WESTERN SILVER CORPORATION

Project Description and Environmental Assessment Report

Carmacks Copper Project

Yukon Territory

Volume I

Main Report

Submitted by:

Western Silver Corporation

June 2005

Prepared by:

ACCESS CONSULTING GROUP

accessconsulting.ca

Project Description and Environmental Assessment Report
Carmacks Copper Project
Yukon Territory

Submitted by:

Western Silver Corporation
1550 – 1185 West Georgia
Vancouver, British Columbia V6E 4E6

DISTRIBUTION LIST

1 Copy + 1 PDF*	Yukon Government (YG) Energy, Mines and Resources, Minerals Management Branch
1 Copy + 1 PDF	YG Executive Council Office, Development Assessment Process Branch
1 PDF	YG Department of Environment, Environmental Affairs Section, Water Resources
1 Copy + 1 PDF	YG Yukon Water Board
1 PDF	YG Highways and Public Works
1 PDF	YG Health and Social Services
1 PDF	YG Tourism and Culture, Cultural Services, Heritage Resources Unit
1 PDF	YG Workers Compensation
1 PDF	YG Energy, Mines & Resources, Client Services – Carmacks NRO
1 PDF	Village of Carmacks
1 Copy + 1 PDF	Little Salmon Carmacks First Nation
1 Copy + 1 PDF	Selkirk First Nation
1 Copy + 1 PDF	Department of Fisheries and Oceans (DFO) Canada
1 PDF	Natural Resources Canada
1 Copy + 1 PDF	Transport Canada
1 PDF	Environment Canada
2 Copies + 1 PDF	Access Consulting Group
2 copies + 1 PDF	Western Silver Corporation
2 copies + 1 PDF	ALM Group

*PDF = CDRom version of report

PROJECT CONTACT LIST

WESTERN SILVER CORPORATION Western Silver Corporation # 1550 – 1185 West Georgia St. Vancouver, British Columbia V6E 4E6 Telephone: (604) 684-9497 Fax: (604) 668-4670 Website: www.westernsilvercorp.com	**Contact: Jonathan E. Clegg, P.Eng., Project Manager** Telephone: (604) 641-2774 Email: jclegg@westernsilvercorp.com
ACCESS CONSULTING GROUP #3 Calcite Business Centre 151 Industrial Road Whitehorse, Yukon Y1A 2V3 Telephone: (867) 668-6463 Fax: (867) 667-6680 Website: www.accessconsulting.ca	**Contact: Dan D. Cornett, BSc., P.Biol., CCEP** **Environmental Assessment Manager** Email: dan@accessconsulting.ca
ALM GROUP 601 West Broadway, Suite 400 Vancouver, British Columbia V5Z 4C2 Telephone: (604) 675-6976 Fax: (604) 713-8601	**Contact: Brad Thrall, Technical Manager** Email: bthrall@attglobal.net
EBA ENGINEERING CONSULTANTS #6 Calcite Business Centre 151 Industrial Road Whitehorse, Yukon Y1A 2V3 Telephone: (867) 668-3068 Fax: (867) 668-4349 Website: www.eba.ca	**Contact: Richard Trimble, P.Eng** Email: trimble@eba.ca

WESTERN SILVER CORPORATION

Western Silver Corporation
#1550 – 1185 West Georgia Street
Vancouver, BC V6E 4E6
Phone: (604) 684-9497

June 3, 2005

Yukon Water Board
Suite 106, 419 Range Road
Whitehorse, Yukon Y1A 3V1

Attention: Ms. Judi White, Manager, Water Board Secretariat

Dear Ms. White:

**Re: Application for Type A Water Use Licence
Western Silver Corporation, Carmacks Copper Project**

Please find enclosed the above referenced Schedule 4 application, together with one unbound copy and one CDRom of the Project Description and Environmental Assessment Report in support of Western Silver's Carmacks Copper Project. The CDRom also includes all supporting reports.

In addition, an Application for Quartz Mining Licence will be submitted directly to the Yukon Government, Minerals Management Branch along with supporting documentation.

Please do not hesitate to contact the undersigned at the above noted address, or by phone at (604) 641-2774.

Alternatively, please contact Dan Cornett, Access Consulting Group, #3 Calcite Business Centre, 151 Industrial Road, Whitehorse, YT Y1A 2V3, phone # (867) 668-6463.

Sincerely,
WESTERN SILVER CORPORATION

for

Jonathan E. Clegg, P.Eng.
Project Manager

Attachments

cc: Bob Holmes – YG, Energy, Mines and Resources
William Dunn – YG, Energy, Mines and Resources
Robert Walker – YG, Executive Council Office
Dan Cornett – Access Consulting Group
Chief Eddie Skookum – Little Salmon Carmacks First Nation

Waters Act **Schedule 4 Application**

If Amendment or Renewal: Licence # ______________

1. NAME: Western Silver Corporation

2. PERMANENT MAILING ADDRESS:
   #1550 - 1885 West Georgia St.
   Vancouver, British Columbia V6E 4E6

TELEPHONE: (604) 684-9497 FAX: (604) 668-4670 EMAIL: jclegg@westernsilvercorp.com

3. SEASONAL MAILING ADDRESS (if different from permanent) From ______________ (Date) to ______________ (Date)

TELEPHONE: FAX:

4. LOCATION OF UNDERTAKING: 38 km northwest of the Village of Carmacks

WATER SOURCE: Groundwater wells - Upper Williams Creek Tributary of Yukon River

WASTE DEPOSIT: Williams Creek (Describe location, attach map, indicate location of waste deposit)

5. QUANTITY OF WATER TO BE USED: 885 m^3/day 6. PROPOSED EXPIRY DATE: May 2020

7. TYPE OF UNDERTAKING
   - Industrial ☐
   - Placer Mining ☐
   - Quartz Mining ☑
   - Municipal ☐
   - Power ☐
   - Agriculture ☐
   - Conservation ☐
   - Recreational ☐
   - Miscellaneous (attach description) ☐

8. WATER USE:
   - To obtain water ☑
   - To divert water ☐
   - To store/alter flow of water ☐
   - To modify the bed or bank of a watercourse ☐
   - To cross a watercourse ☐
   - To deposit waste ☑
   - Other (attach description) ☐

9. OTHER PERSONS OR PROPERTIES AFFECTED BY THIS UNDERTAKING (attach list)

10. NAME, ADDRESS, TELEPHONE AND FAX NUMBER OF AGENT OR ALTERNATE CONTACT
Dan Cornett, Access Consulting Group, #3 Calcite Business Centre, 151 Industrial Road, Whitehorse, Y.T., Y1A 2V3; Phone: 867-668-6463; Fax: 867-667-6680

Signature ______________ Date June 1, 2005

FOR OFFICE USE ONLY

Application Fee Amount ______________ Receipt No: ______________

Water Use Deposit Amount ______________ Receipt No: ______________

MLUR Amount ______________ Receipt No: ______________

YG (YWB-4) 03/2003

WESTERN SILVER CORPORATION

Western Silver Corporation
#1550 – 1185 West Georgia Street
Vancouver, BC V6E 4E6
Phone: (604) 684-9497

June 3, 2005

Government of Yukon
Energy, Mines and Resources
Mineral Development Branch
Box 2703
Whitehorse, Yukon Y1A 2C6

Attention: Mr. William Dunn, Senior Minerals Development Advisor

Dear Mr. Dunn:

Re: Application for Quartz Mining Licence
Western Silver Corporation, Carmacks Copper Project

Please find enclosed one hard copy and one CDRom of the Project Description and Environmental Assessment Report in support of Western Silver's application for a Quartz Mining Licence for the Carmacks Copper Project. The CDRom also includes all supporting reports.

In addition, a Type A Water Use Licence Application will be submitted to the Yukon Water Board along with supporting documentation.

Please do not hesitate to contact the undersigned at the above noted address, or by phone at (604) 641-2774.

Alternatively, please contact Dan Cornett, Access Consulting Group, #3 Calcite Business Centre, 151 Industrial Road, Whitehorse, YT Y1A 2V3, phone # (867) 668-6463.

Sincerely,
WESTERN SILVER CORPORATION

Jonathan E. Clegg, P.Eng.
Project Manager

Attachments

cc: Judi White – Yukon Water Board
Robert Walker – YG, Executive Council Office
Dan Cornett – Access Consulting Group
Chief Eddie Skookum – Little Salmon Carmacks First Nation

CONTEXT OF THIS DOCUMENT

This project description and environmental assessment report presents a summary of detailed project information that has been previously submitted for Western Silver Corporation's Carmacks Copper project ("the project") and provides an environmental assessment (EA) for the project. The report is presented in two volumes; Volume I – Main Report and Volume II – Supporting Appendices.

The project was originally presented to government for environmental assessment in 1995. Western Silver Corporation ("the company") undertook a number of detailed biophysical, engineering, and other related studies to document local environmental conditions and provide supporting information for the project's engineering designs. Much of this information is still relevant and has been relied upon during the preparation of this Project Description and Environmental Assessment Report. Reports issued by the various consultants contain their professional opinions as to the interpretations made and conclusions drawn through the analyses of available information. The results and conclusions drawn from these studies have been incorporated into this document. In particular, information contained in this report has been drawn from the "1997 Basic Engineering Report and Definitive Cost Estimate" prepared by Kilborn Engineering Pacific Ltd. (Kilborn).

Environmental assessment legislation has undergone a number of changes in recent years. This Project Description and Environmental Assessment Report is intended to fulfill the requirements of the Yukon Environmental Assessment Act (YEAA) and the Canadian Environmental Assessment Act (CEAA). There is also recognition of the pending Yukon Environmental and Socioeconomic Assessment Act (YESAA) legislation and the changes resulting from implementation of this new EA process.

YEAA requires that all projects with a "trigger" be subject to a detailed environmental assessment. The proposed Carmacks Copper Project "triggers" YEAA since it falls within the definition of a "project", that being "*any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work*" or *"any proposed physical activity"* and it is subject to the *Law List Regulations*. A "work" includes such undertakings as construction of a mine.

The Carmacks Copper Project falls under the *Law List Regulations* since it will be subject to approvals under the provision of the Yukon Waters Act, and the Quartz Mining Act, which are included in the *Law List Regulations*. The project also falls under the YEAA *Comprehensive Study List Regulations* since the mine will be producing more than 3,000 tonnes of ore per day.

There is an extensive library of studies and other documentation related to the Carmacks Copper Project. The exploration properties that comprise the project have been subject to engineering studies and extensive environmental baseline studies. Several of the documents located in the References (Section 10) have been referred to, or relied upon for this report (indicated with the symbol **"*"**). These documents noted in Section 10 have been submitted with this Project Description and Environmental Assessment Report and should be referred to for further details and information.

Several design drawings for the project have been included in Appendix A, while some are presented as Figures in the main body of the report. The original drawings in

Appendix A are from Kilborn, and Knight Piésold, and have been modified/revised slightly from their original format for presentation purposes. The original engineering design content has not been modified.

In April 2005, Access Consulting Group, on behalf of Western Silver Corporation, prepared an updated “Performance Standards and Design Criteria Parameters” report. This report is included in Appendix C. In June 1997 a Conceptual Closure and Reclamation Plan was prepared for the Carmacks Copper Project; Appendix F of this document contains an updated version of the Conceptual Closure and Reclamation Plan.

In December 2004 EBA Engineering Consultants (EBA) carried out a review of the Carmacks Copper heap leach pad design and prepared an alternative conceptual design. The Heap Leach Pad Liner Design Report is located in Appendix D of this document.

Volume I of this report is organized as follows:

Section 1 outlines the corporate profile for Western Silver Corporation as well as the purpose of the project.

Section 2 provides the project and assessment scope as well as regulatory approvals necessary for the project to proceed.

Section 3 provides the project description of the proposed mine including the project background and history, components and activities, mining manpower, water supply, and waste management.

Section 4 describes alternative means and alternatives to the project.

Section 5 describes the existing environmental conditions and setting for the project area. A number of discipline specific studies were undertaken in support of this assessment. The report focuses on these studies and existing records from past investigations to complete the environmental setting. Socioeconomic conditions are also presented.

Section 6 describes the consultation processes with regulatory agencies, First Nations, the public, and various other interested parties. Input gathered from these consultation processes is presented and summarized.

Section 7 presents the approach to assessing potential environmental effects and project effects using a risk-based assessment. Potential effects to the physical and biological environment, heritage resources, current land uses, and socioeconomic conditions as a result of the project development are assessed. Where adverse environmental effects are predicted, appropriate mitigation methods are outlined. A determination of the significance of potential adverse environmental effects with mitigation is presented. Potential cumulative effects on the environment as a result of project development are addressed. Environmental heath and safety and accidents and malfunctions; a conceptual closure plan; and the capacity of renewable resources are also all addressed.

Section 8 describes the follow-up programs for monitoring safety and environmental protection. Operational procedures and monitoring plans following construction of the project are described.

EXECUTIVE SUMMARY

Western Silver Corporation ("the Company") is a publicly traded mineral exploration company focused on discovering and developing silver properties in the Americas. The company is the 100% owner of the Carmacks Copper Project, and is listed on the American (AMEX:WTZ) and Toronto (TSX:WTC) stock exchanges.

A feasibility study prepared by Kilborn Engineering Ltd. (Kilborn) in 1997 shows that the Carmacks Copper Project is feasible at prices above U.S.$1.10/lb copper. The Company believes that the outlook for long term copper demand is favorable, and this provides an opportunity for Western Silver, their shareholders, local First Nations and communities, and the Yukon Territory to benefit from the project development. Approximately 14,300 tonnes of copper will be produced per year, with a potential for value added local industries using the product.

The Company is moving forward with the Yukon Government environmental assessment and permitting processes so that development can proceed on a timely basis to take advantage of favorable economic conditions. The project requires both a Quartz Mining Production Licence (Yukon Quartz Mining Act) and a Water Use Licence (Yukon Waters Act) to enable project development. These licenses require the completion of an environmental assessment under the Yukon Environmental Assessment Act (YEAA). This Project Description and Environmental Assessment Report has been prepared on behalf of the Company to fulfill the requirements of the YEAA review process.

The Carmacks Copper Project is a proposed open pit copper mine and solvent extraction and electrowinning (SX/EW) processing facility being developed by the Company. The ore body is located in the Yukon Territory (Figure 1), 9 km west of the Yukon River, about 38 km northwest of the Village of Carmacks, or 192 km north of Whitehorse (Figure 2). The site is accessible by an existing exploration road that leads north off the government maintained Freegold Road from Carmacks. A year-round port at Skagway, Alaska, is located 180 km south of Whitehorse and connected via a government maintained secondary paved highway.

The deposit contains an open pit mineable reserve of 13.3 million tonnes at an average grade of 0.97% total copper located on a mineral claim block covering some 1,000 ha. The project will include an open pit, acid heap leach and copper extraction facility, waste rock storage area, soil stockpiles, events pond, drainage ditches, sediment control ponds, roads, construction camp, and miscellaneous facilities to support mining operations. A crushing plant may also be constructed for ore and fill processing.

Mine operations in the open pit will be carried out using conventional mining equipment with a stripping ratio of 4.6 tonnes of waste to 1 tonne of ore (4.6:1). It is estimated that active mining will be undertaken for eight years, producing about 60 million tonnes of waste rock, and 13.3 million tonnes of copper ore. Geochemical testing of the waste ore indicates that the material is non-acid generating.

Oxide ore will be placed on a heap leach pad to produce 14,310 tonnes of copper cathodes per year, at a recovery rate of 80%. The pad will be seasonally loaded and leached year round. Copper in solution will be recovered from the oxide ore by acid heap leaching.

A raffinate (barren acid solution) will be applied to the surface of the ore by a system of buried drip emitters. After leaching through the ore, the pregnant leachate solution will be collected in a network of pipes at the bottom of the heap and flow either directly to the SX/EW process plant, or to the events pond below the heap. Pregnant leach solution will be treated in a solvent extraction plant to purify and concentrate the weak leach solution to a more concentrated solution suitable for electrowinning. High purity copper cathodes produced in an electrowinning plant will be shipped via truck to Skagway, Alaska.

Water supply for the project will come from wells in the Williams Creek valley. Process water makeup will be sourced from surface run-off settlement ponds located below the waste rock storage area (WRSA) and leach pad and shop area. Power will be generated on-site by 5 x 1.6 mW diesel generators complete with heat recovery equipment. Alternatively, Yukon Energy Corporation may supply power to the site via a transmission power line.

Sulphuric acid required for the leaching of copper from the ore will be produced on site from a commercial 120 tpd contact catalytic plant. The plant will burn molten sulfur to produce sulfur dioxide which will be converted, via a select catalyst and recirculated with a sulfuric acid stream, to produce concentrated (98%) sulphuric acid. Alternative acid production processes such as bio-oxidation of agglomerated elemental sulfur are under study and will continue to be investigated.

In addition to the mining and process facilities, the site facilities will include: water supply wells and distribution system, power supply distribution, fire protection, diesel fuel storage, acid storage, sewage treatment, communications system, offices, changehouse, operations camp, gatehouse/first-aid, workshops/warehouse and laboratory.

Design drawings for the project have been included in Volume II - Appendix A, with summary figures presented in the main body of the report (Volume I). The original engineering drawings in Appendix A are from Kilborn, and Knight Piésold Consulting, and have been modified/revised slightly from their original format for presentation purposes.

After mining ceases, site infrastructure will be dismantled and removed from the site. Where appropriate, slopes on the waste rock storage area and heap will be recontoured, covered with stock piled overburden material, and revegetated. Roads and disturbed areas will be decompacted, scarified and revegetated. When leaching is no longer economic, an evaporative transpiration soil cover will be installed. The heap will be rinsed for approximately two to three years with water and then neutralized. In situ biological treatment will be undertaken in the heap to assist in stabilization of metals. Active water treatment using conventional lime treatment will be used to reduce the heap solution inventory. Once heap effluent performance standards are achieved, a long-term passive treatment (infiltration gallery) is proposed for final closure.

Detailed engineering studies and extensive environmental baseline studies have been conducted on the Carmacks Copper Project to support project engineering and design and environmental assessment for the project. These studies have focused on:

- Ground water and surface water quality;
- Surface and ground water hydrology;

- Detailed groundwater model of the heap leach pad area;
- Geology, foundation, geotechnical and hydrogeological studies for proposed infrastructure areas;
- Waste rock and spent ore characterization;
- Metallurgical testing;
- Water treatment performance and treatability testwork;
- Water treatment plant effluent and toxicity testing;
- Petrographic and mineralogical reports;
- Terrain hazard analysis;
- Seismic hazard assessment;
- Meteorological studies;
- Stream sediment survey;
- Fisheries studies;
- Benthic macro invertebrate surveys;
- Vegetation survey;
- Wildlife surveys;
- Archeological and heritage resource assessments;
- Traditional and cultural resource use assessment (traditional knowledge); and
- Socioeconomic impact assessment of the local and regional communities.

A summary of the local environmental and socioeconomic conditions in the project area is presented with detailed references to specific reports provided.

The Carmacks Copper Project falls within the traditional territory of the Little Salmon Carmacks First Nation (LSCFN) and Selkirk First Nation (SFN). The LSCFN community is located in Carmacks, Yukon. LSCFN are considered the principal traditional users of lands located near the Carmacks Copper Project. Previous consultations have occurred with the LSCFN regarding the project development to determine and document important cultural and heritage features and traditional use areas as well as valued ecological components.

Based on discussions with LSCFN and consultation with other interested parties, and studies of ecological features in the area, the following valued ecosystem and cultural components (VECC's) have been identified for the project:

Ecosystem Components:

- Air Quality;
- Surface Water Quality;
- Groundwater Quality;
- Permafrost;
- Fisheries Resources located in lower Williams Creek and Yukon River (Juvenile Chinook Salmon and Arctic Grayling; and
- Wildlife Resources, including moose and furbearers.

Socioeconomic/Cultural Components:

- Traditional Use – Trapping;
- Traditional Use – Wildlife and Cultural;

- Heritage Resources;
- Community Social Values;
- Community Economic Values; and
- Human Health and Safety.

The VECC's identified for the project are within the EA study area and include a regional context for components that will be affected by the project. Consultation with LSCFN, the Village of Carmacks, and regulatory agencies, knowledge of local environmental conditions, and best professional judgment, lead to the selection of the project VECC's. The list of VECC's is considered comprehensive and accurate for the project.

