to be set up to determine the optimum conditions necessary for anaerobic activity to bind copper in the sulphide form. An organic containment approximately 7 metres by 10 metres will be constructed on the site based on the test information and other data.
Figure 3. Plan of Site
Figure 4. Cross Section of Site
Figure 5
Legend:
Discharge recorder ——— M
Water sampler ———  
Piezometer water level sensor ———+  

Figure 6 Layout of site information
LOADING OF COPPER VS DISCHARGE

- W#1
- W#2
- W#3

DISCHARGE OF W#1 AND W#2 (l/s)

LOADING (kg/day)

Figure 7
174
Figure 8
Figure 9: Schematic section showing detail of treatment of drain for seepage emerging under covered waste.