Terms of Reference

Evaluation and Costing of Remediation Options
North Pit and East Waste Rock Dump
Mt. Washington Mine Site

PURPOSE

The Consultant will identify, evaluate and provide detailed costing of site-specific options for permanent remediation of the Mt. Washington mine site to minimize releases of dissolved copper from the site into the Tsolum River. It is expected that the Consultant will use the data from "Levelton, 1998" and the analysis from "SRK, 2000", along with a technical literature search to identify any innovations implemented since these reports were written to address copper acid rock drainage (ARD) in their evaluation. Reports available at www.tsolumriver.org (see Appendix A for list of available reports and studies)

BACKGROUND

This small copper mine site is located at the 1350 metre elevation on Mt. Washington, 18 km. northwest of Courtenay, on Vancouver Island. The mine operated for two years, closed in 1967 and has not been rehabilitated. ARD conditions in the mine's North Pit and associated waste rock areas have introduced toxic concentrations of copper into the drainage basin of the Tsolum River. The problem is heightened by transport of leached copper to the Tsolum River in late spring and fall, during periods of high snowmelt runoff and fall precipitation. It is during these periods that runoff from lower elevations has decreased and is, therefore, unavailable to dilute contaminated mine runoff entering the Tsolum River. Dissolved copper inputs from the Mt. Washington mine are implicated in the inability to recover demonstrated by Tsolum River salmonid stocks.

1987 - 1992
Beginning in 1987, federal and provincial agencies have funded studies to address the ARD problem. An initial 1987 estimate for covering the mine site and subsequent monitoring was $1.6 M, with a clear benefit in recovered fisheries values. Subsequent fieldwork installed monitoring equipment (including fourteen shallow bore holes) and placed a partial cover on one of the waste rock dumps that was releasing copper into the environment. Other work completed in this program included placement of a limestone berm and some surface ditching as recommended by the remediation consultants. Work on various covers and monitoring scenarios continued until 1992, and included stripping the oxidizing rock, washing exposed bedrock and constructing several different kinds of covers. This work did not significantly reduce copper released from the site. Consequently, the provincial government limited funding for the 1993 and subsequent field seasons.

The perceived failure of this government-sponsored work to achieve a reduction in the pollution discouraged further efforts. In the meantime, British Columbia Ministry of Environment, Lands and Parks (MELP) set water quality objectives for the Tsolum River to establish the needed reduction copper loadings. The water quality objectives established for dissolved copper in the Tsolum River (measured 500 metres below the confluence with Murex Creek) are:

- 30-day average concentration of 0.007 mg/l. dissolved copper, and
- maximum concentration of 0.011 mg/l. dissolved copper.

1993 - 2000
A 1997 report on the problem for Environment Canada (EC) and MELP showed clear economic benefits for the Courtenay-Comox area to be achieved from the restoration of salmon stocks. Shortly after, the establishment of the Tsolum River Task Force (TRTF) provided strong community involvement in the problem, as well as resources for extensive fish habitat restoration and stock enhancement in the watershed.

Funding for the TRTF ended in March 31, 1999, and the group issued its final report, "State of the Tsolum River". A technical committee of the Task Force, including site owners, industry, government and environmental interest, concluded that a detailed study of the mine site hydrogeology was essential to allow design of an effective cover. Subsequently, the report "Hydrogeological and Hydrological Evaluations for Development of Remediation Options for Mt. Washington, Courtenay, BC" (SRK, 2000) produced a water and copper load balance model for the site. The model was used to evaluate (in conceptual fashion) the potential reduction in copper loading that could be expected from cover placement over source areas and/or improved diversion of upgradient shallow groundwater recharge.