The environmental assessment (EA) for this project has considered the environmental effects (biological and physical aspects) on the project area as well as socioeconomic effects, including effects on traditional and cultural use, archaeological and heritage resources, social and economic values, and human health. The EA scope considered a local geographic study area as well as a regional context for certain environmental and social components, and considered all development phases including construction, operations, reclamation and decommissioning, and final closure for the temporal scope of the EA. An analysis of alternative means of carrying out the project and the potential environmental effects associated with those alternatives was undertaken. The EA identified project environmental effects and measures to mitigate potential environmental and socioeconomic effects. A risk assessment and characterization was completed and included the identification of potential accidents and malfunctions associated with the project. The analysis of potential environmental and socioeconomic effects integrated the project risk assessment to determine the significance of identified potential project effects. To support the EA, a cumulative effects assessment was completed to assess the combined effects resulting from project development with other regional activities.

The Company has initiated a consultation program for the project. It is expected that additional community consultations will be held in Carmacks and Whitehorse, and discussions with regulatory agencies and the LSCFN will be undertaken as part of the EA and regulatory processes. Community and LSCFN open houses will be open to all members of the public. The company will continue to work closely with the LSCFN and to communicate on a regular basis with the local community to obtain input and feedback and apprise residents of ongoing activities and potential for socioeconomic opportunities resulting from the project.

The Company is committed to minimizing the effects of its activities on the surrounding environment by using existing access infrastructure and minimizing the project footprint. The Company has developed the project using preventative engineering to minimize the potential for environmental effects. Specific mitigation measures have been incorporated into the project to provide environmental protection. Emergency response and contingency and monitoring plans are in place to ensure that potential effects to cultural and environmental features are minimized. An assessment has been completed to identify potential environmental and socioeconomic effects, including cumulative effects, and mitigation measures have been developed to address those effects.

Potential effects have been assessed for significance using accepted criteria and best professional judgment. A risk assessment has been completed to augment the significance effects determination. Although the project will leave permanent features in the area, such as an open pit, the geographic extent of the project is relatively small. The project is expected to be constructed, operated, and decommissioned within a reasonable timeframe (20 years) based on a passive closure strategy that will leave all disturbances reclaimed and revegetated. The area does have important ecological and cultural attributes; however, the magnitude of potential effects is considered low, with most effects highly reversible. Potential project hazards, failure modes, and accidents and malfunctions have been identified and their exposure mechanisms and consequences assessed as part of a risk characterization. The risk characterization incorporates preventative engineering design measures to minimize the potential for project effects. Although social and economic effects both positive and negative to the local communities are expected, overall the potential effects are thought to be mitigable and provide benefits to community members and Yukoners. Based on the assessment, the project is not predicted to cause significant adverse environmental, socioeconomic or cumulative effects with the implementation of planned mitigation measures.

The following table presents an overview of the project.

Carmacks Copper Project Overview

Annual Copper Production	Average production capacity of 14,310 tonnes per year of cathode copper
Total Copper Production	114,480 tonnes of cathode copper
Mine Life	8 years
Total Project Life	15 years (0 – 8 years construction and mine operation; 8 – 15 years decommissioning and reclamation, closure, and post closure)
Overall Copper Recovery	80%
Extraction Kinetics	80% recovery in 300 days
Ore Production Rate	Maximum rate of 9,872 tonnes per day for up to 230 days per year for eight years
Location	46 km by gravel road: Freegold Road (33 km) and an exploration trail (13 km) northwest of Carmacks, Yukon
Deposit Type	Carmacks Copper, copper-gold deposit hosted by feldspathic-mafic gneisses (generally quartz deficient) that form a roof pendant within Upper Triassic hornblende-biotite granodiorite of the Granite Mountain Batholith = No. 1 Zone. 91 drill holes with 12,900 metres of drilling.
Host Rocks	Yukon Cataclastic Terrane
Physiography	Yukon Plateau-Central Ecoregion
Mineable Reserves	13.3 million tonnes at an average grade of 0.97% total copper, at a marginal cutoff grade of 0.29% total copper
Stripping Ratio	4.6 tonnes of waste per tonne of ore
Mining Method	Conventional seasonal open pit
Ore Mining and Placement Schedule	Ore mining for maximum of 230 days/year; 28,400 tpd (ore and waste); Maximum of 9,872 tpd ore placed for leaching for up to 200 days per year; 13.3 million tonnes of ore placed in the heap over 8 years, commencing in May of Year 1 and completed by June of Year 8

Carmacks Copper Project Overview (Cont'd)

Crushing	Trailer mounted unit consisting of open circuit primary jaw crushing followed by open circuit secondary gyratory crushing; 521 tonnes per hour.
Leach Schedule	365 days/year
Leach Pad Area	31.5 ha 47,400 m^2 max area under leach at any time
Stacking	Valley fill heap - 8 m lifts and 1.6 t/m^3 dry density
Heap Leach Pad Liner	Double composite with LDRS lower heap, single composite upper heap
Reagent Consumption	Crusher Liners (steel) 0.03 kg/tonne ore; Sulphuric Acid 25 kg H_2SO_4/tonne ore; Guartec 0.5 kg/tonne Cu; Cobalt 100 ppm Co in bleed stream; Extractant 0.014 kg/tonne ore; Diluent (Kerosene) 0.040 kg/tonne ore.
Solution Application	Barren leaching solution applied using drip emitters at a total flow rate of 540 m^3/hr @ 0.204 litres/min/m^2
Copper Recovery Process	Solvent extraction-electrowinning process (SX/EW)
Events pond	160,000 m^3
Work Force	109 persons average; 130 peak.
Airstrip	Carmacks
Power	Diesel generating plant (5 X 1.6 mW)
Water Supply	8 wells located in the bedrock confined aquifer underlying Williams Creek drainage; each well estimated to provide ~ 150 m^3/day
Elevation	485 m to 1,000 m
Average Temperatures	January –30.6^{o}C; July 12.8 ^{o}C.
Land Position	Western Silver 100% owner of 206 claims on the Carmacks Copper Property

Carmacks Copper Project Overview (Cont'd)

Exploration Potential	Zone 1 extends in trench exposures and drill intercepts over a 700 m strike length and 450 m down dip; 14 defined zones total.
Environmental Baseline	Completed throughout 1989 to 1999. Ongoing data collection programs.
Project Permitting	Scheduled for completion in 2006
Mine Waste Rock	Design capacity of 60 million tonnes placed at 2.0 t/m^3; Annual waste rock production of about 7.5 million tonnes.
Effluent Testing	Passed acute toxicity tests for treat and release and end of mine life treated solutions
First Nations	Little Salmon Carmacks First Nation (LSCFN); Selkirk First Nation (SFN).
Archaeological / Heritage Sites	2 historic archaeological sites – outside of project footprint; 3 areas of medium heritage site potential along access road.
Environmental	No key wildlife habitat on site. Trapping concession in the project area
Total Reclamation Fund	No existing liabilities

Table of Contents – Volume I

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

List of Tables

List of Tables (Cont'd)

List of Figures

Volume II – Supporting Appendices

1.0 CORPORATE PROFILE

In February 2003, Western Copper Holdings Limited changed its name to Western Silver Corporation (hereafter referred to as "Western Silver" or "the Company") to reflect the Company's focus on silver. Western Silver is a publicly traded mineral exploration company focused on discovering and developing silver properties in the Americas (Western Silver Corporation, 2004). The Company, which is internationally recognized for its technical ability, is listed on the American (AMEX:WTZ) and Toronto (TSX:WTC) stock exchanges. Contact information for the head office is presented below:

Western Silver Corporation
1550 – 1185 West Georgia
Vancouver, British Columbia
Canada, V6E 4E6

Telephone: (604) 684-9497
Fax: (604) 668-4670
Email: info@westernsilvercorp.com
Website: www.westernsilvercorp.com

Western Silver's primary project, located in Peñasquito, central Mexico, is a large silver-gold-lead-zinc district. Peñasquito has been independently confirmed as one of the world's largest undeveloped silver deposits, and is one of the few bulk silver deposits that is economic at recent low metal prices (Western Silver, 2004). Western Silver also has an interest in the San Nicolas zinc-copper project with Teck Cominco. The Carmacks Copper Project is 100% owned by Western Silver.

As a member of the Mining Association of Canada (MAC), Western Silver subscribes to the MAC Environmental Policy. The 1995 revision of the MAC environmental policy was developed by the environmental managers of major mining companies in Canada and is based on six years of experience in implementing the Association's initial Environmental Policy.

> *"Member companies of The Mining Association of Canada are committed to sustainable development which embodies protection of human health, the natural environment and a prosperous economy."* (MAC, 2004)

Western Silver has adopted a Safety and Environmental Policy, which is presented in Appendix B. The purpose of Western Silver's Safety and Environmental Policy is to provide a measurable framework for the performance of Western Silver's activities in an environmentally responsible manner, ensuring compliance by the Corporation and its employees with all applicable environmental regulations and commitments.

Western Silver will take positive action to protect the safety of its workers, conserve natural resources, and minimize the effect of its activities on the environment through diligent application of appropriate technology and responsible conduct at all stages of exploration, mine development, mining, mineral processing, decommissioning, and reclamation. The company intends to develop and operate the project in an environmentally responsible and sustainable manner.

1.1 PROJECT PURPOSE AND NEED

Economic analysis of the Carmacks Copper Project showed that the project is feasible at prices above US$1.10/lb copper. With the recent move in copper prices to above US$1.10/lb, Western Silver is investigating ways to advance project development. After having spent considerable time, effort and money on the project in previous years, Western Silver is moving the EA permitting process to completion so that development can proceed in a timely basis to take advantage of higher copper prices.

Western Silver believes that the outlook for copper demand is favorable for the long term. This provides an opportunity for Western Silver, their shareholders, local First Nation's and communities, and the Yukon Territory as a whole to benefit from the project development. The Carmacks Copper Project will also provide an economic benefit to the Yukon economy, which in recent years, in the mining sector, has been quite poor.

2.0 PROJECT AND ASSESSMENT SCOPE

2.1 PROJECT SCOPE

The Carmacks Copper Project is a proposed open pit copper mine and solvent extraction and electro winning (SX/EW) processing facility being developed by Western Silver. The orebody is located in the Yukon Territory (Figure 1), about 38 km northwest of the Village of Carmacks, or 192 km north of Whitehorse (Figure 2). The deposit contains an open pit mineable reserve of 13.3 million tonnes at an average grade of 0.97% total copper, at a marginal cutoff grade of 0.29% total copper. The project will include an open pit, acid heap leach and copper extraction facility, waste rock storage area (WRSA), soil stockpiles, events pond, drainage ditches, sediment control ponds, roads, construction camp, and miscellaneous facilities to support mining operations. A crushing plant may also be constructed for ore and fill processing.

The scope of the project includes all undertakings involved with the physical works and activities relating to the development, construction, operation, and decommissioning of the Carmacks Copper Project. The principle development for this project is the open pit mining of copper oxide ore. The proposed accessory developments to the project consists of the following main components:

- Waste rock storage and handling;
- Ore crushing and handling to lined heap leach facility;
- Events pond and other water management structures;
- SX/EW processing facility and raffinate solution management;
- Acid plant;
- Haul road;
- Ancillary facilities; and
- Support services (e.g. access, power supply, site accommodation, communications).

2.2 MINERAL ASSETS

The reserves used in the Basic Design Report have been calculated to be 13.3 million tonnes of ore at an average grade of 0.97% total copper based on a cutoff grade of 0.29% total copper and a mining dilution of 10%. Western Silver is the 100% owner of 206 claims on the Carmacks Copper property (Figure 5-6, Section 5.4). Figure 3-4, (Section 3.1.2) prepared by HKP in 1995, shows the location of the No. 1 zone and the geological reserves in the area.

2.3 ASSESSMENT SCOPE

The approach to the environmental assessment (EA) for this project is outlined in Figure 2-4. This approach is a step-wise determination of the various development phases for the project.

The EA for this project will consider the following issues:

- The purpose of the project;
- Alternative means of carrying out the project and a consideration of the environmental effects of those alternatives;
- The environmental effects of the project, including the environmental effects of accidents or malfunctions that may occur in connection with the project, including an assessment of effects on:
  - The physical and biological environment;
  - Heritage resources and current land uses in the project area;
  - Socioeconomic effects on local communities;
  - Effects on human health; and
  - Capacity of renewable resources.
- Any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- The significance of the potential effects;
- Comments from the public that are received during public consultations;
- Measures that are technically and economically feasible and that would mitigate any significant adverse environmental effect of the project;
- The capacity of renewable resources that are likely to be significantly affected by the project to meet present and future needs; and
- The need for and requirements of a follow-up program.

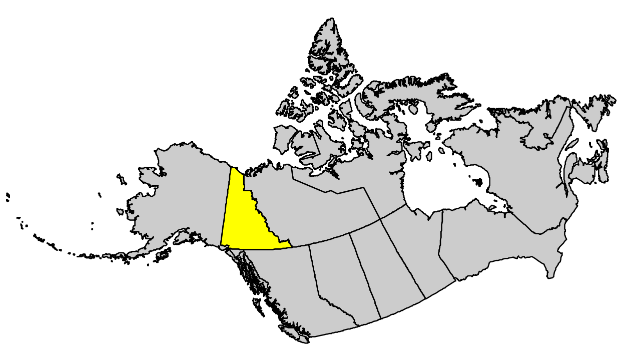
Throughout the assessment, the definitions of “environment” and “environmental effect” will be defined as per YEAA:

> **environment** – means the components of the earth including land, water and air (all layers of the atmosphere); all organic and inorganic matter and living organisms; and the interacting natural systems that include the previously mentioned components;
>
> **environmental effect** – any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the Species at Risk Act, any effect of any such change on health and socioeconomic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance; any change to the project that may be caused by the environment.

The scope established by these definitions does not consider socioeconomic effects that do not result from changes in the environment. A socioeconomic effect as defined in the Yukon Environmental and Socioeconomic Assessment Act includes effects on economies, health, culture, traditions, lifestyles, and heritage resources. It is historically established that major projects in remote areas can result in socioeconomic effects to original inhabitants as a result of rapid immigration of outsiders seeking work. Major projects also bring many positive socioeconomic benefits through employment and tax revenues. In this case, the social and economic benefits do not result from changes to the environment (as defined by YEAA and CEAA) but from changes to the local social and economic conditions. For the purposes of this environmental assessment, the Company intends to include the effects to social and economic conditions of the area in the definition of the project “environment”.

If the potential environmental and socioeconomic effects of the project are found to be insignificant, justified under the circumstances or minimized with known technology, the project may then proceed to the regulatory stage for the issuance of necessary approvals. This report has identified potential environmental and socioeconomic effects and proposed mitigation measures and assessed the significance and likelihood of these residual effects.

A schematic representation of the EA review process for the Carmacks Copper Project, as Western Silver currently understands it, is shown in Figure 2-4.



WESTERN SILVER CORPORATION

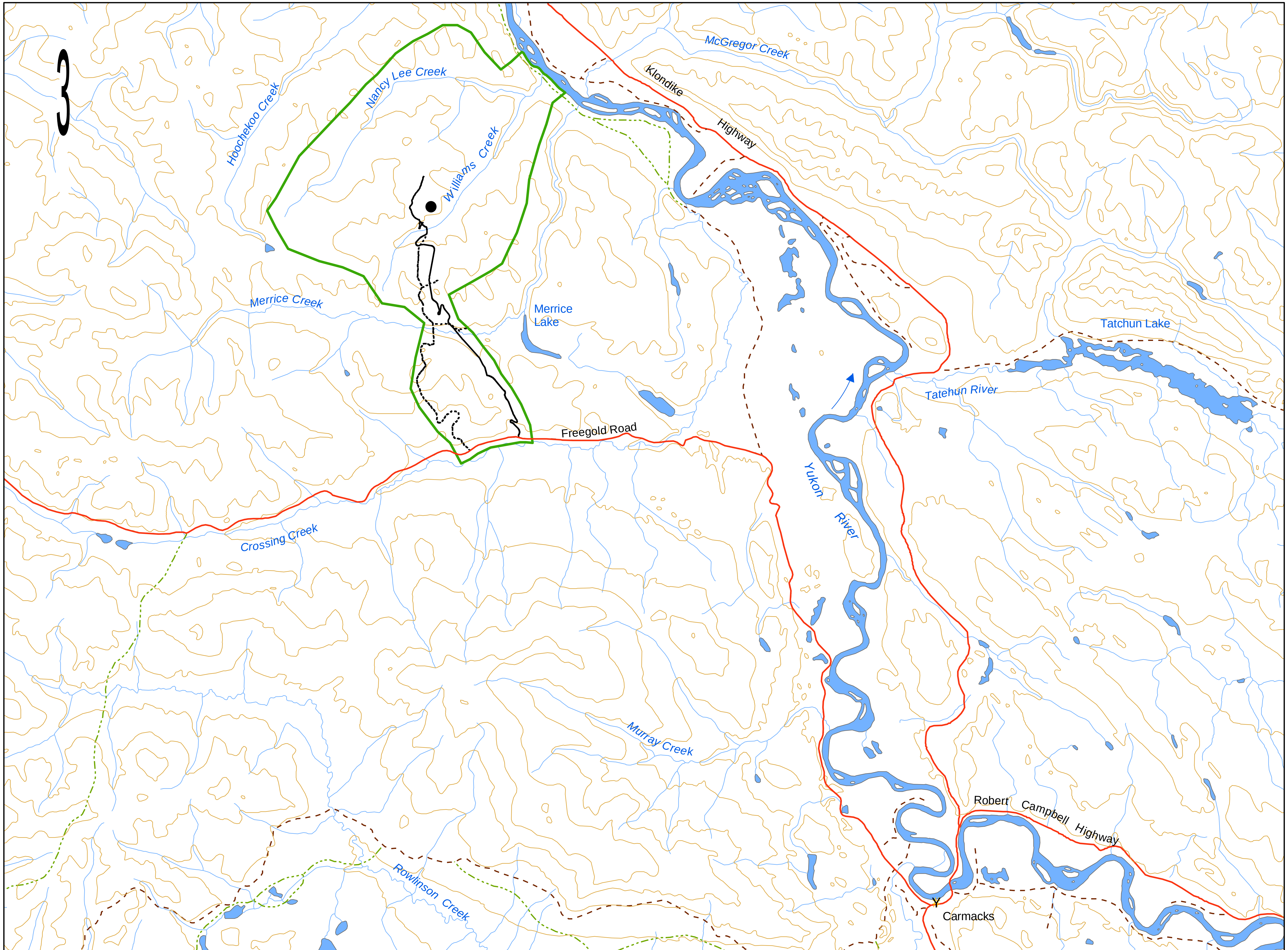
ACCESS CONSULTING GROUP

Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

Drawn By: HD	**Figure 2-1**
Checked By: DC	Date: April, 2005

Our file:D:\Project\AllProjects\WCH-011\GIS\mxd\Fig2_1_Loc.mxd



Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

Legend:

- Town
- Ore Deposit
- Water Course
- Proposed Access Road
- Exploration Road
- Limited-used Road
- Road
- Trail
- Contour
- Water Body
- Environmental Assessment Study Area

UTM Zone 8 NAD83 Meters

Project Area Overview

Figure Number: **2-2**

Scale: 1:150,000

ACCESS CONSULTING GROUP

Drawn by: HD	Checked by: DC
Date: April, 2005	

Our File: D:\Project\AllProjects\WCH-01\gis\mxd\Fig2_2_OV.mxd

Figure 2-3 Approach to Project Development

Project Development
- Understand area history and scope
- Consultation with community and First Nations
- Identify design alternatives and community aspirations
- Establish scope of project and proposed scope of assessment, including spatial and temporal boundaries

Project Characterization
- Establish environment setting and valued ecosystem components
- Undertake discipline specific studies (vegetation, hydrology, hydrogeology, geotechnical and water quality)
- Establish project design criteria
- Continue public and interested parties consultation

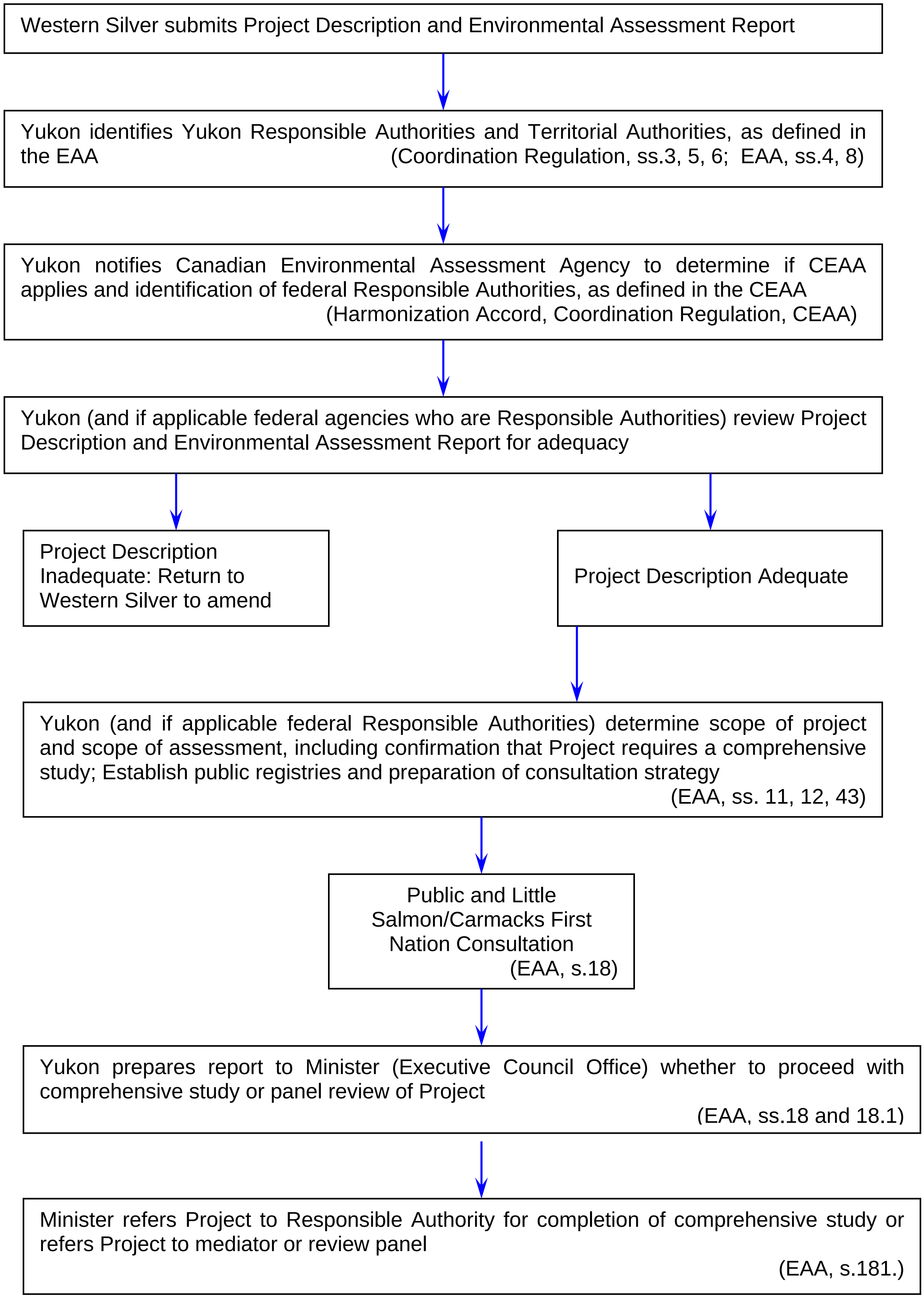
Evaluation/Assessment
- Identify potential environmental effects
- Identify potential human, cultural, and socio-economic effects
- Identify potential public health and safety effects
- Identify project hazardous material and pathways to environment
- Identify potential for accidents and malfunctions and their magnitude and consequence
- Assess potential effects
- Determine significance of potential adverse effects
- Conduct risk assessment
- Outline proposed mitigation measures including environmental and risk management plans; monitoring programs, operating plans; and closure and reclamation plans.

Project Construction
- Employ risk management and environmental management tools to ensure sensitive ecosystems and cultural resources are sustained
- Ensure project final engineering design addresses environmental effects and public concern
- Develop operational plans, procedures, protocols to ensure designs and mitigation plans are implemented
- Ensure that environmental effects are mitigated

Project Operation
- Monitor operational systems and mitigation measures
- Undertake physical and environmental monitoring to ensure system performance
- Ensure compliance with terms and conditions of regulatory approvals

Figure 2-4 Environmental Assessment Process

Part One: Steps Leading to Determination of Comprehensive Study or Panel



Part Two: Completion of EA by Comprehensive Study

Yukon consults with public and government agencies to identify and refine issues of concern; identify adequacy and completeness of information to complete EA

Western Silver addresses information deficiencies, if any identified above

Yukon (and if applicable federal Responsible Authorities) draft comprehensive study report

Yukon (and if applicable federal Responsible Authorities) assess Project for adverse environmental effects; Use of YERC and Technical Committees as appropriate

Yukon consults with public and LSCFN on draft comprehensive study report

Yukon revises draft comprehensive study report in light of comments received; Consultation with Western Silver

Comprehensive Study Report referred to Minister (ECO) (and if applicable to federal Minister of Environment)

Minister considers Comprehensive Study Report and comments submitted on it; determines if public concerns necessitate acquisition of further information or action to address these concerns

(EAA, s.19)

Minister issues environmental assessment decision statement that, taking into account mitigation the Minister considers appropriate, indicates that the project is or is not likely to cause significant adverse environmental effects and need for follow-up program

(EAA, s.19)

Determination that likely to cause significant adverse effects – no action by Yukon unless approved by Commissioner in Executive Council

(EAA, s.33(1.1)

Determination that likely not to cause significant adverse environmental effects – Yukon Responsible Authority makes determination as to effects and enabled (or not) to take action to permit Project to be carried out

(EAA, s.33(1)

Notes:

1. Initial overview may change based on discussions with First Nation government regarding appropriate role in assessment.

2. If federal department is an RA for CEAA then a number of the steps shown will be conducted in conjunction with Canada.
3. Overview assumes Western Silver is Comprehensive Study based on discussions with proponent's agent.

2.4 SPATIAL AND TEMPORAL BOUNDARIES

It is proposed that the approximate spatial boundaries for assessment be based on the potential geographic extent of effect. The spatial boundaries proposed for the assessment of biological environment, physical environment, aboriginal land use, and archaeological and heritage resources are defined in Figure 2-2 as the Environmental Assessment Study Area. The boundary shown in Figure 2-2 is intended to encompass all mine infrastructure including the access road and waterways in the downstream flow path from the mine. The assessment of socioeconomic and economic effects is presented in a regional context, including the Village of Carmacks and the Yukon Territory as a whole. There is also recognition that particular wildlife species are better assessed at a regional context and this has been considered for this assessment.

The temporal boundaries of the assessment are proposed to include the construction, operations, decommissioning and reclamation, closure, and post closure phases of the project:

Construction and Mine Operation	0 – 8 years
Decommissioning and Reclamation, Closure, and Post Closure	8 – 15 years

2.5 REGULATORY APPROVALS

To proceed with the project, licence or permit applications for the following are required:

Type A Water Use Licence	Issued under the Yukon Waters Act, submitted to Yukon Water Board
Quartz Mining Licence	Issued under the Yukon Quartz Mining Act, submitted to YG, Energy Mines & Resources
Explosive Licence (obtained by explosives supplier)	Issued under the Explosives Act and Ammonium Nitrate and Fuel Oil Order, submitted to Natural Resources Canada
Air Emissions Permit	Issued under the Environment Act, submitted to YG, Environment Yukon

It is not anticipated that Department of Fisheries and Oceans (DFO) authorizations will be required for the Merrice Creek bridge crossing. The bridge abutments are not expected to encroach on the creek wetted perimeter and the design is for a clear span bridge. A culvert crossing is planned for the upper Williams Creek road crossing. No fish have been observed in upper Williams Creek based on fisheries investigations. A letter of advice from DFO may be required for the road stream crossing.

While no authorization is required for the *Metal Mining Effluent Regulations,* all effluent, which is discharged from the project, both during operation and at final decommissioning, shall meet the effluent quality standards provided in Schedule IV of the regulations.

Additional information requirements for the Water Use Licence Application are provided at the back of this report in Appendix N.

2.6 PERFORMANCE STANDARDS AND DESIGN CRITERIA

In April 2005, Access Consulting Group, on behalf of Western Silver Corporation, prepared an updated "Performance Standards and Design Criteria Parameters" report, which is included in Appendix C. This document presents performance standards and objectives for environmental protection consistent with industry best practices, and the design criteria and parameters that were used to update the design of the mine facilities. The document has been presented for discussion with government authorities to ensure that regulatory requirements are being met. YG performance standards have been included in Appendix A of the "Performance Standards and Design Criteria Parameters" report. The performance standards and design criteria will guide the construction, operation, and decommissioning of the project, and therefore, the EA and permitting process. Refer to Appendix C for additional information and details.

3.0 PROJECT DESCRIPTION

The following summary has been extracted from the "Western Copper Holdings Ltd., Carmacks Copper Project 1997 Basic Engineering Report" (Basic Engineering Report) prepared by Kilborn in December 1997 and updated as necessary. Figures 3-1 and 3-2 show the general arrangement of the project components and the overall site plan for the facilities, respectively. Figure 3-3 shows a simplified flowsheet of the Carmacks Copper Project process. Drawing 100-13-45 shows the overall site plan at year 2 while Drawing 100-13-08 shows the detailed ultimate overall site plan. Pertinent information from the Basic Engineering Report is summarized below.

- The Carmacks Copper Project is located 46 km by gravel road (Freegold Road and an exploration trail) northwest of Carmacks in Yukon.

- The project site proposed for the development is located within a group of mineral claims covering 1,000 ha.

- The open pit mine will have a stripping ratio of 4.6 tonnes of waste to 1 tonne of ore (4.6:1).

- Mine operations will be carried out using conventional mining equipment.

- The project will treat oxide ore to produce 14,310 tonnes of copper cathodes per year, at a recovery rate of 80%.

- Crushing and heap leach pad loading will take place during 200 days of the year (early summer to late fall). Ore leaching will continue year round with solution heating during winter operation utilizing waste heat from power generation and acid production, if available.

- Active mining is estimated to be for eight years, producing about 60 million tonnes of waste rock, and 13.3 million tonnes of copper ore. For about 300 days each year, the mine will use haul trucks (run of mine ore) or a series of mobile conveyors to place up to 9,872 tonnes per day of crushed ore on a 31.5 ha lined heap leach pad in 8 m lifts.

- Copper in solution will be recovered from the oxide ore by acid heap leaching of crushed minus 19 mm, agglomerated ore.

- Pregnant leach solution (PLS) will be treated in a solvent extraction (SX) plant to purify and concentrate the weak leach solution to a more concentrated solution suitable for electrowinning (EW).

- High purity copper cathodes will be produced in an electrowinning (EW) plant for shipment via truck to the ice-free port of Skagway, Alaska.

- The process facilities, ultimate leach pad, open pit and waste rock storage will occupy an area of approximately 100 ha.

- In addition to the mining and process facilities, the site facilities will include: water supply wells and distribution system, power supply distribution, fire protection, diesel fuel storage, acid storage, sewage treatment, communications system; offices, changehouse, operations camp, gatehouse/first-aid; work shops/warehouse and laboratory.

- Water supply for the project will come from wells in the Williams Creek Valley. The well water and surface run-off collected in settlement ponds located below the WRSA and leach pad and shop area will be the source of process water makeup. During winter, water will be provided by deep wells developed in bedrock below the Williams Creek valley. Water will be pumped to fire/freshwater tanks at the process plant and camp sites for distribution.

- Power will be generated on-site by 5 X 1.6 mW modulized diesel generators complete with heat recovery equipment and electrical/control cubicles. Recovered waste heat will provide hot water, which will be used for process solution and building space heating. Alternatively, Yukon Energy Corporation (YEC) may supply power to the site via a transmission power line.

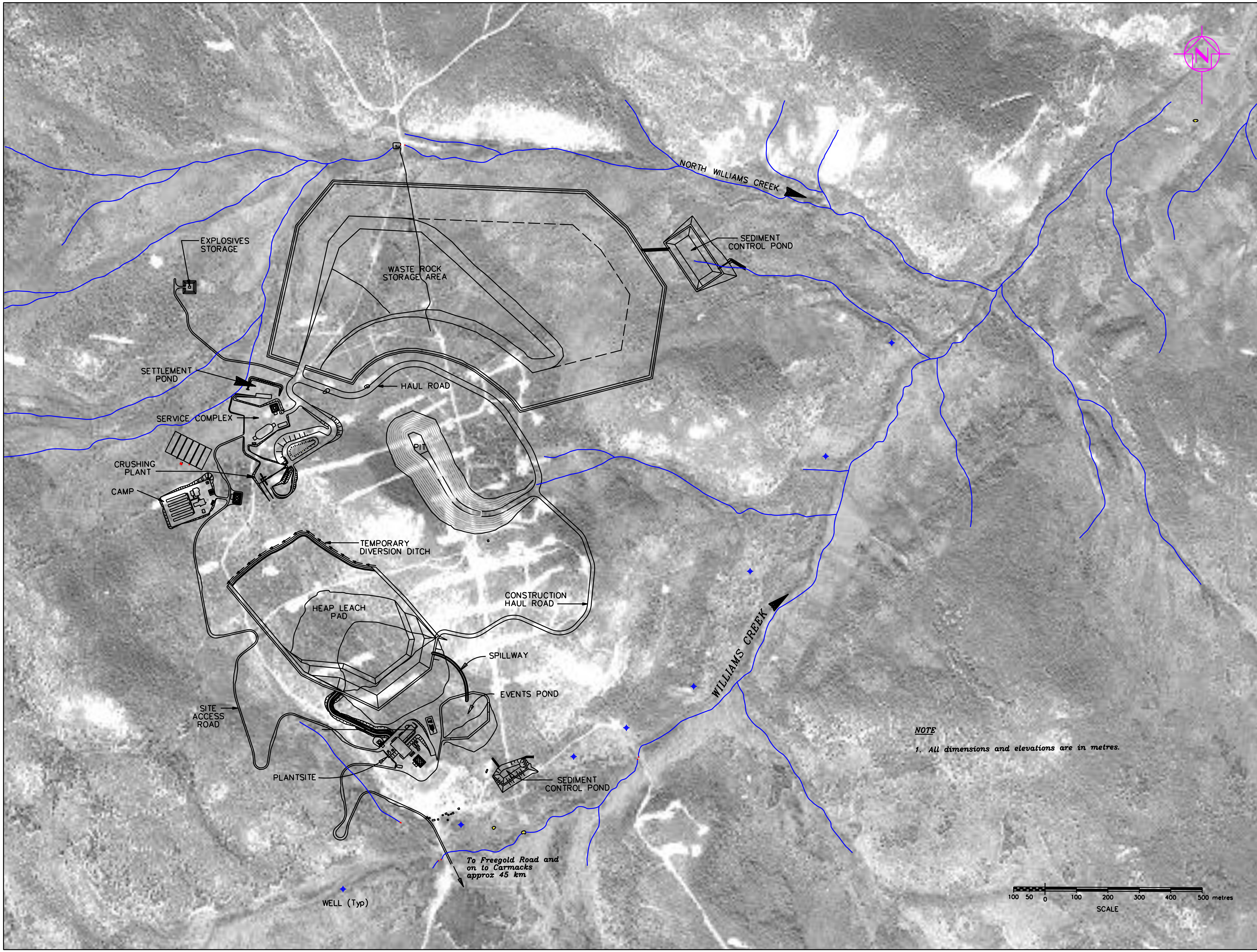
- Sulphuric acid required for the leaching of copper from the ore will be produced at site from a commercial 120 tpd contact catalytic plant. The plant will burn molten sulfur to produce sulfur dioxide which will be converted, via a select catalyst and recirculated with a sulfuric acid stream, to produce concentrated (98%) sulphuric acid. Alternative acid production processes such as biooxidation of agglomerated elemental sulfur are under study and will continue to be investigated.

- The following off-site infrastructure has been included: 13 km of property access road (which has already been cleared and grubbed), and project administration offices and warehousing in Carmacks.

- The project site is located within a region where the average annual total precipitation is 372 mm with evaporation on average 402.4 mm, yielding a net loss of 30.4 mm. The average annual temperature is -5.8^{o}C. There will be no liquid discharges from the process facilities and surface run-off, from disturbed areas, will be collected and treated before discharge.

- Once on the heap, raffinate (a barren acid solution) from the process plant will be applied to the surface of the ore by a system of buried drip emitters. After leaching through the ore, the pregnant leachate solution will be collected in a network of pipes on top of the leach pad liner and flow either directly to the SX/EW process plant or to the events pond below the heap.

- After mining ceases, the heap will be leached for about two more years and covered with an evaporative transpiration soil cover. When the leaching is no longer economical, the heap will be rinsed for about two to three years with water then decommissioned. The solutions in the heap will be neutralized and in-situ biological treatment will be undertaken in the heap to assist in stabilization of metals. Active water treatment using known technology will be used to reduce the heap solution inventory. Water treatment may be required for a period of time after heap neutralization to reach effluent performance standards; however, a long-term passive treatment (infiltration gallery) is proposed for final closure.



Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Knight Piesold Limited, "Overall Site Plan Year 2", Drawing #100-13-45

General Arrangement

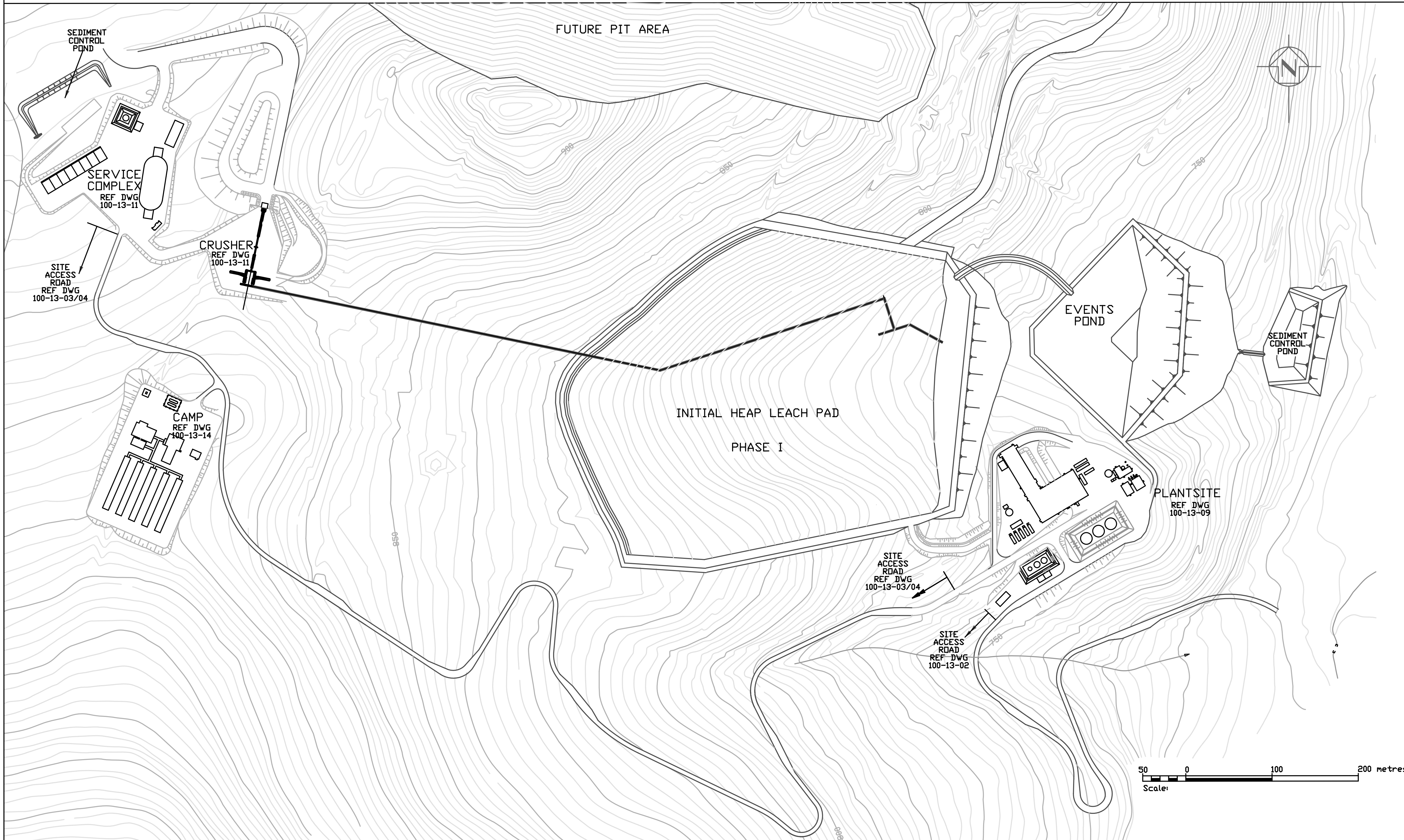
Figure Number:
3-1

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_1_Gen_Arr.dwg



Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Kilborn,
The engineering data on this drawing is solely for the purpose and project for which this drawing is issued.
"Overall Site Plan Pre-Production",
Drawing #700-13-43 Rev C