It has been noted that there remain two key geotechnical uncertainties that should be addressed before initiating any final design of a cover option:

1) The reduction in oxygen by a soil cover may not stop oxidation by the ferric ion (Nov. 29, 1995 letter from Y.T. John Kwong, EC Research Scientist, Appendix B), and

2) A reduction in copper loading from the mine may result in a release of copper from the sediments in the downstream reaches (SRK 2000, 4.3.4 page 4-16 available electronically at www.tsolumriver.org)

2000 - Present
Monitoring carried out by MWLAP/ MOE, EC, TimberWest Forest Corp. (TW), and the Tsolum River Restoration Society (TRRS) since the "SRK, 2000" report was written has shown a reduction of approximately 50% in the copper loading from the abandoned mine site. (See graphs produced from 2004 partnership sampling, Appendix C)

In 2003 a partnership was developed to implement a Passive Wetland Treatment utilizing the Spectacle Lake Wetland located approximately 6.7 kilometres downstream of the minesite or 4.1 kilometres directly downhill of the site. (See map Mt Washington Mine Site to Spectacle

Wetland Appendix D). The partners include Pacific Salmon Foundation (PSF), TimberWest Forest Corp., Environment Canada, then Ministry of Water, Land and Air Protection (now MOE) and the Tsolum River Restoration Society.

The Spectacle Lake Wetland Project was implemented to achieve a water quality in Murex Creek that would be non-toxic downstream of the "triple confluence" of Pyrrhotite, McKay and Murex Creeks (see map Triple Confluence, Appendix E). The wetland has been approximately 85% to 90% ? successful in achieving this goal. This form of treatment is time limited and the facility will become less effective at removing ARD over the next few years. There has been little formal discussion regarding improving the facility through utilization of more of the wetland by realignment of the diversion channel into the more southern lobe of Spectacle Wetland. It has been suggested that consideration be given to this during the implementation phase of further remediation works to mitigate for short-term increases in ARD caused by site activity.

SUMMARY OF THE PROBLEM AND PROPOSED SOLUTION

There are clear social, environmental and economic benefits to the restoration of Tsolum River salmonid stocks. However, a necessary precondition is a major reduction in copper leaching from the Mt. Washington mine site and a consequent improvement of Tsolum River water quality. To achieve an average 30-day concentration of 0.007 mg/l. dissolved copper in the Tsolum River, The preferred remediation option or combination of options must, therefore, ensure that copper contamination from Mt. Washington mine site drainage is prevented or mitigated, such that dissolved copper levels in Pyrrhotite Creek at Branch 126 is less than 0.6 mg/l.

Technical studies over the past ten years confirm that dissolved copper loads from the Mt. Washington mine site can be controlled by several means, such as placing an engineered soil cover over the North Pit and East waste rock dump to control or prevent oxygen diffusion and water infiltration. As well, there is reasonable consensus that shallow groundwater entering the Pit and East dump via fractured near-surface (~2m or less) is a significant contributor to the ARD process on site, and that any remediation option should include improved interception and diversion of upgradient groundwater and runoff.

This contract, with a completion date of July 31, 2006 and an estimated value of less than $60,000.00 is offered to obtain practical, site-specific conceptual options for remediation of the Mt. Washington site. The Consultant will incorporate knowledge and data from previous technical reports and the recent hydrogeological/hydrological modeling to identify and assess various remediation options, including combinations of remediation approaches. Detailed lists as well as quantities, sources and costing of materials and material deployment to complete each option or combination of options are required. Detailed costing of capital and labour for monitoring and maintenance for various options will also be required.

AVAILABLE STUDIES AND DATA

Appendix A lists reports available from www.tsolumriver.org, which include detailed flow and chemistry studies completed prior to 1997 and the recent hydrogeological/hydrological

evaluations and copper/water balance model. These will be available for viewing until bid closing, at the TRRS website.

Other data include:

- MELP at Nanaimo has, since 1977, collected meteorological, water chemistry and other data at the mine site.
- EC has recorded surface flows for this site since July 1997, to date.
- A current, large-scale (2 metre contours) topographic map of the mine site was prepared in the fall of 1998 by the Canadian Pacific Railway and is available from EC.
- Published reports of the BC Ministry of Mines have descriptions of the mine and regional geology.
- Softer Resources Ltd. may have drill core from the site and other geological information.
- In July 1999, Tsolum River Task Force volunteers collected hydrogeological samples and measured recharge rates at all mine site monitoring wells, work which was repeated by EC and MELP in October '99.
- Meteorological data and Piggott Creek stream flow measurements can be obtained (as arranged by EC) for the adjacent Mt. Washington ski village.

TASKS

A. Information Review

The Consultant is expected to review existing technical reports, maps and agency files for background site information and data related to conditions and previous remediation work at the Mt. Washington mine site and other information applicable to this contract. The Consultant is expect to be familiar with the state of the art in mine remediation and bring that knowledge to bear on the remediation options proposed for the Mt. Washington mine site.