Overall Site Plan - Facilities

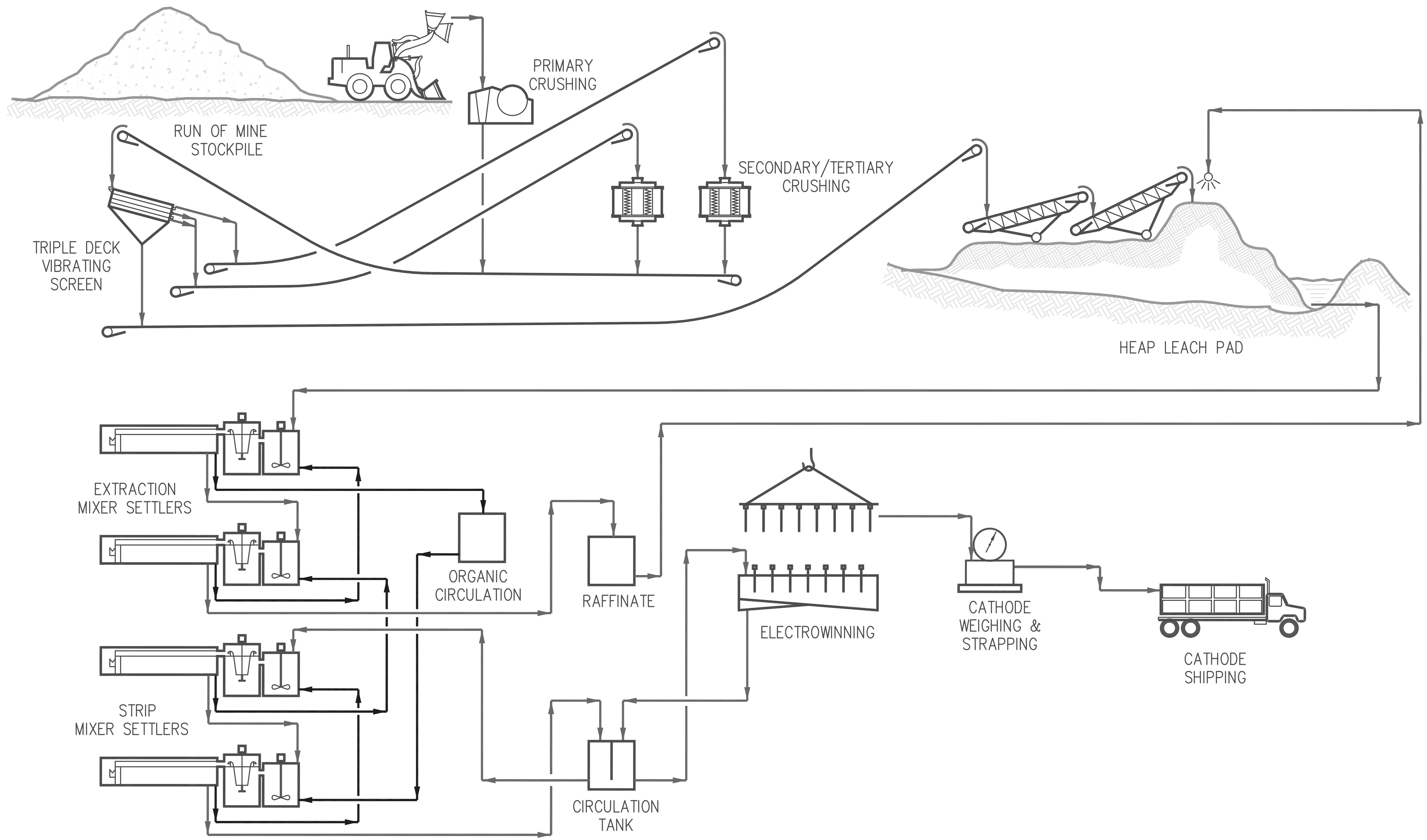
Figure Number:
3-2

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_2_Fac.dwg



Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Kilborn, "Western Copper Holdings Limited Carmacks Copper Project Simplified Flowsheet", Drawing #100-10-02

Simplified Flowsheet of the Carmacks Copper Project Process

Figure Number:
3-3

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_3_Flow.dwg

3.1 BACKGROUND / INTRODUCTION

3.1.1 Location

The Carmacks Copper Project is located in the Dawson Range at latitude 62°-21'N and longitude 136°-41' W, some 200 km north of Whitehorse, Yukon. The project site is located on Williams Creek, 8 km west of the Yukon River, and some 38 km northwest of the Village of Carmacks. The site is accessible by an existing 13 km exploration road that leads north from km 33 of the secondary, government maintained roadway (Freegold Road) from Carmacks. Carmacks, on the Yukon River, is 175 km by paved road north of Whitehorse, which is 180 km north of the year-round port at Skagway, Alaska.

The existing project site exploration road from the Freegold Road will be utilized during the initial development of the project. A new 5 m wide project site access road will be constructed to the east of the exploration road alignment (currently cleared and grubbed). Upgrading of the YG Freegold Road will be required prior to the commencement of the project operations. Discussions have been initiated with YG on their plans for upgrading this road, including the bypass road (also currently cleared) around the Village of Carmacks.

3.1.2 History

In the proposed project area, the first report of copper was made in 1887 and the first claims were staked in 1898 in Williams Creek and Merrice Creek canyons, east of the present Carmacks Copper deposit. The discovery of a copper deposit 104 km northwest of the Carmacks Copper deposit precipitated a staking rush that led to the staking of the Williams Creek property in 1970. During subsequent examinations, the present No. 1 and No. 2 zones were located, followed by 11 additional zones. Figure 3-4, prepared by HKP in 1995, shows the location of the No. 1 zone and the geological reserves in the area.

In the 1970's, exploration of the No. 1 zone consisted of bulldozer trenching, x-ray diamond drill holes, soil sampling, geophysical surveys, and road construction. In 1974, a legal survey was carried out over the key claims that covered most of the known showings, including the No. 1 zone. In the early 1980s, the downturn in copper essentially ended exploration and development.

In 1989, the property was optioned to Western Copper Holdings Ltd (WCHL) and Thermal Exploration Company (TEC). During 1989 WCHL and TEC collected 3 tonnes of surface oxide material for testing of leaching characteristics. In 1990, metallurgical tests were carried out and diamond drill holes were drilled on the No. 1 zone.

During 1991 and 1992 WCHL and TEC conducted major work programs: a total of 3,463.7 m of HQ size diamond drilling was carried out; 3,401 m in 35 holes on the No. 1 zone and 62.7 m in 1 hole on the No. 4 zone. Twenty-one trenches, totalling 1,856.2 m, were cut on the No. 1 and No. 4 zones. An area of approximately 1 ha was stripped at the southern end of the No. 1 zone. A geophysical program, consisting of electromagnetic (VLF-EM) and magnetic surveys, was carried out on a single grid of 62 survey lines, totalling 83.8 km. Baseline environmental studies for fish and wildlife populations and water quality commenced in 1991.

In another major program in 1992, WCHL and TEC carried out work on the Nos. 1, 2, 4, 5, 7, 12, 13 and 2 000 zones and on anomalies elsewhere on the property. Extensive metallurgical testing of drill core from the No. 1 zones was carried out.

A total of 6,520 m of trenching was conducted on the Nos. 1, 2, 4, 5, 7, 12, 13 and 2 000 zones, and for condemnation purposes, over potential leach pad, waste dump and plant site areas. A total of 856.79 m of reverse circulation drilling in 11 holes was conducted on Nos. 1, 5 and 2 000 zones, and on geophysical anomalies found in the 1991 survey. Ten HQ size diamond drill holes, totalling 1, 005.23 m were drilled, two on No. 1 zone, two on No. 4 zone, four on No. 12 zone and two on No. 13 zone. One oriented NQ size triple (split) tube diamond drill hole of 157.19 m was drilled on the No. 1 zone for geotechnical studies.

To summarize, a total of 12,900 m of drilling in 80 diamond drill holes and 11 reverse circulation drill holes has been completed on the property including zones other than No. 1. Several kilometres of surface trenching has been carried out at 30.48 m intervals across the strike, with some trenches excavated along the strike to confirm continuity. Over 25 tonnes of bulk sample was gathered and shipped to Vancouver for metallurgical testing.

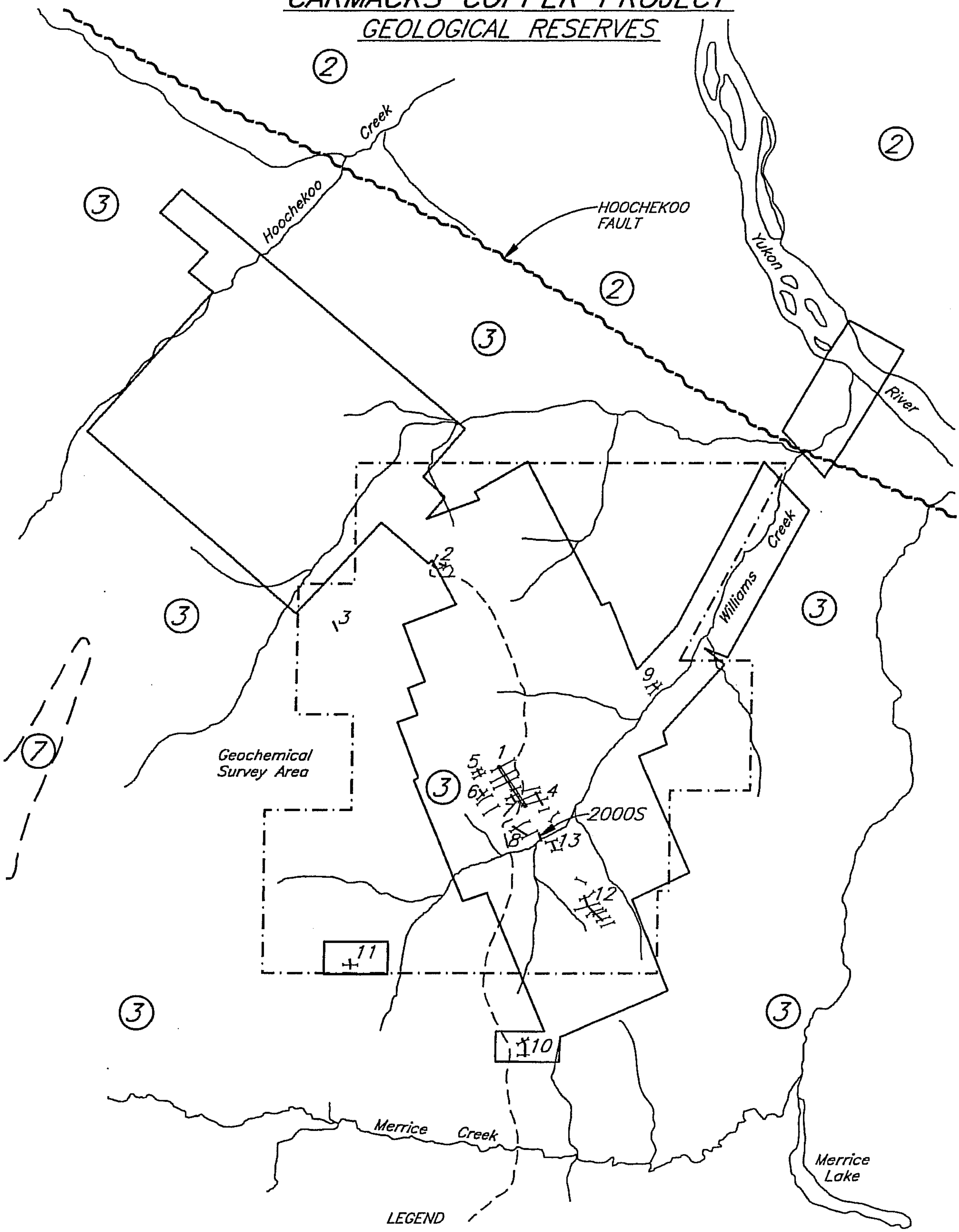
In September 1993, WCHL (Western Silver) contracted Kilborn to carry out a mining feasibility study of the Williams Creek property. In 1994 Western Silver began the permitting process and held preliminary economic development discussions with both the YG and LSCFN. In September 1994 Kilborn returned a positive feasibility study and Western Silver announced their intentions to place the property into production.

Western Silver continued geotechnical and engineering studies under the review process of CEAA from 1996-1998. During 1997 the company cleared the access road, leach pad and plant site and contracted Kilborn to carry out run-of-mine bulk sampling of the zone 1 deposit. Leaching and decommissioning testwork was then carried out by Beattie Consulting Ltd. to provide a basis for predicting copper recovery and neutralization requirements.

WESTERN COPPER HOLDINGS LIMITED

CARMACKS COPPER PROJECT

GEOLOGICAL RESERVES



LEGEND

NOTE: No reserve figures available for zones other than No. 1 zone.

7 Carmacks Group – taff & andesitic basalt flows
3 Granite Mountain Batholith – biotite hornblende granodiorite with feldspar hornblende biotite gneiss
2 Povoas Fm. – andesitic basalt, volcanic breccia, tuff & conglomerate
Zone
No. 1 Deposit
Trench
Geophysical survey area
Property outline

Based on information from
Hallam Knight Piesold Ltd., May 16, 1995

Figure3-4

3.1.3 Geology and Mineralization

3.1.3.1 Regional Geology

The Carmacks region lies within the Intermontane Belt, which in the Carmacks map-area is divisible into the Yukon Cataclastic Terrane, Yukon Crystalline Terrane and Whitehorse Trough.

Units of the Whitehorse Trough lie to the east of the Hoochekoo Fault, east of the Carmacks Copper property. The Whitehorse Trough comprises Upper Triassic intermediate to basic volcanic (Povoas Formation) capped by carbonate reefs (Lewes River Group) and Lower Jurassic greywacke, shale and conglomerate, derived from the underlying Upper Triassic granitic rocks (Laberge Group). The Yukon Cataclastic Terrane includes hornblende-biotite-chlorite gneiss with interfoliated biotite granite gneiss, Permian Selwyn Gneiss, intruded by Upper Triassic Klotassin Suite-Minto Pluton and Granite Mountain Batholith. Weakly foliated, mesocratic, biotite-hornblende, Granite Mountain granodiorite contains screens or pendants of strongly foliated feldspar-biotite-hornblende-quartz gneisses that host the Carmacks Copper deposit.

The Yukon Crystalline Terrane, extensively exposed southwest of the Carmacks Copper deposit, includes quartz-mica schist with quartzite, marble and amphibolite, Early Palaeozoic age and possibly equivalent to Pelly Gneiss, intruded by Cretaceous and Jurassic granites and syenites. Templeman-Kluit (1985) has included Upper Cretaceous Carmacks Group intermediate to basic volcanic and Cretaceous Mount Nansen intermediate to acid volcanic and sub-volcanic equivalents in the Yukon Crystalline Terrane.

Mesozoic strata of the Whitehorse Trough are only exposed in fault contact with the Yukon Crystalline Terrane and Yukon Cataclastic Terrane, but may rest depositionally on them or certain of their strata. The relationship between the Yukon Crystalline Terrane and Yukon Cataclastic Terrane is unknown.

Younger plutonic rocks intrude all three divisions of the Intermontane Belt and the contacts between them. Carmacks Group and Mount Nansen volcanic overlie portions of all older rocks, suggesting that they should not be classified in the Yukon Crystalline Terrane, but are younger rocks that obscure relationships between the older terrane rocks.

The predominant northwest structural trend is represented by the major Hoochekoo, Tatchun and Teslin faults to the east of the Williams Creek property and the Big Creek Fault to the west. East to northeast younger faulting is represented by the major Miller Fault to the south of the Williams Creek property.

3.1.3.2 Property Geology

The Carmacks Copper, copper-gold deposit lies within the Yukon Cataclastic Terrane. The deposit is hosted by feldspathic-mafic gneisses (generally quartz deficient) that form a roof pendant within Upper Triassic hornblende-biotite granodiorite of the Granite Mountain Batholith. The deposit constitutes the No. 1 zone, which is one of 14 defined zones containing copper mineralization known on or in the immediate vicinity of the property.

Granite Mountain granodiorite is massive in appearance, medium to coarse grained and generally equigranular. A weak foliation is present, particularly at or near the hanging wall contact of the gneiss units. The granodiorite has been separated into five divisions; four based on quartz, biotite, hornblende, and K-feldspar contents and a fifth based on assimilated gneiss.

Petrographic examination indicates Granite Mountain granodiorites have a varied mineralogical content with areas of silica under-saturation and plagioclase over-saturation. These variations are probably the result of the assimilation of precursor rocks to the gneiss units.

The general lack or very low quartz content and the high mafic content suggest a volcanic origin for the gneisses. An origin of arkosic sediments derived from a basic volcanic or plutonic regime could also be considered, but the poor continuity of rock units down dip, as demonstrated in Cross-section 1000N, weighs against a sedimentary origin. An andesitic to basaltic pyroclastic volcanic, probably tuffaceous, agglomeratic or breccia precursor rock is considered the most likely.

Post mineralization aplite and pegmatites are common. They range in thickness from a few cm up to 3.0 m. Quartz veins are uncommon and average 2 to 5 cm in thickness. Thin mafic dykes that were feeders for Carmacks Group volcanic are also uncommon. The only copper mineralization in these dykes and veins is non-sulphide secondary copper in aplite and pegmatite.

The deposit, as presently defined, is the No. 1 zone which extends over a 700 m strike length and at least 450 m down dip. The deposit is open at depth. The deposit is a northwest trending tabular body approximately 30 m thick, 0.5 km long and dipping 70 degrees to the east. Figure 3-4 shows the location of the No. 1 zone and the geological reserves in the area.

Copper-gold mineralization at Carmacks Copper is hosted by feldspathic-biotite-hornblende-quartz gneisses. These gneisses have been subdivided into nine categories based on coarseness and biotite-hornblende content. All of the gneisses are silica undersaturated and mafic rich.

The character of the deposit changes along strike leading to a division into northern and southern halves. The northern half is more regular in thickness, dip angle, width and down dip characteristics. The southern half splays into irregular intercalations, terminating against sub-parallel faults down dip. Both the north and south ends of the deposit are offset by cross-cutting faults. The No. 4 Zone is interpreted as the southern offset extension of the No. 1 zone.

In the northern half of the zone, copper grades are higher in the footwall relative to the hanging wall. Oxide copper grades increase with depth in both the footwall and hanging wall. There is no association of copper values with rock type, mafic mineral content or grain size.

Gold values are higher in the north half of the deposit. They average 0.022 ounces gold per ton (0.75 g/t) compared with 0.008 ounces gold per ton (0.27 g/t) in the south half of the deposit. There is no apparent increase in values with depth and the highest grade gold values are not associated with the highest copper values; however, gold values in the northern half are higher in the footwall section. This lack of increase in gold values with depth suggest that the fold distribution reflects a primary distribution rather than a secondary distribution such as oxide copper values. As with oxide copper, gold content does not correlate with rock type, mafic constituents or grain size.

3.1.3.3 Mineralization

The majority of the copper, approximately 86%, in the Carmacks Copper No. 1 zone is in the form of the secondary minerals malachite, cuprite, azurite and tenorite (copper limonite) with very minor other secondary copper minerals (covellite, digenite, djurlite). Other secondary minerals include limonite, goethite, specular hematite and gypsum. Primary copper mineralization is restricted to bornite and chalcopyrite. Other primary minerals include magnetite, gold, molybdenite, native bismuth, bismuthinite, arsenopyrite, pyrite, pyrrhotite, and carbonate. Molybdenite, visible gold, native bismuth, bismuthinite and arsenopyrite occur rarely.

Alteration minerals that could be considered strictly related to the mineralizing event rather than weathering or dyke intrusion are not recognizable. Epidotization and potassium feldspathization are obviously related to pegmatite dyke intrusion which is a post-mineralization event. Clay (montmorillonite type) and sericite development are clearly weathering products. Silica introduction, usually as narrow veinlets, is not common and may be related to aplite dyking or metasomatism. Chloritization of mafics, biotitization of hornblende, rare garnets, carbonates and possibly anhydrite all appear related to metasomatism and assimilation of precursor rocks to the gneissic units.

The upper 250 m of the No. 1 zone is oxidized. Within the oxidized area pyrite is virtually absent and pyrrhotite is absent. Weathering has resulted in 1% to 3% pore space and the rock is quite permeable. Secondary copper and iron minerals line and in-fill cavities, form both irregular and coliform masses, fill tractures and rim sulphides. Primary sulphide minerals and magnetite are disseminated and form narrow massive bands or heavy disseminations in bands. Non-copper sulphides are not common in the weathered zone and are usually intergrown or associated with each other when they do occur. They most commonly occur in hematite but also occur in copper culphides and in the gangue minerals. Gypsum occurs as microveinlets. Carbonate occurs as pervasive matter, irregular patches or microveinlets, not commonly, but on the order of 1% where present. Gold occurs as native grains, most commonly in cavities with limonite or in limonite adjacent to sulphides, but also in malachite, plagioclase, chlorite and rarely in quartz grains. Gold is rarely greater than 5 microns in size.

Secondary copper mineralization does not appear to be preferential to a particular rock type. In the north half of the No. 1 zone, copper mineralization forms high and low grade zones that are reasonably consistent both along strike and down dip and these zones transcend lithologic boundaries. Higher grades tend to form a footwall zone while lower grades form a hanging wall zone.

Primary mineralization, below the zone of oxidation comprises chalcopyrite, bornite, molybdenite, magnetite, pyrite and pyrrhotite. Primary copper mineralization appears to be zoned from bornite on the north to chalcopyrite and finally to pyrite and pyrrhotite on the south. Narrow veinlets of anhydride were found in the deepest drill hole. Refer to Appendix 1 of the IEE Addendum prepared by HKP in 1995 for a Petrographic Report on 21 samples (rocks) collected in the Carmacks Copper deposit area.

3.1.4 Ore Body Modelling

3.1.4.1 Polygonal Model

Polygonal modeling was carried out by first creating polygons in the vertical plane on each section line where trenching and diamond drilling was conducted. These polygons were assigned grades according to the trench or drill hole intercepts. The areas of the polygons were then calculated and distance-weighted with the adjacent sections to give a tonnage between sections. The tonnages were then totaled.

3.1.4.2 Block Model

Geological in-situ resources for the No. 1 zone were calculated by developing a block model and then using three-dimensional kriging.

Two block models were generated, one with 20 foot (6.10 m) high blocks and the other with 30 foot (9.14 m) high blocks. Although greater selectivity of higher grade blocks appeared possible using a 20 foot (6.10 m) bench height, the anticipated increase in mining costs outweighed the possible advantage of selectivity. As a result, only the 30 foot (9.14 m) model was completed and presented herein.

Using GEOMODEL software, plans were generated every 30 feet (9.14 m) vertically from the 1,885 foot (574.55 m) elevation, to a plane 200 feet (60.96 m) above the highest known surface elevation on the No.1 zone. These plans were generated from the cross-sections that were constructed to calculate the geological resource by polygonal method, and were established at the mid-point of each 30 foot (9.14 m) bench. Polygons were then digitized outlining the copper mineralization in gneiss and, separately, the seepage copper mineralization in granodiorite. The two types of mineralization were identified and the polygons were then exported to PC-MINE software.

In PC-MINE software, a block model was constructed with a 30 foot (9.14 m) block height, a 30 foot (9.14 m) block width and a 50 foot (15.24 m) block length. A partial block model was chosen to allow for better identification between copper mineralization in gneiss and seepage mineralization in granodiorite. The partial block model also allowed and undiluted reserve to be calculated. Within the model, separate models were built for waste rock type and density, ore rock type and density, percent ore, total copper grade and variance, gold grade and variance, topography and economics.

Grades for total copper oxide copper were calculated by ordinary three-dimensional kriging based upon the semi-variogram parameters for each type of copper. As the gold semi-variograms were not satisfactory, gold grades were calculated by inverse distance. Multivariate statistics showed that gold had a higher coefficient of correlation with total copper than with oxide copper so the same parameters used for total copper grade interpolation were used for total gold grade interpolation.

Grades were interpolated for each block with the following restrictions:

- Only composite samples within 200 feet (60.96 m) of the block centre were to be used;
- A minimum of three composite samples within the search area were required to calculate a grade for that block;

- A maximum of ten composite samples were used to calculate the block grade and if more were present they were sorted by a distance weighting factor and only the closest ten were used;
- Samples to be used were also restricted by rock type, i.e., only mineralized gneiss samples were used for grade interpolations of gneissic material and only seepage mineralization was used for grade interpolations of seepage copper in granodiorite;
- Any assay sample with an assay reported below detection limits was assigned a zero value;
- Any interval with a missing sample length was left out rather than assigned an average value or zero; and
- All composite samples with zeros were used in the interpolation of grades by kriging or inverse distance.

At various stages, the models were checked to ensure the correctness of rock type assignments and grade interpolations. Cross-sections with drill holes and trenches with 30 foot (9.14 m) composite grades, reserve polygons and block grades were plotted and compared to the model. Complete details are presented in the Basic Engineering Report.

3.2 PROJECT COMPONENTS / STRUCTURES

The following sections describe the various components and structures that comprise the Carmacks Copper Project. Figures showing the main components of the project are provided, and detailed drawings of additional project elements are located in Appendix A.

3.2.1 Open Pit

Mining will consist of a single open pit designed to mine No. 1 zone. The pit will be mined in 12 m benches at an average strip ratio of 4.6 tonnes of waste per tonne of ore. Reserves have been calculated as 13.3 million tonnes at an average grade of 0.97% total copper, at a marginal cutoff grade of 0.29% total copper. The resulting mine life will be 8 years. It is anticipated that a significant portion of the sub grade material that must be removed from the pit will be sent to a low grade stockpile. Depending on economic conditions, this material may be processed at a later date.

The open pit will have a long, narrow NW-SE configuration with a length of approximately 780 m, a maximum width of 450 m, and a depth of 240 m at its deepest point. Figure 3-1 shows the overall arrangement for the open pit plan.

Access to the pit will be provided by a 26 m wide haul road (including width allowances for an inside drainage ditch and an outside barrier) from the crusher along the SW side of the pit. The ultimate ramp on the SW wall will switch back once to the NW endwall.

The main access road provides for a two-way haulage route from the mine to move waste to the waste dumps and the ore to the primary crusher. Waste will be mined from the pit and placed in waste dumps to the north of the pit. All run-of-mine ore production will be directly trucked to the primary crusher and/or to a small surge stockpile adjacent to the crusher.

During the early years of production the operation will generally be focused on the mining and processing of lower strip ratio ore. As the mine progresses, successively higher strip ratio ore will be mined until year 5 and, thereafter decreases to the end of mine life. Ore grade is relatively constant throughout the mine life.

Pit development plans by anticipated year are shown in Drawings 800-05-13, 800-05-14, 800-05-15, 800-05-16, and 800-05-17. Appendix C presents the performance standards and design criteria for the open pit.

3.2.1.1 Pit Slope Design

A geotechnical evaluation of pit slopes has been undertaken by Knight Piésold Ltd. This evaluation is based on geotechnical logging of selected trenches across No. 1 zone and one triple tube diamond drill hole.

Consideration of the slope design included an analysis of potential failure modes. Possible failure mechanisms which have been considered include failure involving structural discontinuities and deep-seated failure mechanisms. In the pit, the potential failure mechanism will be controlled by local structural discontinuities. For pit design purposes, Kilborn has adopted the recommendations of Knight & Piésold for maximum interramp final wall slopes of 55 degrees. Track dozer access to the catchment berms will be maintained to allow removal of accumulated debris.

Refer to the report prepared by Knight Piésold Ltd. in 1993 entitled “Report on Pit Slope Stability” for an evaluation of the stability of the open pit slopes.

3.2.1.2 Drilling

The majority of the waste rock and all of the ore will require mining by drilling and blasting. The near surface waste and topsoil will be ripped by bulldozers for removal.

Drill patterns will be established on benches prepared by a bulldozer equipped with a ripper tooth. The diesel powered rotary drills will drill holes 13.5 m deep with 1.5 m for subgrade, resulting in bench heights of 12 m. Patterns will be laid out initially on a 6 m by 6 m (burden by spacing) square or staggered pattern.

Initially one rotary blasthole drill will be required. As the strip ratio increases and greater pit planning flexibility becomes necessary, a second blasthole drill will be added in year 2.

A track mounted percussion drill will be operated for secondary drilling of hard final wall toes and also for boulders resulting from primary blasting in frozen ground conditions.

3.2.1.3 Blasting

Blastholes will be charged with ammonium nitrate/fuel oil (ANFO) blasting agent by means of a truck mounted ANFO supply and slurry mixing/dispensing unit.

Approximately 30% of all pit blasting is anticipated to be in wet conditions. Eighty-three percent of these holes will be lined with plastic liners to keep the explosive dry, while the remaining 17% will be loaded with a water-resistant slurry.

Non-electric, delayed blasting will be employed. The blasts will be initiated using a safety fuse assembly, detonating cord trunklines, capped nonel primacord downline, and one primer per blasthole. The powder factor is estimated to be 0.205 kg/t. Ore and waste will be blasted separately in order to minimize the amount of ore loss and waste dilution. Blast initiation will take place along strike as much as possible to assist in minimizing dilution.

It is anticipated that ore and waste rock will be well fragmented. As more operating experience is obtained, changes to the drill pattern design and blasting parameters may be required in order to optimize costs and rock fragmentation; the objective will be to provide a consistent minus 600 mm top size product to the crusher.

In order to maintain competent ultimate walls effectively for the life of the mine, experience-based controlled blasting techniques will be utilized.

3.2.1.4 Loading

The equipment units selected for loading will be one 10.7 m^3 diesel hydraulic front end loader (FEL), and one 10.5 m^3 diesel hydraulic shovel. The shovel will be used for waste mining and for bench clean-up to final pit walls. The FEL will load ore. Excess loader capacity will be utilized for; rehandling surge stockpile ore, handling crushed gravel, road maintenance and waste loading.

A rubber-tired dozer will be available for clean-up in loading areas.

3.2.1.5 Haulage

The open pit haulage equipment will be a fleet of used and refurbished 91 tonne capacity, off-highway mechanical drive haul trucks. The trucks will be four pass loaded by either of the loading units, and will be utilized for hauling ore, waste and overburden. Truck requirements start at two units for pre-production stripping and increase to nine units in year 5. Five units are required for year 8.

3.2.1.6 Roads, Dumps and Pit

Pit and mine site roads will be maintained by one of two ripper equipped track dozers, a grader, an excavator, a sand truck in winter and a water truck in summer. The dozer will be available on the waste dump for spotting dumping trucks and for dump maintenance work. A diesel generator powered light stand will provide additional visibility for night shift dumping and dump maintenance work, and for night shift in-pit operations.

The rubber tired dozer will be operated in-pit for shovel and loader face clean-up, and for ramp and toe clean-up. A second, smaller, ripper-equipped dozer will be utilized for breaking out bench face toes, for in-pit temporary and permanent ramp access work, and for catch berm scaling and clean-up.

3.2.1.7 Grade Control

Grade control will be provided by sampling and assaying cuttings produced by the production drills. Preliminary identification of ore limits will be based on exploration drilling. The mine geologist will ensure that the samples are properly taken by the drill operators, identified, and sent to the assay lab.

In order to assist the loading equipment operators in minimizing ore losses and reduce dilution from waste material, an ore control technician will stake digging limits for high grade ore, low grade ore and waste after each blast.

Allowances will be made for blasting displacement as appropriate. Bench elevations will be accurately monitored in order to control digging depths. A lighting plant will be operated as required to help improve visibility for the equipment operators.

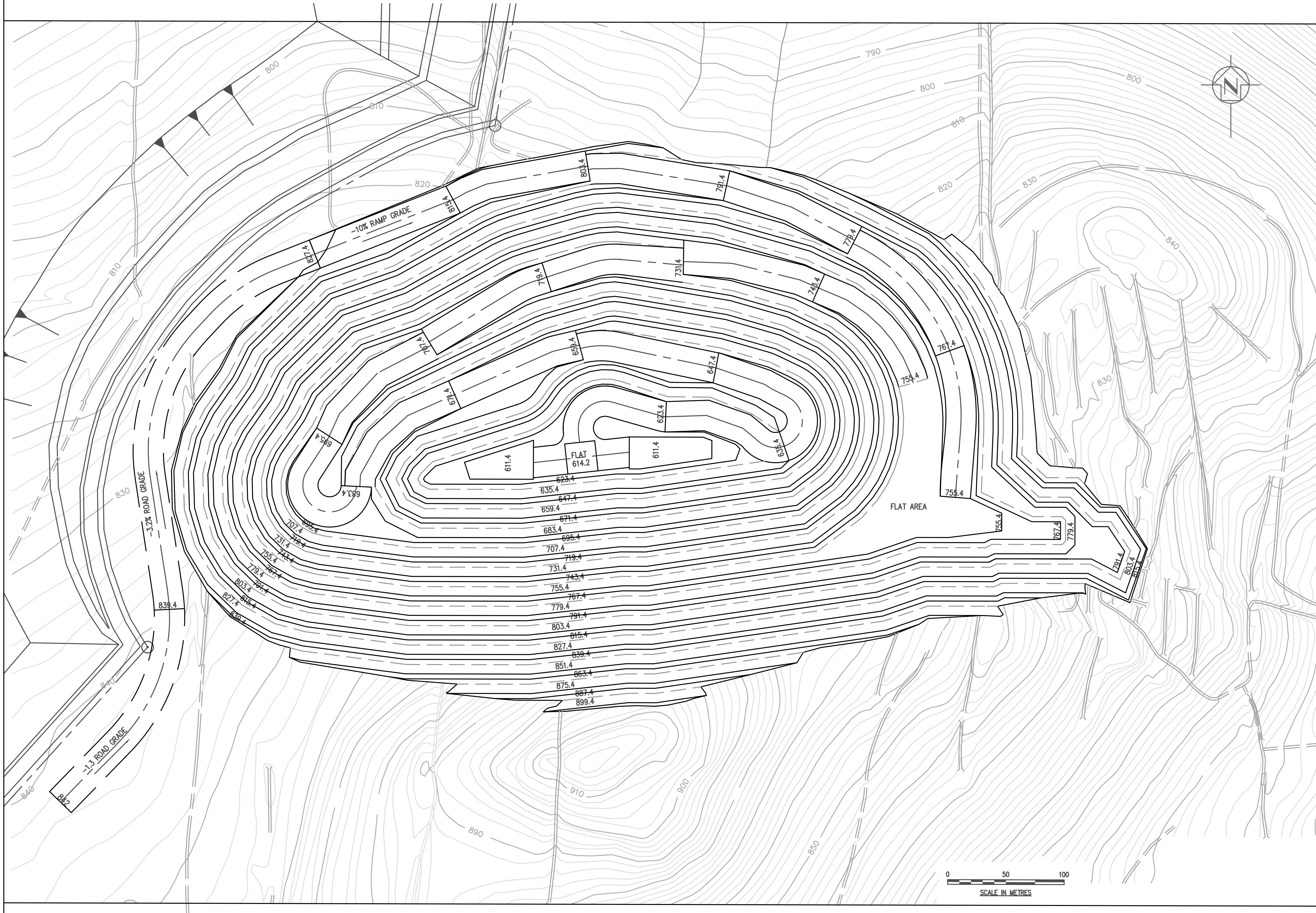
The shift supervisor will be responsible for ensuring that material is hauled to its appropriate destination.

3.2.1.8 Dilution and Ore Recovery

Calculation of dilution and ore loss has been based on the assumption that the total quantity of material within the pit is finite, and losses are caused by the mixing of ore material with waste.

Dilution in the vertical direction will be controlled by mining the ore in 12 m high benches while dilution in the horizontal direction will be minimized by close spacing of production drill holes.

Dilution has also been based on the assumption that there will be some dilution from each adjacent ore/waste contact. The overall dilution factor has been calculated to be 10%. Recovery of the reserve is expected to be 100% at the expense of mining the additional waste dilution tonnage. An average grade of 0.00% Cu has been assigned to the diluting waste.



Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Kilborn,
The engineering data on this drawing is solely for the purpose and project for which this drawing is issued.
"Open Pit Plan End of Year 8 Ultimate Pit",
Drawing #800-05-17 Rev C

Final Open Pit Plan - Year 8

Figure Number: 3-5

ACCESS CONSULTING GROUP

Revised by: HD | Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_5_Pit.dwg

3.2.2 Waste Rock Storage Area

The following information has been included from the “Waste Rock Storage Area Evaluation and Detailed Design Report” prepared by Knight Piésold for Western Copper Holdings Ltd. in June 1997. Refer to Figure 3-6 for an overview of the WRSA.

3.2.2.1 Evaluation of Options

Several options for waste rock dump location, configuration and foundation preparations have been considered in development of the plan for the Carmacks Copper Project. These options include:

a) placing rock on the existing surface on the south side of the valley north of the open pit without any special foundation preparation;

b) stripping the area immediately north of the open pit of its vegetative cover, allowing thaw to begin and providing ditches to transport melt water with and without providing a contingency buffer area around the dump toe;

c) preserving the permafrost in the location immediately north of the open pit by placing an insulating layer of rock on the original ground in winter and later depositing lifts of rock waste on top of the frozen ground year round;

d) constructing of the dump on original ground with a stabilizing berm placed at the toe of the dump and keyed into thaw stable material;

e) constructing the dump across the valley bottom north of the pit using the opposite valley wall to help add stability to the dump;

f) locating the dump at higher elevation in the valley northwest of the pit and north of the heap leach pad;

g) locating the dump south of the pit on steep slopes free of permafrost; and

h) removing potentially thaw unstable material in two locations north of the pit before placing rock in the dump.

A review of the WRSA alternatives and the rationale for selecting the final option is presented in Section 4.3. The option selected for waste rock dump disposal is b) outlined above with a contingency buffer zone which allows further consideration of option d) if required at a later date. The selected option is briefly summarized below and described in detail in the “Report on Detailed Design of Waste Rock Storage Area” prepared by Knight Piésold in May 1997. This report includes detailed design drawings consideration of foundation preparation, dump sequencing, contingencies for increased stability, water balance and water management, stability analysis, proposed monitoring, and an outline of reclamation proposed.

3.2.2.2 Design Objectives

The principal objectives for the design of the WRSA are as follows:

- Provide a geotechnically stable and cost-effective configuration for staged waste rock storage with particular attention to permafrost and foundation conditions;

- Minimize potential effects to the groundwater system and surface runoff flows during the life of the mine operation and in the long term by providing collection ditches and a sediment control pond;

- Develop the facility in stages to allow for ground thawing and drainage;

- Incorporate field observation and performance monitoring during the initial stages of waste rock placement to ensure on-going stability and performance of the waste rock storage area; and

- Provide adequate contingencies to deal with localized instabilities which may arise from areas of potentially thaw unstable foundation.

3.2.2.3 Design Basis

The following assumptions were made for the final design of the WRSA;

- A design capacity of 60 million tonnes placed at 2.0 t/m^3;

- Annual waste rock production of approximately 7.5 million tonnes;

- Hauling and placing of mine waste rock occurs year round;

- Placement of waste material in maximum 25 metre lifts by end-dumping from the face of an advancing lift; and

- Material waste comprised of coarse, durable granodiorite and biotite gneiss rock types.

The following design parameters have been used for the design of the sediment control pond for the WRSA:

- Provide storage for the 1 in 10 year 24 hour storm event; and

- Provide a spillway that can safely pass the 1 in 200 year 24 hour storm event.

3.2.2.4 General Arrangement

The waste rock storage area is located immediately north of the open pit on a gentle, north-east facing slope. The general arrangement for the waste rock storage area and sediment control pond is shown on Drawing 1784.301. The WRSA covers an area of approximately 70 hectares and is designed to provide for permanent, secure storage and total confinement of the mine waste rock. This particular site was chosen to minimize the haul distances from the pit and also to minimize any potential effect on existing surface drainage courses. The design includes surface drainage ditches to drain the footprint of the waste dump. Surface runoff and seepage from the WRSA will be collected in perimeter collection ditches located at the toe of the facility and transported via the WRSA outlet channel to the sediment control pond.

For additional design information, the reader is referred to the “Report on Detailed Design of Waste Rock Storage Area” (KP, 1997). Further details on the characteristics of the waste rock are presented in Section 3.6.3. The performance standards and design criteria for the WRSA are provided in Appendix C. Drawings 1784.301 and 1784.302 show the WRSA foundation preparation plan and the WRSA sections and details, respectively.