B. Identify and Evaluate Site-specific Remediation Options

The Consultant will evaluate previously proposed remediation options and other remediation methods that may represent single or combined options. As stated above, the preferred remediation option or combination of options must ensure that copper contamination of Mt. Washington mine site drainage is prevented or mitigated, such that dissolved copper levels in Pyrrhotite Creek at Branch 126 is less than 0.6 mg/l. The evaluation shall include (but is not limited to) the following remediation options and methods:

- Construction of an improved, engineered cover system over the North Pit floor and walls and the East waste rock dump. The cover system should be designed to minimize the infiltration of precipitation and oxygen to the underlying reactive material. Covers may be constructed from local till material amended with a fine-grained material to improve moisture retention and/or decrease hydraulic conductivity or alternate material designed and blended to achieve the same result. The cover system would be keyed into competent bedrock in order to control *in situ* gaseous oxygen concentrations at the site.

.600
600mg/L

Integral to the overall cover design, the site must be capable of sustaining vegetation native to the setting. Appendix B (Letter from Kwong, 1995) presents one innovative option of using a combination of soil and water cover and is attached to demonstrate the level of innovation that the Partnership desires in the proposals.

- Construction of an improved groundwater diversion ditch upgradient of the north pit (i.e. improvement of the current Uphill Creek diversion ditch) keyed into competent bedrock. The Consultant must identify whether the horizontal and vertical configuration of the existing Uphill Creek diversion ditch is adequate to intercept any surface and shallow ground water entering the north pit area; if not, the Consultant shall identify the lateral extensions, deepening of the ditch or grouting required to effectively intercept these flows. The Consultant's evaluation of this work shall address the need to manage potential acid-generating rock excavated from the diversion ditch bed;

- Evaluation of options for the mitigation of acid drainage by mixing acidic copper-contaminated surface water in the North Pit with deep alkaline groundwater, by addition of a neutralizing pretreatment prior to applying the cover system, by addition of bio-solids either as an admixture or as a separate layer to reduce the oxygen flux and other innovative options should be undertaken by the Consultant;

- Downstream storage and release of Pyrrhotite Creek or Murex Creek water, including the sub-options of: a) no treatment of stored water before release, or, b) treatment prior to discharge to achieve the objective of **< 0.027 mg/l upstream of Spectacle Lake Wetland.?(OR Pyrrhotite Lake or?)**

- Fill acquisition, amending and deployment and availability of funding may require the phasing of the construction over two or more construction seasons. The Consultant shall identify any changes to the construction cost caused by the delays and the appropriate point(s) in the construction project where any phase should be stopped if project completion is unlikely during work season.

All remediation options and methods subject to the Consultant's evaluation must be based upon proven systems and technologies. Remediation options that require further technology development or process research shall not be included in the Consultant's evaluation.

All remediation option designs and methods subject to the Consultant's evaluation must, at a minimum, accommodate 50-year return period snowpack and 50-year return period 24-hour rainfall and surface runoff events without physical failure or loss of chemical stability in the built system. The Consultant shall account for these 50-year events when applying the "SRK, 2000" water/copper load balance model to various remediation configurations.

The Consultant is required to estimate the hydrogeological changes and/or the consequent reduction in copper loadings which might be achieved by each remediation option or combination of options, and support those estimates with technical discussions and calculations as appropriate.

The Consultant shall identify any assumptions associated with the evaluation of remediation options.

EVALUATION CRITERIA

The Consultant shall use the following evaluation criteria when assessing specific remediation options and combinations of options:

I. Overall ability of the remediation option or combination of options to achieve the maximum identified dissolved Cu level **in Pyrrhotite Creek where?**; Branch 126 or? We should decide on one location and one number and be consistent throughout.

II. Overall cost;

III. Short-term (0-25 years) and long-term (200+ years) risks which may compromise or negate the effectiveness of the remediation option or combination of options. The Consultant shall consider, but not limit consideration to, factors such as:
   a) estimated design life of engineered and constructed works;
   b) possible risks of physical works or process failure, and measures which may avoid or mitigate those risks;
   c) requirements for periodic maintenance of engineered and constructed works and of process machinery, as applicable; and
   d) monitoring requirements, including the extent of reporting required, monitoring period and length, and responsibility for monitoring.