3.2.3 Heap Leach Operation

The heap leach facility has been designed for the valley heap leach method, which involves the preparation and placement of leach ore behind a confining embankment. Leaching of the ore is performed with subsequent lifts progressing up slope. Solution storage capacity is provided in an external solution pond designated the events pond, which is located down gradient from the heap leach pad. The valley heap leach method was selected for use in steep terrain and for severe climatic conditions. Drawing 1785.202 provides an overall rough grading plan for the heap leach facility.

Solutions from the leach pad will be collected by a network of solution pipes within the overliner and conveyed to the events pond and/or directed to the process plant via gravity flow solution pipes. The design includes an events pond with a high integrity engineered double composite liner system with a leak detection and recovery system (LDRS) located downstream of the heap leach pad.

The events pond is connected to the leach pad via gravity flow solution pipes and a double lined spillway. Diversion ditches collect and convey runoff around the facility to a sediment control pond.

Details of the leach pad water balance and the determination of design solution storage volumes are presented in the Clearwater Consultants Ltd. Design Memorandum CCL-CC4, and Section 3.5.1.2 of this report.

The operation of loading the heap and leach solution handling described below includes: the raffinate distribution, PLS collection, interconnecting piping, the heap stacking sequence, solution management and the liner system preliminary design. The design and siting of the heap leach pad, retaining embankment and event ponds below the heap were undertaken by Knight & Piesold, and more recently by EBA. Refer to Appendix D for the document entitled “Carmacks Copper Mine Heap Leach Pad Liner Design” prepared by EBA for details on specific engineering components.

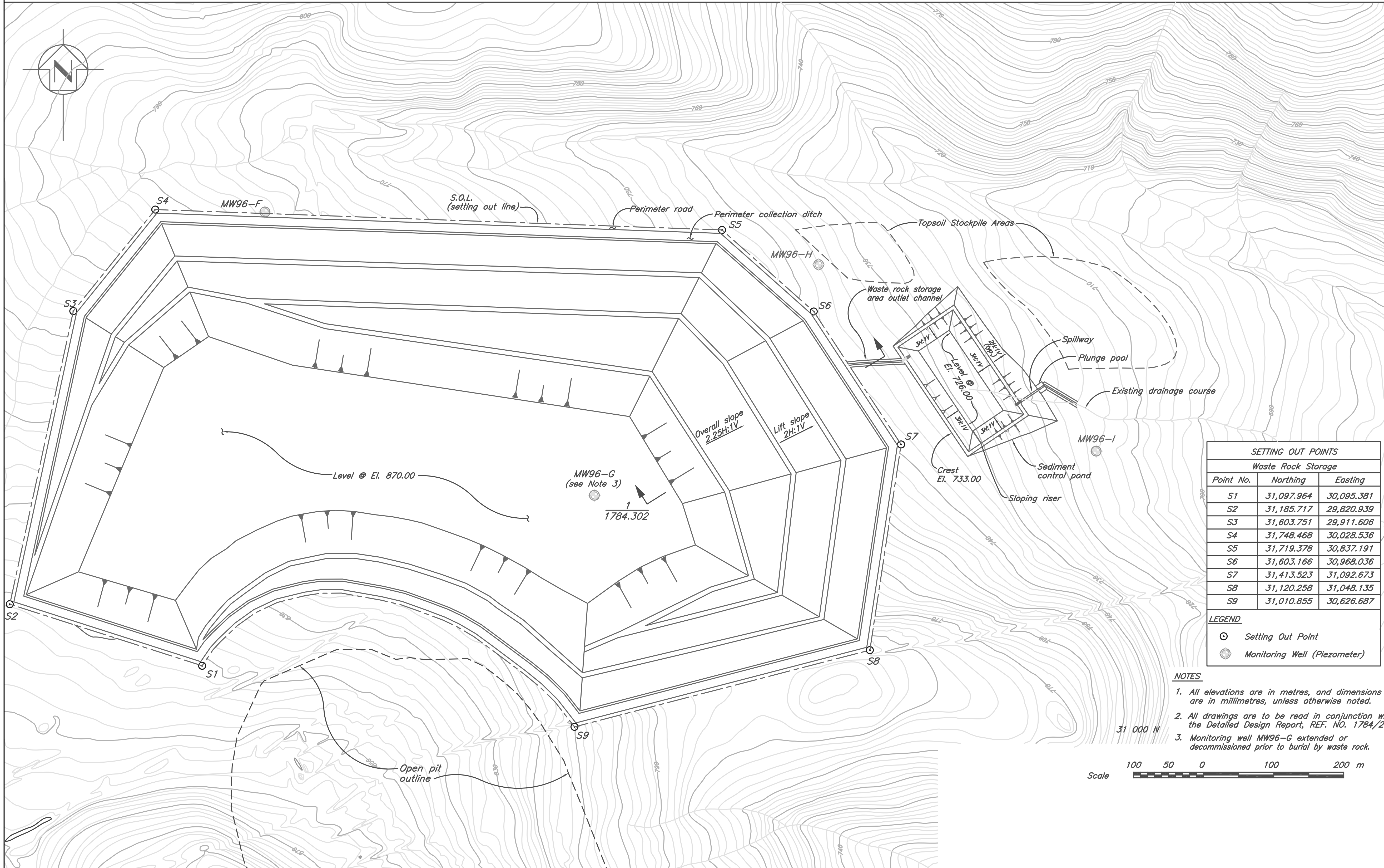
Figure 3-7 shows the heap leach pad conveyor layout.

Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION



SETTING OUT POINTS		
Waste Rock Storage		
Point No.	Northing	Easting
S1	31,097.964	30,095.381
S2	31,185.717	29,820.939
S3	31,603.751	29,911.606
S4	31,748.468	30,028.536
S5	31,719.378	30,837.191
S6	31,603.166	30,968.036
S7	31,413.523	31,092.673
S8	31,120.258	31,048.135
S9	31,010.855	30,626.687

LEGEND

⊙ Setting Out Point

Monitoring Well (Piezometer)

NOTES

1. All elevations are in metres, and dimensions are in millimetres, unless otherwise noted.
2. All drawings are to be read in conjunction with the Detailed Design Report, REF. NO. 1784/2.
3. Monitoring well MW96–G extended or decommissioned prior to burial by waste rock.

Original drawing from Knight Piesold Limited, "Waste Rock Storage Area Final Arrangement", Drawing #1784.300

Waste Rock Storage Area

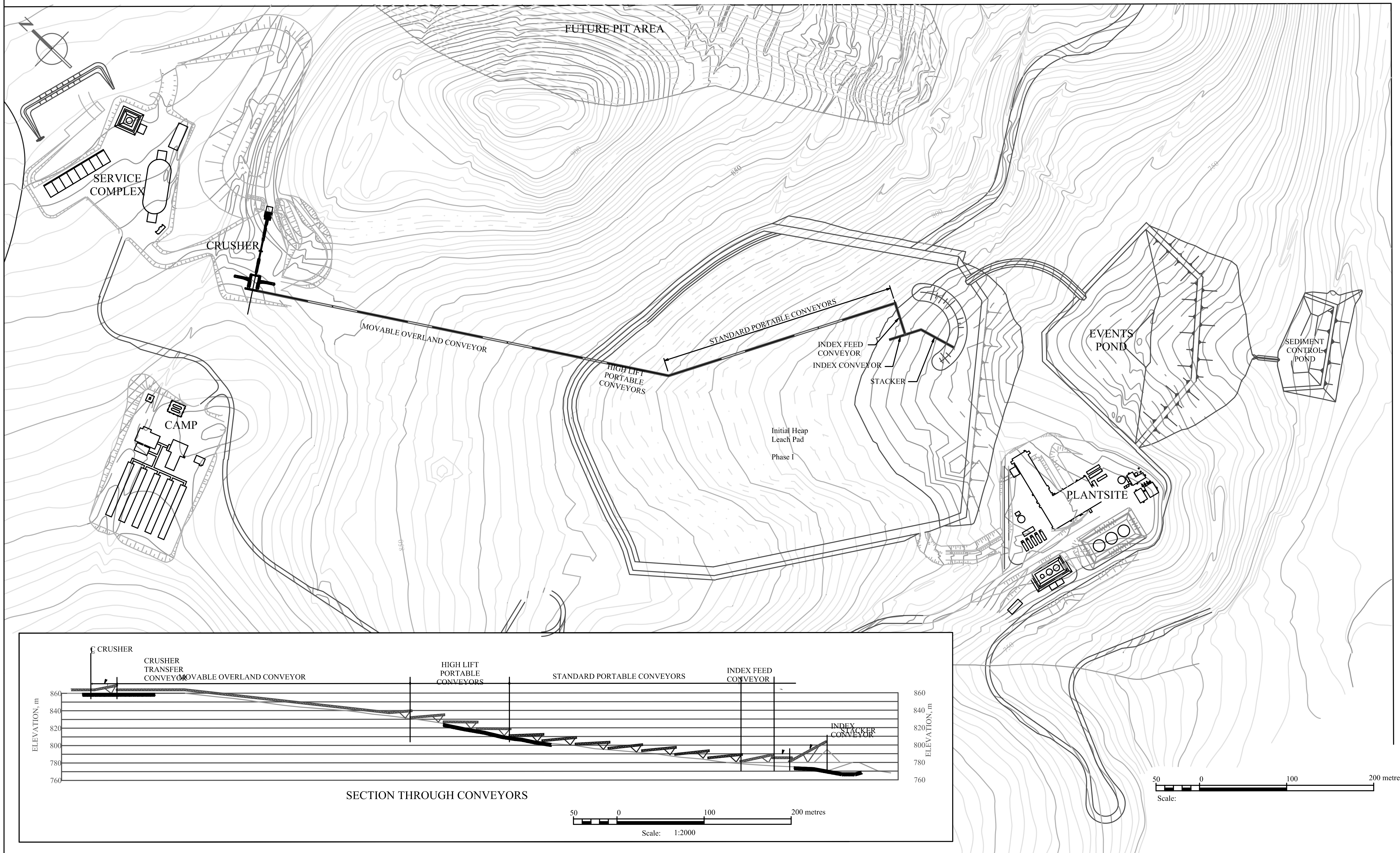
Figure Number: **3-6**

ACCESS CONSULTING GROUP

Revised by: HD | Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_6_WR.dwg



Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Kilborn,
The engineering data on this drawing is solely for the purpose and project for which this drawing is issued.
"Heap Leach Pad Conveyor Layout
Initial Phase Plan and Section - Year 2",
Drawing #700-10-03

Heap Leach Pad Conveyor Layout

Figure Number:
3-7

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_7_HLP.dwg

3.2.3.1 Design Basis

The heap will be designed to store approximately 13.3 million tonnes of ore at a dry density of 1.6 tonnes/m^3. The ore density may be higher in the later years of operation due to consolidation under load, possibly reducing the size of the final pad expansion. The leach pad could be expanded beyond this capacity to the west or the height could be increased. Ore will be placed for eight years at a maximum rate of 9,872 tonnes per day for up to 200 days per year. The 31.5 ha leach pad will be constructed in three stages ahead of ore placement. Ore will be placed in 8-m lifts at an overall slope of 2½h:1v using haul trucks. It is anticipated that two years of residual leaching, three years of heap rinsing and eventual decommissioning will follow the eight years of ore placement.

The raffinate will be applied through a system of drip emitters at a rate of 0.204 litres/min/m^2. The total raffinate flow to the heap will be 540 m^3/hr for a design leaching cycle of 120 days. Solution will not be stored within the heap but will drain through perimeter piping and a low level outlet to the process plant or the events pond.

3.2.3.2 General Arrangement

The ore will be placed on the valley-fill heap in 8-m lifts by haul trucks and leached in subsequent lifts, progressing up slope and atop previously leached lifts. Storage for excess solution and extreme precipitation events will be provided in an events pond located down gradient from the heap.

The proposed leach pad will be lined with a double composite liner system with LDRS. The pad will be surrounded by a 2-m high perimeter berm on the north and west sides and a perimeter bench on the east side. A confining embankment will form the lower limit of the leach pad to support the heap. With a crest elevation of 780 m, it will be about 22 m high and 350 m long.

There will be no in-heap solution storage behind this confining embankment. Solution from the heap will be collected by a network of corrugated polyethylene tubing (CPT) above the leach pad liner and conveyed by gravity flow to the process plant. There will be a double lined spillway over the heap confining embankment to the events pond to convey solution during extreme precipitation events. Diversion ditches will collect and convey runoff from upslope of the heap leach facility to a sediment control pond, thereby reducing the quantity of water reporting to the heap and minimizing PLS dilution.

3.2.3.3 Foundation Preparations

<u>Pad Grading</u>

Most of the organics and topsoil were stripped from the foundation area in 1996. At the start of construction, any remaining windrows or piles will be removed and the area will be rough graded. Site preparation activities at this time will include:

- completion of a drilling investigation to delineate any potential unstable soil and assess suitability for soil liner material;

- removal or treatment of the unstable/unsuitable soils and controlled fill placement to subgrade elevation;
- in areas cut to subgrade elevation – scarification, moisture conditioning, and compaction of the subgrade level soils to depth of at least 300 mm;
- proof-roll of prepared subgrade; and
- construction of the liner.

As part of the pre-construction investigation, soil samples representative of the subgrade will be taken and tested for particle size, plasticity indices, and natural moisture content. There will also be enough control tests to relate the index properties and visual characteristics of the subgrade soils to the expected permeabilities. From the test results, the subgrade soils are to be classified as follows:

- Soil Liner Material - permeability of 10^{-8} m/s or lower. This material will satisfy the grading requirements for soil liner material, and will be suitable for compaction;
- Random fill – permeability greater than 10^{-8} m/s. These materials will be used selectively for site grading below the depth of any proposed soil liner or uses as appropriate in zoned earthfills based on grading requirements; and
- Waste Materials – waste materials will include organic rich materials, potentially unstable materials or any other materials deemed deleterious. These materials will be excavated and hauled to a designated waste stockpile.

All potentially thaw-unstable materials within 5 m of the ground surface that are identified during the delineation program will be excavated. Excavations deeper than 1 m below final subgrade will be filled to 1 m below final subgrade with acceptable rock fill, then filled with soil liner material. These materials will be placed and compacted as subgrade. Further details will be provided in a QC/QA Manual.

Areas where potentially thaw-unstable materials are deeper than 5 m will be assessed individually and specific treatments developed.

<u>Foundation Drainage</u>

A foundation drainage system will be installed beneath the leach pad to intercept and remove near-surface and seasonal groundwater flows and to reduce the possibility of uplift pressures beneath the liner. The foundation drains will be installed at least 1.5 m below the prepared subgrade surface and will comprise perforated CPT surrounded by select drain gravel and wrapped in geotextile. The select drain gravel will provide continued foundation drainage in the event of blockage or collapse of the CPT. The drains will be located in the natural drainage swales and extended to intercept any springs, seeps, or damp spots identified during pad grading and mapping. These drains will convey any intercepted groundwater seepage under the embankment to a foundation drainage collection sump located at the toe of the confining embankment. Flow into the sump will be tested periodically. If its quality is acceptable, it will be discharged below the events ponds; otherwise, it will be discharged into the events pond.

Once the foundation drains are installed they will be covered by compacted soil liner material and the double composite liner system. The upslope ends of the main collection pipes extend beyond the limits of the pad area through solid CPT pipe so they can be periodically flushed with dye-traced water to verify operation of the drain. The ends of the pipes will be capped to prevent animals from entering the pipe and to prevent icing. If blockage of the CPT is suspected an attempt will be made to pressure clean with water or mechanically clean the tubing. Given the redundant drainage provided by the surrounding drain gravel, no further attempt to recover the CPT installation will be made if cleaning is unsuccessful.

Perimeter Berm and Bench

The perimeter bench on the east side of the leach pad will be wide enough for the access road perimeter diversion ditch, perimeter piping and sumps, and the liner anchor trench. The perimeter berm on the north and west sides of the pad will incorporate the liner anchor trench and perimeter piping and sumps. The perimeter road and diversion ditch will be outside of this berm. The berm and bench will separate the surrounding diverted areas and the heaped ore. A channel, formed by the depression between the perimeter berm or bench and the sloping ore, will convey surface runoff from the heaped ore to the perimeter sumps. From there, it will be piped to the plant or events pond.

3.2.3.4 Liner System

General

The entire leach pad and the uphill face of the confining embankment will be lined with a double composite liner with an integral LDRS. Three separate designs are envisioned with protection for the environment appropriate to the potential for leakage in any given zone: these zones have designated as the upper works, lower works and trenches.

The upper works comprise the upper portion of the heap leach pad, at elevations greater than 830 m. In this zone, the base slope exceeds 7:1 with a consequence that PLS flow velocities are high and hydraulic heads are low.

The lower works comprise the lower portion of the heap leach pad adjacent to the confining embankment. In this zone, PLS velocities are low and the hydraulic head will approach 1.0 m. Therefore, there is a potential for higher leakage rates through the primary liner in this area.

The trenches are constructed in the LDRS to move PLS laterally. In the trenches, PLS velocities will be high but, because these are the collector system for the LDRS, the hydraulic head will also be high. There is therefore a higher potential for leakage of the primary liner in this area.

Subject to the results of product specific laboratory testing of the liner system, the components of the liner system for the upper and lower works will generally comprise the following:

Upper Works

The upper works liner system comprises (listed from the top down):

- High-permeability, durable overliner cushion layer with solution collection piping;
- 60 mil textured HDPE upper liner;
- LDRS comprising a high transmissivity tri-planar geocomposite;
- 60 mil textured HDPE lower liner; and
- Subgrade (with foundation drains).

Lower Works

The lower works liner system comprises (listed from the top down):

- High-permeability, durable overliner cushion layer with solution collection piping;
- 60 mil textured HDPE upper liner;
- LDRS comprising a high transmissivity tri-planar geocomposite;
- 60 mil textured HDPE lower liner;
- Compacted lower soil liner with a permeability not greater than 10^{-8} m/s; and
- Subgrade (with foundation drains).

Trenches

The trench design profile comprises (listed from the top down):

- High-permeability, durable overliner cushion layer with solution collection piping;
- 60 mil textured HDPE upper liner;
- 12 oz nonwoven polypropylene geotextile;
- Drainage layer comprising durable crushed ore or sand and gravel with permeability of at least 5×10^{-4} m/s and solution recovery piping;
- LDRS comprising a high transmissivity tri-planar geocomposite;
- 12 oz nonwoven polypropylene geotextile;
- 60 mil textured HDPE lower liner; and
- Subgrade.

The components of the various liner designs are further described as follows:

Subgrade

The subgrade will be suitable in-situ material that has been scarified and recompacted, or borrow material imported to backfill excavations of unsuitable material as described above. The design criteria for subgrade are:

- Random fill as defined in the technical specifications; and
- Maximum particle size equal to 75% of the approved layer thickness.

Soil Liner

Lower Works
Laboratory tests and correlations with index properties will confirm that the liner material meets the required permeability criterion of 10^{-8} m/s. These will be described in the QA/QC manual.

The soil liners will be compacted with a smooth drum vibratory roller in lifts of less than 150 mm, with careful inspection of the soil surface to ensure the removal of any stones larger than 10 mm under strict quality control. The liner installer will certify acceptance of the final surface as part of the QC and warranty process.

Upper Works
Beneath the upper works, subgrade preparation will require sufficient effort to remove any organic materials, provide a competent base and prevent rock fragments and gravel

from puncturing the lower geomembrane liner. Product-specific laboratory testing under expected loads will dictate the maximum allowable particle size and final methods of subgrade preparation for the upper works.

Textured HDPE Liner

Both geomembrane liners will be 60 mil textured HDPE. Careful manufacturing quality control and construction quality assurance will confirm the specifications are achieved.

Leak Detection and Recovery System

An LDRS will be constructed using a high flow triplanar geocomposite. The geocomposite utilizes a tri-planar structure with rigid vertical ribs that significantly increase the tensile strength and compressive resistance of the geocomposite. These ribs are also supported by structural planar ribs that reduce intrusion into the high flow drainage core. The LDRS will be subdivided into cells of appropriate size to allow for solution management in each pad area.

Geotextile

A 12 oz, non-woven, needle punched geotextile will be used as a separation and filtration layer in the trenches (“French drain”).

Overliner

A maximum 1.0 m thick layer of processed, durable crushed ore or sand and gravel will cover the upper HDPE liner to protect it from puncture under ore loading and to promote the effective under-drainage and collection of PLS from the ore. The design criteria for the overliner are as follows:

- Maximum particle size of 19 mm to prevent liner puncture, unless specific testing shows a larger size is acceptable;
- Durable, hard rock resistant to acid degradation; and
- Permeability of at least 5×10^{-4} m/s to enhance PLS recovery and to minimize hydraulic head on the upper liner.

Within the overliner, there will be a network of pipes to collect the solution within the overliner and transfer it to either the process plant or the events pond. This system of solution recovery piping also will reduce the hydraulic head on the upper liner. As within the LDRS, the overliner will be subdivided into cells of appropriate size to allow solution management above the liner.

Leakage Criteria

Previous leakage criteria used in the Yukon were reviewed to develop the liner design. These criteria require an allowable leakage rate into the LDRS of 100 L/day averaged over a twelve-month period, with a maximum of 300 L/day averaged over a 3-month period. Initially, because of the lack of a defined area in the criteria, we used the leakage rate to define the largest detection “cell” that could be allowed in the design.

At the outset of EBA’s design, it was believed that the design criteria could be accommodated with a conventional double-lined geomembrane system, commonly used in hazardous waste impoundments in low precipitation situations. However, when we apply accepted design standards for the geomembrane as proposed by Giroud and Bonaparte (1989) and updated by Maxxon and Feeney (1993), the leakage into the LDRS required a large number of cells to be constructed to remain below the leakage criteria.

The permeability of the various layers used in the design is as follows:

- Overliner: k> 5 x 10^{-4} m/s;
- Textured HDPE liners: k< 1 x 10^{-10} m/s (permeability controlled by construction defects);
- LDRS: k> 1 x 10^{-4} m/s; and
- Soil liner: k< 1 x 10^{-8} m/s.

Liner Terminations

All HDPE liners will be terminated in anchor trenches. These trenches will be either permanent trenches along the perimeter berm, bench and embankment, or temporary trenches on the edges of pad extensions. The design criteria for the trenches are:

- to ensure water cannot enter drainage systems by seeping through the trench backfill; and
- to provide adequate anchoring resistance to withstand the pullout forces generated by gravity and thermal expansion and contraction of the HDPE geomembranes.

Frost Protection

To protect the soil portion of the leach pad liner from frost damage, the liner will be covered with at least 4.5 m of ore and overliner prior to winter. At least 1.5 m of ore will provide frost protection of the active drip emitter pipes, with exothermally-generated heat from the leaching process, solution heating, and snow insulation providing the remaining protection.

Geotechnical Instrumentation

Geotechnical instruments will be used to monitor and confirm design assumptions and performance of the solution collection system, perimeter berms and heap confining embankments. They will include permanent surface movement monuments on the system embankment crest, and piezometers within the pad foundation, overliner and confining embankment. All piezometers will be monitored regularly but will not form a requirement for continued operation of the facility should they cease to function.

Leach Pad Settlement

Leach pad settlement could potentially result from several sources – thaw of ground ice in permafrost, and subsequent consolidation of thawed soils from overburden pressure; and elastic compression of coarser-grained soils, and consolidation of fine-grained soils due to vertical loads imposed by the heap.

The design criteria for the leach pad settlement are as follows:

- Differential settlements will not compromise the integrity of the liner system;

- Tensile strains of less than five percent in the synthetic and soil liner systems will be maintained;
- Positive drainage of foundation drains and LDRS and PLS collection pipes will be maintained by "overbuilding". All drainage grades and locations will be determined with an allowance for settlements of the foundations; and
- Pipe joints will be capable of sustaining settlement-induced tensions without separation.

For additional design details on the liner system please refer to EBA's "Heap Leach Pad Liner Design" report in Appendix D.

3.2.4 Events Pond

Normally, solution will flow directly from the heap to the plant. When there is a high-rainfall or high-precipitation event, or when the plant cannot accept solution, the flow can be directed from the heap to the events pond. The events pond will have a capacity of approximately 160,000 m^3 to store the following combinations of events:

- The operating solution volume, plus
- Excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus,
- An allowance for heap draindown as follows:
  - During the first year of operation, 100% of the total potential heap draindown volume, or
  - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m^3/hr this volume is 26 000 m^3; and
- Redundant systems (i.e. pumps, power, spare parts).

The total available solution storage volume of 160 000 m^3 will provide storage for 100% of the total potential draindown volumes in the winter months. This volume is calculated to be 22,000 m^3 more than the maximum required solution storage volume (Clearwater Consultants Ltd., 1998). At the start of the winter season and until the start of the snowmelt every year, the events pond will be empty thereby ensuring that the full solution storage capacity of the system is available during the winter and in advance of the annual snowmelt. Therefore, 100% of the total potential draindown volume may be stored in the winter at all times throughout the mine life for all precipitation conditions.

The events pond comprises: installation of a foundation drainage system independent of the leach pad system, a prepared basin surface, construction of an earthfill confining embankment, and lining of the basin facility with a double composite liner system with LDRS. The events pond area will be stripped of vegetation, down to mineral soil. The basin will be shaped, and the subgrade will be prepared to a smooth surface, free of protruding rocks, roots, etc. which could damage the liner. A zoned confining embankment will be constructed using similar materials defined for the leach pad confining embankment.

The engineered liner system for the embankment is comprised of two synthetic roughen HDPE 60 mil liners placed on a prepared soil liner and separated by a plastic geonet for an integral LDRS. The LDRS will recover leakage along the low point of the embankment toe from a collection pipe and ditch which will drain to a sump.

The removal of solutions from the LDRS is accomplished by a submersible pump at the bottom of the sump comprising a sloping riser pipe located between the two liners on the confining embankment. The pump will be activated by level switches to prevent the build-up of water in the LDRS. The flow from the pump will be continuously monitored.

Leakage rates through the inner and outer liners were estimated and presented in KP's "Report on Updated Detailed Design of Heap Leach Pad and Events Pond."

Under normal operational conditions the events pond will contain only 14,000 m^3 (12 hrs) operational solution volume. During storm events, however, the pond will fill to some level above this (depending on the severity of the storm) and for the maximum storage level in the pond the maximum leakage rate would apply. In this case, the pumping rate of 235 m^3 per hour would be implemented in order to remove the excess solution in the pond and minimize the leakage rate into the LDRS.

The embankment for the events pond has the same structural section and foundation conditions as the confining embankment for the leach pad. The requirements for foundation preparation with respect to the removal of ice rich permafrost will be the same. A drainage blanket will be constructed beneath the embankment to ensure that additional pore water from thawing is drained, and therefore increases in pore water pressure will be avoided.

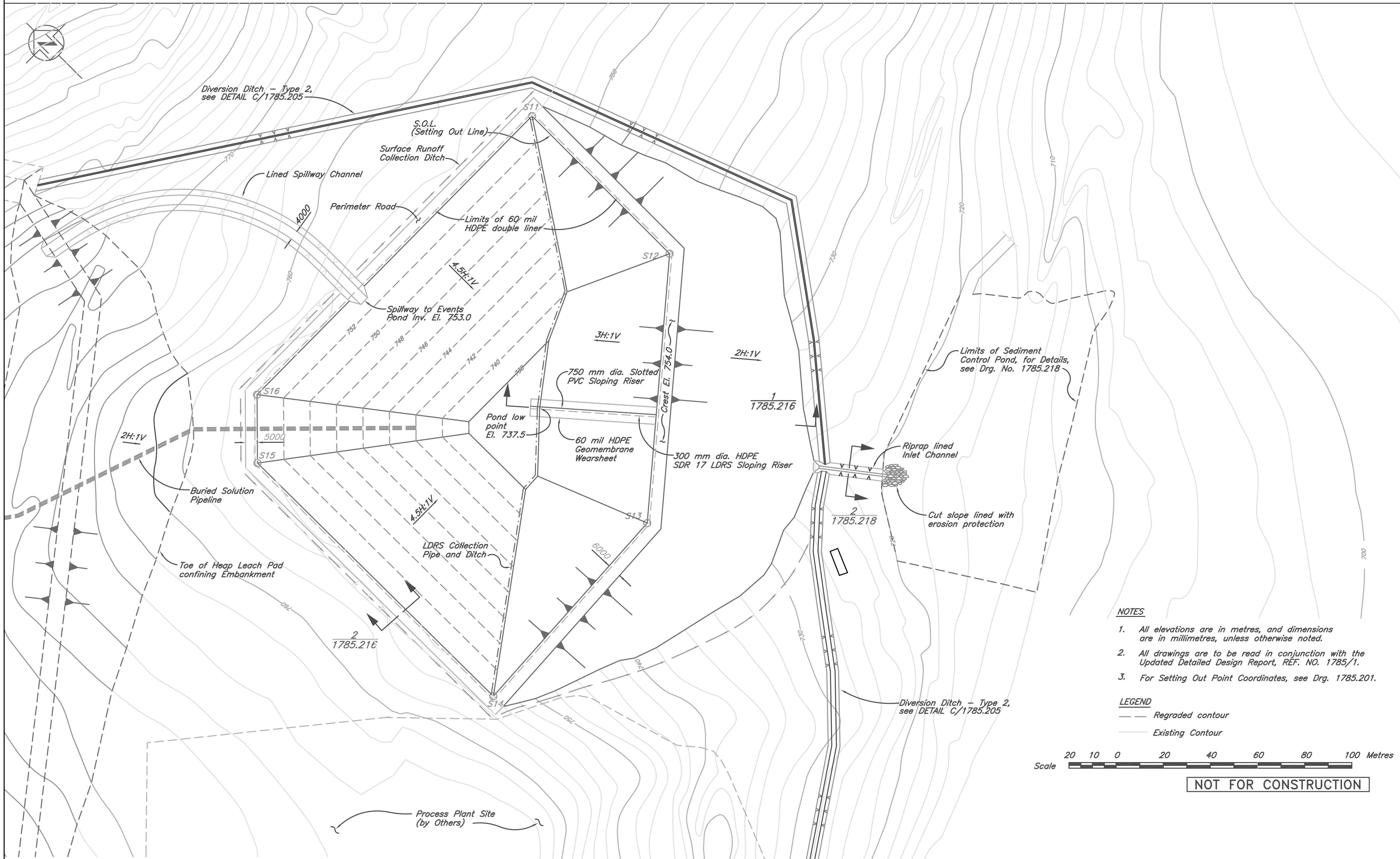
Detailed engineering designs for the heap events pond is presented in the KP "Report on Updated Detailed Design of the Heap Leach Pad and Events Pond" (1997). Details of the leach pad water balance and the determination of design solution storage volumes are presented in the Clearwater Consultants Ltd. Design Memorandum CCL-CC4.

The events pond is shown in plan on Drawing 1785.215 with typical sections and details on Drawing 1785.216 and 1785.217. Figure 3-8 presents an overall arrangement for the events pond plan.

Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION



Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Knight Piesold Limited, "Events Pond General Layout", Drawing #1785.214

Events Pond

Figure Number: **3-8**

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig3_8_Event.dwg

3.2.5 Processing Facilities

Copper will be extracted from the ore using conventional acid heap leach technology followed by solvent extraction for concentration of the resulting copper sulphate solutions and electrowinning (SX/EW) for the recovery of product cathode copper metal. Drawing 400-10-06 shows the plan for the overall recovery arrangement and Drawing 400-03-04 shows details of the flotation and organic treatment system.

The projected operating schedule for ore from the mine, crushing plant and heap leach loading is 200 days per year. Solution processing facilities including solution flow to the heap, solvent extraction and electrowinning will operate year round.

Drawing 100-13-09 shows the layout plan for the processing plant site.

3.2.5.1 Crushing

The crushing plant will be a modular, trailer mounted unit consisting of open circuit primary jaw crushing followed by open circuit secondary gyratory crushing. The plant will be composed of six trailers with interconnecting conveyors. Ore haul trucks will normally discharge into a 140 tonne capacity dump hopper fitted with a sloped stationary grizzly with 600 mm openings. Surge capacity for variations in the mine production schedule will be provided by a coarse ore stockpile located prior to the crusher. The design capacity of the crushing plant will be 521 tonnes per hour resulting in a required operating availability of 80%.

Mined ore with an estimated maximum lump size of 600 mm will be delivered to the dump hopper or coarse ore stockpile by 91 tonne haul truck. Oversize will be caught on a 600 x 600 sloping stationary grizzly mounted on top of the hopper. Ore will be drawn from the hopper to the primary jaw crusher by a vibrating grizzly feeder with a slot opening of 152 mm. The vibrating grizzly oversize will be crushed to a nominal 150 mm in a 1,067 mm x 1,220 mm jaw crusher. The grizzly undersized material and the crusher product will be combined on the primary crushing product conveyor. The ore will then discharge into a radial stacker conveyor which can direct ore to the secondary crusher feed conveyor or to the crushed ore stockpile. The stockpiled material may be returned back to the crushing circuit by FEL and belt feeder. The secondary crusher feed conveyor will transfer primary crushed ore to the secondary, 220 kW, gyratory crusher, which will have a 38 mm closed side setting, operating in a closed circuit. The nominal 25 mm crushed product will be returned back to the secondary screen deck. The 100% passing 25 mm screen product sized material will feed onto the pad loading conveyors.

The pad loading conveyor system will begin with a 914 mm x 350 m long overland conveyor which will transport the ore down to the operating elevation of the heap. The overland conveyor will be followed by a series of standard 914 mm x 38 m portable conveyors which will transport the ore to the section of the pad being loaded. An “index” feed conveyor will transfer the ore to the index conveyor which in turn will transfer the ore to the radial stacker. The pad will be loaded in an uphill direction by removing horizontal standard conveyors and allowing the stacker to retreat. Once a row in the heap is loaded, the stacker will be moved to a new position adjacent to the starting position of the first row and the portable standard conveyors are added. The stacker will again be retreated, forming a new cell for leaching. Pad design is discussed in greater detail in the subsequent sections. Crushing and conveying are directly linked without any surge capacity provided, other than the coarse ore stockpiles, prior to the primary and secondary crushers.

Drawing 200-03-01 presents a flowsheet of the crushing and screening process.

3.2.5.2 Agglomeration

The ore, crushed to a nominal 25 mm, will be agglomerated with 5 kg of concentrated sulphuric acid per tonne of ore. Agglomeration is expected to bind the fine material to the coarse particles, thus preventing them from compacting in the pore space of the heap which could result in a loss of percolation. Agglomeration will be effected by spraying a solution containing 350 g H_2SO_4/L directly onto the ore at conveyor transfer points and mixed as it is transferred between portable conveyor sections. For environmental protection the agglomeration step will take place on the overland conveyor section on lined pad areas only. Portable conveyor drop points will allow mixing of the acid and ore prior to placement on the pad. The acid and water will be premixed and added using a plastic pipe delivery system. Additional benefits of agglomeration result from the availability of free acid in the ore prior to solution addition. Heat is generated with the addition of solution to the heap due to the exothermic hydrolysis reaction, and reaction of the acid with the ore may improve the stability of the leach solution pH during the initial stages of leaching.

3.2.5.3 Heap Leaching

As determined by laboratory and pilot testing, the agglomerated ore will be leached by applying a weak sulphuric acid solution (raffinate from the solvent extraction circuit) to a section of the crushed ore for a period of time. Previous testwork has demonstrated that copper can be leached successfully from Carmacks materials by crushing to minus ¾ inch followed by heap leaching with a weak sulphuric acid solution. Such a process is practiced widely for the recovery of copper from oxide copper ores and the parameters required for the Carmacks deposit are consistent with general practices in the industry.

The leaching testwork, summarized in the “Leaching and Decommissioning of Carmacks Samples” prepared by Beattie Consulting Ltd. in 2001 (Appendix E), was initiated to evaluate the potential for leaching of the Carmacks deposit at Run-of-Mine size. A parallel test on a portion of the same sample crushed to minus ¾ inch was conducted to enable the results for this sample to be compared to those obtained previously with drill core composites. The most recently completed test program on samples from the Carmacks Copper oxide deposit has confirmed the following:

- The copper is readily leachable by means of crushing to minus ¾ inch followed by heap leaching. A copper extraction of just over 85% was achieved over a leach period of 187 days. Over the design leach time of 120 days the column achieved a copper extraction of 83%, corresponding to a commercial extraction of about 78%. For a multiple lift leach configuration it is recommended that the primary leach cycle be ended when about 70% copper extraction has been achieved in order to minimize acid consumption. For the current sample the primary leach cycle would be about 60 days;

- The predicted acid consumption for Carmacks is 22 kg/tonne. It is recommended that 20 kg/tonne be added to the cure stage with the balance being added to solution for control of feed pH; and

- Leaching of the Carmacks material at Run of Mine size results in a significant loss in copper extraction of about 20% unless very long leach times, in excess of 1,000 days are used. The test was conducted with a top size of 10 inches and some additional loss in copper extraction can be expected with the presence of even coarser material. The present test operated for 360 days and has not demonstrated the ultimate copper extraction achievable at a Run of Mine size.

The design primary leaching cycle for the Carmacks Copper ore is 120 days. The ore will be leached through a minimum of two cycles. The initial period when solution is applied directly to it and during the period when the lift above it is leached, resulting in a minimum total leaching period of 240 days. The area under active leaching and thus total solution flow is determined by the ore production rate, the leaching cycle and the nominal solution flow rate per unit surface area of the heap. Solution application will continue 365 days per year so a 120 day cycle will result in 580,000 tonnes under active leaching. The lift height will be 8 m. The resulting area under leach will be 47,374 m^2. The solution application rate will be 0.204 $l/min.m^2$ giving the total leach solution flow rate of 512 m^3/h. The pregnant solution (PLS) exiting the heap will be collected in three perforated leach collection sumps within the heap and flow by gravity to the SX plant. Approximately 55% of the PLS will be recycled to the raffinate stream and returned to the heap before solvent extraction. The resulting steady state PLS grade is predicted to be approximately 7.98 g/L copper.

Distribution piping on the heap will be placed as new crushed ore becomes available. It is not intended that a full cell become available before initiation of leaching. By leaching smaller increments of ore in succession, the variation in PLS grade will be minimized.

Solution application in the summer months will be accomplished using drip emitters placed on the surface of the heap. During the winter months, the drip emitters will be used exclusively and buried approximately 0.5 – 1.0 m beneath the pad surface to prevent freezing. Snow cover, estimated to be 75 cm thick, will provide insulation of the heap surface and protection from the wind chill effects.

Pilot heap testing in Carmacks during the winter of 1993-1994 provided data for thermal modeling performed by Brown & Root, Braun. The modeling indicated that freezing will not occur if solution flow rates are maintained above a minimum, emitters lines are buried and a snow cover is maintained. The project includes the use of heat exchangers, utilizing hot water from recovery boilers on the diesel generators and acid plant, for solution heater during the freezing months as a precaution to ensure solution temperatures will not drop below 10°C. The heating of raffinate solutions may also be utilized to raise the core temperature of the heap prior to freezing conditions; however, based on operating experience at the Brewery Creek mine, these measures may not be necessary.

Drawing 700-03-02 depicts a flowsheet of the leaching process.

3.2.5.4 Solvent Extraction

PLS will be channelled from the heap leach overliner layer containing the network of perforated solution collection piping directly to the PLS sumps and then flow by gravity to the solvent extraction plant at a rate of approximately 512 m^3/h. Fifty-five percent of the total PLS flow will bypass the solvent extraction circuit and report to the raffinate pond.

Water and makeup acid will be added to the raffinate pond. The raffinate will then be pumped to the heap at the full rate of approximately 540 m^3/h. The remaining 232 m^3/h of PLS solution will report to the solvent extraction circuit.

The solvent extraction circuit consists of a single train of extraction and stripping mixer settlers. The extraction circuit consists of two mixer settlers in series and the stripping circuit consists of two stripping mixer settlers in series. The design capacity of the solvent extraction circuit is 270 m^3/h providing flexibility in solution application rates to the heap. The design solution flow rate equates to the quantity of solution required to provide a leaching cycle of 120 days assuming similar design criteria as presented. In addition, the option exists for operating the circuit in a series parallel configuration providing additional though less efficient capacity.

The extraction and stripping mixer settlers are the same size and are a conventional design configuration. The mixers are two stage and consist of two 2.6 m diameter by 3.1 m tanks in series. The first stage provides the mixing, contacting the aqueous with the organic, and the second stage provides pumping as well as mixing to deliver the head required to move the solutions through the mixer settler circuit. The settler consists of a wide launder that is mounted above the main settler providing initial phase separation and transport of the organic/aqueous mixture to the feed end of the settler which consists of a 27 m long by 5.6 m wide by 1.0 m tall rectangular vessel. The settler provides low flow velocities and sufficient retention time to allow disengagement of the organic phase from the aqueous phase and hence separation of the two streams by the underflow and overflow weirs at the end of the settler.