IV. Remediation option or combination of options uses available, proven technology.

Any additional criteria that the Consultant might wish to incorporate will be adjudicated by the Partnership in consultation with an advisory group comprising technically qualified people from government, industry and the local community.

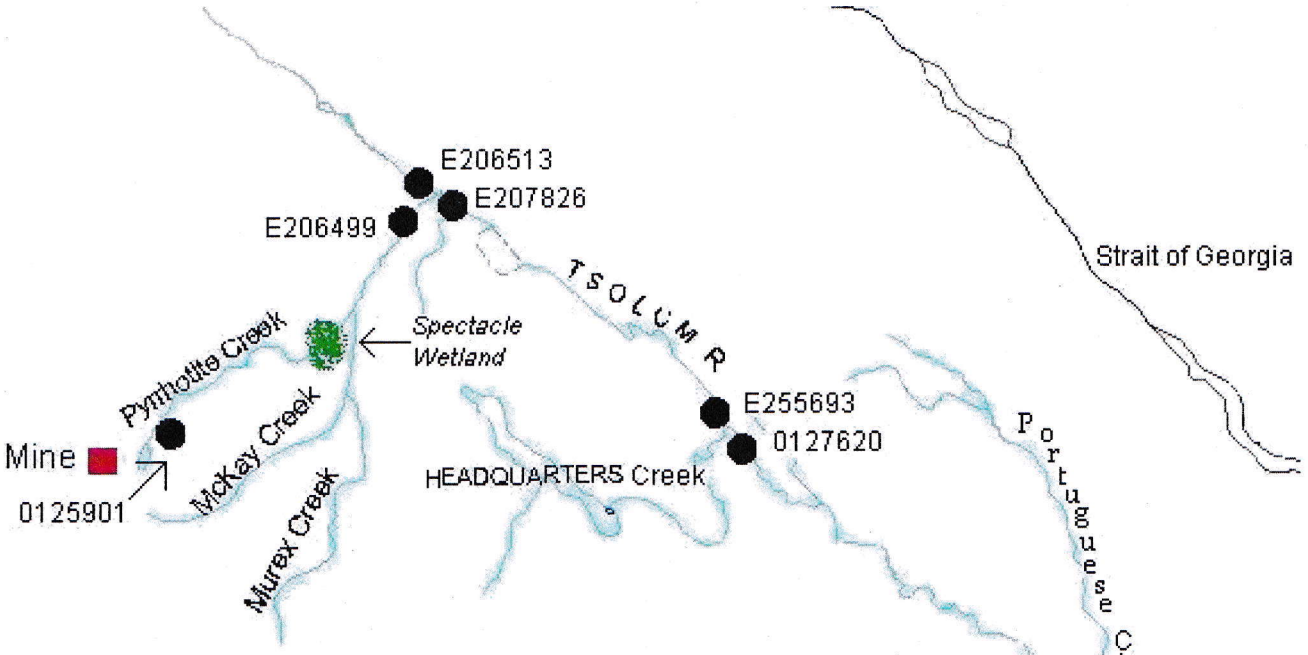
When a combination of remediation options is evaluated, the Consultant shall identify the sequence in which the individual options should be constructed or implemented.

C. Provide Detailed Costing of Preferred Remediation Options

The Consultant shall identify costs to repair access roads to the Mt. Washington site. It is assumed that the repairs will be required to bring access roads to a standard required for 3-season intensive truck traffic.

The Consultant shall provide detailed costing for capital, labour, monitoring and maintenance required for implementing each remediation option. The level of cost detail to be provided by the Consultant is shown in the attached costing example (Appendix F). To facilitate future remediation contract tendering, the Consultant shall, wherever possible, provide best

Tsolum River Watershed



Site ID	Name
0125901	Pyrrhotite Creek
E206499	Murex Creek at Duncan Main Road
E206513	Tsolum River at Duncan Main Road
E207826	Tsolum River 500 m downstream Murex Creek
E255693	Tsolum River upstream Headquarter's Creek
0127620	Tsolum River at Farnham Road Bridge