PLS solution entering the solvent extraction circuit will initially be contacted with organic in the E-1 mixer where the copper in the PLS will be transferred to the organic. The organic is composed of a liquid ion exchange reagent (extract) dissolved in a kerosene base diluent. The organic/aqueous mixture will then pass over the launder and into the settler for phase disengagement as previously described. Aqueous solution will then discharge from the settler through the underflow weir and flow to the E-2 mixer settler where it will again be contacted with organic to reduce the copper concentration further. The organic will discharge the settler by passing over the overflow weir and reports to the loaded organic tank. The aqueous solution discharging the E-2 mixer settler will then pass through an entrainment separator for the coalescing and removal of trace amounts of organic before flowing to the raffinate pond. The raffinate will be pumped from the raffinate sump to the heap leach pad becoming new leach solution. Makeup water, acid, and, if required, heat will be added to the raffinate solution in the raffinate sump. Overall extraction efficiency for the solvent extraction circuit is approximately 90%.

Organic transfers the copper from the PLS or leach solution to the electrolyte. The electrolyte is a strong acid solution containing approximately 45 g/L copper from which the copper is recovered as cathode metal by electrowinning.

Stripped organic will flow to the E-2 extraction mixer settler contacting the solution containing the lowest copper concentration. This will provide the greatest driving force for transfer. Organic will then flow to the E-1 mixer settler and on to the loaded organic tank. From here organic will be pumped to the S-1 stripping mixer settler in which the strong acid of the electrolyte will strip the copper from organic, exchanging it for acid. Organic will then progress through the second stage, or S-2 mixer settler, and on to the E-2 extraction mixer settler, to complete the circuit.

The overall process results in the transfer of copper from the PLS or aqueous solution to the electrolyte and the transfer of an equivalent amount of acid from the electrolyte to the raffinate.

Crud is composed of inorganic solids or precipitate that becomes saturated with organic and tends to collect at the organic/aqueous interface in the settler. The crud will be removed by suction through a series of header pipes located at various levels within the settler. Some systems utilize pipes on density floats that aid in finding the interface and allow for efficient removal of crud. Crud build-up will result in loss of organic by entrainment.

Crud will be pumped from the settler using a portable air actuated self-priming diaphragm pump to a crud storage tank. The crud will be pumped to a conical bottomed crud treatment tank where it will be mixed with a relatively large quantity of clean organic from the organic storage tank. The mixture will be agitated to release the crud and aqueous from the organic which settles to the bottom of the tank. The clean organic will be decanted from the top of the tank. The settled crud and aqueous will be pumped from the underflow cone to a plate and frame filter press to separate the remaining aqueous from the crud. The filtered aqueous will be returned to the E-1 mixer settler and the solid crud will be disposed of on the heap.

Drawing 400-10-07 shows the solvent extraction general arrangement plan; Drawing 400-10-09 shows the solvent extraction general arrangement sections; and Drawing 400-03-03 provides a flowsheet for the solvent extraction & stripping process.

3.2.5.5 Electrowinning

Rich electrolyte will flow by gravity from the S-1 stripping mixer settler to a column flotation cell for the primary recovery of entrained organic. Air will be sparged into the column floating the entrained organic droplets to the surface to form a froth. The froth will be skimmed and will flow by gravity to the crud treatment tank for recovery. The electrolyte will flow to a high filter feed tank. The electrolyte will then be pumped through two mixed media pressure filters in parallel for recovery of any remaining entrained organic. The organic recovered from backwashing the filters will report to the crud storage tank for treatment.

The filtered electrolyte will then flow through two plate and frame heat exchangers increasing the temperature to the operating level of 45°C. The first exchanger will recover heat from the lean electrolyte as it is pumped from the electrolyte circulation tank to the stripping circuit. Heat for the second, trim heat exchanger will be supplied by a diesel fired hot water heater or boiler. The hot water will be circulated in a closed loop providing final temperature control for electrolyte feeding the electrowinning circuit.

The heated electrolyte will be collected in a divided electrolyte circulation tank and circulated through the electrolyte distribution headers to the electrowinning cells for copper recovery. The lean electrolyte discharging the cells will flow by gravity through the combined electrolyte return launder to the lean electrolyte side of the electrolyte circulation tank where it will mix with rich electrolyte prior to recirculation. Mixing of the two solutions reduces fluctuations in solution concentrations. The copper concentration of the rich electrolyte feeding the cells will be approximately 38 g/L and is reduced to approximately 35 g/L through electrowinning.

The electrowinning cells will be "Dremco" type cells employing stainless steel permanent cathodes. The cathodes will be equipped with plastic edge strips to prevent growth of copper around the edges. Cathode stripping will be accomplished in a semi-manual washing and stripping apparatus. The cathodes will be removed from the cells using a bale connected to the overhead bridge crane and placed in a stainless steel wash tank. The cathodes will be moved to a stripping rack where they will be flexed to allow the copper sheet to break away from the cathode. The copper cathodes will then drop to a roller conveyor and be stacked on a pallet for weighing and banding for shipment.

There will be a total of 44 electrowinning cells in the tank house, arranged in two parallel rows of 22 cells. The transformer-rectifier will be located outdoors adjacent to the electrowinning building. The rectifier will be connected by bus bars to the nearest cell on each row. The direct current flows up one row and back down the other.

Sulphuric acid and oxygen will be released during the EW reaction. The regeneration of sulphuric acid is significant and is accounted for in the overall acid requirement calculations. It will be necessary to bleed solution from the EW circuit to the extraction circuit in order to control impurity build-up. This bleed will be made up with cathode wash solution.

The oxygen bubbles formed at the cathode carry sulphuric acid into the air above the cells resulting in the formation of an acid mist in the tank house.

Oxygen produced at the anodes will be scrubbed by a layer of polypropylene balls, and then retained in the cells by the presence of anode gaskets. The extraction system will draw the partially cleaned gas through a duct system to the scrubber where the remaining acid mist will be removed so that only clean oxygen will leave the plant. The recovered acid will be returned to the plant.

The water balance has been established so that fresh water will enter the scrubber where it will clean the gas and pick up the sulphuric acid. This water will be pumped to the cathode wash tank, and then will overflow into the spent collection header for return to the tank farm. The volume of water is intended to match the makeup requirement established by an electrolyte bleed. The latter will be set to control iron transfer in solvent extraction.

The addition of cobalt sulphate to the electrolyte has been shown to decrease the decomposition of the lead anodes. This not only reduces the anode replacement cost, but also reduces the amount of lead particulate, which contaminates the cathode copper. A gaur solution will be added to the electrolyte to improve cathode quality. Both of these reagents will be added by metering pumps, fed from agitated tanks.

Drawing 400-10-11 shows the electrowinning building plan; Drawing 400-03-05 provides a flowsheet for the electrowinning process.

3.2.5.6 Sulphuric Acid Plant

Sulphuric acid will be produced by burning elemental sulphur in a sulphur burner and converting the sulphur dioxide into sulphuric acid. Molten elemental sulphur will be purchased from Fort Nelson and trucked directly into the acid plant. Approximately one 40 tonne truckload per day will be required to produce 120 tonnes of sulphuric acid.

Sulphur will be stored molten at the minesite in a heated storage. Molten sulphur will be pumped into a sulphur burner where it reacts with air to form sulphur dioxide.

Steam will be produced from the process, however during a plant start up, a small start up boiler will be required to operate until the process produces enough heat to operate on its own.

Air required to burn the sulphur, as well as in other parts of the process, will be dried in a drying tower. Dry air will be required to prevent humidity in the air forming sulphuric acid early in the process thus, causing corrosion. The gases from the burner are cooled and blown into a converter. In the converter, selected catalysts are used to convert sulphur dioxide to sulphur trioxide with air. Gases are introduced into the catalysts in four stages. The converting process is exothermic producing heat and therefore, between stages, the gases are cooled. The waste heat is used to produce steam, which in turn is used to run the blowers and pumps. Under steady state conditions only 120 kW external power is required to operate the plant.

After the converter, the gases are cooled and introduced into absorption towers. There, sulphur trioxide is absorbed into water thus forming sulphur acid. The absorption will be accomplished in two stages. Two stage absorption produces maximum efficiency and ensures that no toxic air emissions are released. The acid will be produced at 93.5% strength. At this strength the freezing point of the acid is low and can be stored in an unheated tank. Water vapor from absorption is discharged to the atmosphere through a stack.

Boiler quality water is produced in the ion exchange units, which are located in the plant. For every tonne of acid, 1.3 tonnes of superheated steam is produced. To minimize water usage a maximum amount of water is circulated. Steam is condensed and fed back to the system. Cooling water is recycled. During winter heat from cooling water and steam will be recovered and used to heat buildings and process solutions.

Drawing 400-10-16 shows the sulphuric acid plant site layout; Drawing 400-03-13 shows the sulphuric acid plant stream distribution diagram; and Drawing 400-03-12 provides a flowsheet of the sulphuric acid plant.

3.2.5.7 Reagents and Materials

Table 3-1 lists reagents and materials that will be used for processing; Drawing 400-03-06 provides a flowsheet for reagents. Reagents and materials will be segregated and stored to ensure the integrity of product containers and their safety. Secondary containment measures are planned for particular products and emergency response and spill contingency plans will be in place to ensure worker health and safety and environmental protection. Reagents and materials storage and containment areas will be protected, signed and monitored as part of the Environmental Management System (EMS).

Table 3-1 Reagents and Materials

Crushed Liners	
Material	Steel
Consumption (steel)	0.03 kg/tonne ore
Usage	45 tonnes/year
Distribution	Manual
Storage	Outside storage area on pallets
Sulphuric Acid	
Consumption	25 kg H_2SO_4/tonne ore
Usage	121 tonnes H_2SO_4/ - 44100 tonnes H_2SO_4/year
Distribution	93% acid
Control	Metering pump
Storage	Bulk liquid storage – 2^o containment
Guartec	
Form	Dry powder
Consumption	0.5 kg/t Cu
Usage	20.0 kg/day - 7,155 kg/year
Distribution	Concentrated solution
Control	Metering pump
Mix system	Agitated tank
Liquid storage	1,000 mm dia x 1,000 mm high tank
Dry storage	Bags on pallets in warehouse
Cobalt	
Form	Cobalt hepahydrate powder
Consumption	100 ppm Co in bleed stream
Usage	9,774 kg/year
Distribution	Concentrated solution
Control	Metering pump
Mix system	Agitated tank
Liquid storage	1,000 mm dia x 1,000 mm high tank
Dry storage	Bags on pallets in warehouse
Lime	
Storage	Powder stored in 75 tonne silo within lined containment dike adjacent to solvent extraction building.
Organic Solvent	
Consumption	25 mg/L
Storage	200 litre kegs in the warehouse
Extractant	
Form	Liquid
Consumption	0.014 kg/tonne ore
Usage	24,900 kg/year
Distribution	Dissolved in diluent
Extractant concentration	27.7%
Storage	Drums in outside, lined containment
Diluent (Kerosene)	
Form	Liquid
Consumption	0.040 kg/tonne ore
Usage	188.2 kg/day - 68,700 kg/year
Bulk Storage	4,500 mm dia x 5,000 mm high tank - 2^o containment

Table 3-1 Reagents and Materials (Cont'd)

Cathodes/ Anodes	
Form	
cathodes	Stainless steel
anodes	Lead alloy
Usage	
cathodes	267/year
anodes	542/year
Storage	Pallets, outside
Diesel	
Vehicle fuelling facility fed from steel above ground vertical tank	265 m^3 capacity, within a lined bermed enclosure sized to contain 100% of the capacity of the tank, and 300 mm of freeboard
Generator diesel fuel storage facility	Two 265 m^3 tanks similar in design to the above
Gasoline	
Gasoline fuel tank	38 m^3 capacity - 2^o containment
Propane	
e tanks	Tanks located outside buildings as required for heating. Tank locations protected
Maintenance Shop Lubrication Oils and Solvents	
Bulk storage	Tanks located outside the pit shop in a concrete bermed Area; smaller day tanks located inside the pit shop
Warehouse Storage of Solvents and Degreaser Materials	
Storage	Solvents and degreasers delivered in small containers will be stored inside cold storage warehouses

3.2.5.8 Process Controls and Instrumentation

The central control room for the project will be located in the electrowinning building. Drawing 400-10-11 shows the electrowinning building plan.

The SX/EW process plant will have a Programmable Logic Controller (PLC) looking after all of the analog and discrete controls in the plant. There will be a Man/Machine Interface (MMI) in the form of two (2) computers with monitors located in the central control room. The PLC controller and I/O will reside in system/marshalling cabinets located in the control room. The remote I/O will be in NEMA 4 enclosures and will be controlled by the SX/EW PLC.

The operator will be able to monitor and control every piece of equipment in the process including the water distribution system at the crusher, and remote water supply wells The operator will be able to only monitor the crusher/conveyor system and acid plant, as they will be supplied as a package with their own complete control system. One remote I/O will be pole mounted by the well pumps, a second will be in the water booster pumphouse and the third will be in the crusher/camp site water distribution pumphouse.

The crusher/conveyor equipment will be supplied as a complete package, with an integral control system. The control system will be a PLC complete with MMI. It will be interfaced with the SX/EW PLC via a data highway. The MMI will be able to monitor and control the crusher/conveyor equipment only. The owner PLC controller in the water distribution pumphouse, will serve as a system/marshalling cabinet.

Similarly the sulphuric acid plant equipment will also be supplied as a complete package, including an integral control system. The control system will be a PLC (Allen Bradly) complete with MMI and interfaced with the SX/EW PLC via a data highway. The MMI will allow for the operator to only monitor the sulphuric acid plant equipment.

The data highway for the crusher and acid plant control systems will be a 6-core 200 micron fibre optic cable. The fibre optic cable will be underslung on the overhead power line to the crusher site from the process plant control room.

3.2.5.9 Equipment

The mining equipment required will be purchased and the core mining fleet will be owned by Western Silver. Short term additions of haul trucks to the fleet will be leased.

In addition to the major drilling, dozing, loading and haulage units, a fleet of support equipment will be required. This fleet is based on the requirements at similar open pit mines with adjustments made according to throughput, length of haul roads and size of equipment.

The main criteria by which equipment was selected for the pit were cost, productivity, reliability and maneuverability. Acquiring and maintaining durable equipment capable of working under difficult conditions will be essential.

All equipment selected is diesel powered since both operating and capital cost of generating electric power is high. Table 3-2 details the initial and ongoing equipment requirements.

Table 3-2 Initial and Ongoing Equipment Requirements

		Initial	Ongoing Annual Requirements							
YEAR		**-1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Equipment										
Hydraulic Front Shovel - 10.5 m^3, 563 kW	no.	1	1	1	1	1	1	1	1	1
Front End Wheel Loader - 10.7 m^3, 530 kW	no.	0	1	1	1	1	1	1	1	1
Off Road Haultruck - 91t, 699 kW	no.	2	3	4	5	7	7	7	6	2
Motor Grader - 205 kW, 27.2 t, 4.9 m blade	no.	1	1	1	1	1	1	1	1	1
Track Dozer - 425 kW, 65.8 t, w/ Ripper	no.	0	1	1	1	1	1	1	1	1
Track Dozer - 302 kW, 47.9 t, w/Ripper	no.	1	1	1	1	1	1	1	1	1
Excavator - 165kW, 33.7 t, 2 cu m	no.	1	1	1	1	1	1	1	1	1
Wheel Dozer - 235 kW, 5.8 t, 4.5 m blade	no.	1	1	1	1	1	1	1	1	1
Airtrack Drill, 64 mm	no.	1	1	1	1	1	1	1	1	1
Rotary Blasthole Drill, 200mm, 39 t	no.	1	1	2	2	2	2	2	1	1
Water Truck - 90,000 litre, 699 kW	no.	1	1	1	1	1	1	1	1	1
Mine Services Dump Truck, 10.7 cu m	no.	1	1	1	1	1	1	1	1	1
Sand Truck, 10.7 cu m	no.	1	1	1	1	1	1	1	1	1
Personnel Van, 12 man	no.	1	1	1	1	1	1	1	1	1
Blasthole Stemmer, 59 kW, 9.7 t	no.	1	1	1	1	1	1	1	1	1
Offroad Tire Manipulator, 67 kW, 7.9 t	no.	1	1	1	1	1	1	1	1	1
Fuel and Lube Service Truck, 2000 l, 15 t	no.	1	1	1	1	1	1	1	1	1
Mechanical Field Service Truck, 15 t, 5 t crane	no.	1	1	1	1	1	1	1	1	1
Field Welding Truck, 15 t	no.	1	1	1	1	1	1	1	1	1
Service / Utility Flatbed Truck, 15 t, 5 t crane	no.	1	1	1	1	1	1	1	1	1
Pickup Truck, 3/4 ton, 4*4	no.	5	6	6	6	6	6	6	6	6
Blaster's Truck, 1 ton	no.	1	1	1	1	1	1	1	1	1
Dewatering Pumps	no.	2	2	2	2	2	2	2	2	2
Light Stands/Generators, 4 kW	no.	4	4	4	4	4	4	4	4	4

Table 4.6.7-1 in Western Copper Holdings Ltd. Carmacks Copper Project 1997 Basic Engineering Report by Kilborn

3.2.5.10 Process Buildings

Major process equipment for the project will be located in the SX and EW buildings. Drawing 400-10-11 shows the electrowinning building plan.

The building layout allows for gravity flow from the mixer settlers to tankage located below and between the SX and the EW equipment. This will require solutions to be pumped into the EW cells and return by gravity to the tankhouse. In the SX plant, the elevation of the top of the conventional settlers and mixers will be similar. This has been achieved by locating the mixers on a lower slab foundation adjacent to the settlers.

The EW plant will be constructed with acid-resistant concrete slabs and foundations. The area between foundations will be lined with a geomembrane (HDPE) liner to contain spills. All internal grades will slope to a transverse concrete trench that drains to a sump located in the cathode stripping area. The polymer concrete electrowinning cells will be supported on cast-in-place pier foundations in two rows down the length of the building. The cells will be arranged in two lines and will support the central walkway, power supply cabling, feed and discharge piping. The rectifier will be located at the end of the two lines of cells to minimize the length of the bus bars. The two lines of electrowinning cells and cathode stripping areas will be serviced by an overhead gantry crane running on rails supported by the building columns.

The buildings will be pre-engineered steel structures complete with insulated metal cladding. Building foundations will be concrete spread footings founded below the depth of frost penetration. The exterior of structures not founded on rock will have perimeter rigid insulation to minimize heat loss through concrete foundations and slabs. Space heating for the buildings will be hot water radiant or electric unit heaters. Ventilation equipment will be corrosion resistant and sized to ensure that the required air charges provide a safe environment for operating personnel. The control and electrical equipment areas for the SX/EW buildings will be isolated from the process areas.

The raffinate tank will be HDPE lined concrete, placed below building grade. It will serve as the low point drain and spill containment sump for all process equipment. There will be a high level overflow out of the raffinate tank to permit temporary upsets to discharge into the adjacent double lined events pond.

3.2.6 Haul Roads

Haul roads within and around the open pit, WRSA and heap leach facility will have an overall width of approximately 26 m, including an allowance for ditches and safety berms. The maximum grade will be approximately 10 percent on all main roads and approximately 12 percent on bench access roads. See Appendix A, Drawings 100-13-05 and 100-13-06 for typical road sections and details.

All haul roads will be protected from flooding or washout at stream crossings. In general, culverts will be sized to convey peak flows from a 25-year return period event without water surcharge above the culvert crown. Extreme peak flows with return periods of up to 100 years may be considered for critical road sections. Small stilling basins will be excavated at the intake of all culverts to prevent sedimentation and blocking within the culverts and to improve water quality.

3.2.7 Ancillary Facilities and Services

3.2.7.1 Site Layout

The project site will be split into two distinct areas based on the process requirements. The local topography of the area gently slopes east to Williams Creek, which drains to the Yukon River 8 km away. The surrounding area is uniformly tree covered with a maximum elevation above the open pit of 930 m and a minimum elevation of 670 m at Williams Creek.

The open pit mine will be located on a hillside on the southeast side of the property and will have a pit crest elevation of 860 m and bottom elevation of 645 m. The maintenance/service facilities, primary crusher and construction/operations camp will be located above the leach pad area on a saddle west of the open pit at elevation 850 to 880 m. The process plant, acid plant, laboratory, process office and gatehouse will be situated below the heap leach pad at elevation 766 m. The administrative offices will be located off-site at Carmacks. Drawing 400-03-07 illustrates the location of ancillary facilities.

The heap leach pad will be located to the north of the process plant and below the maintenance/service facilities in a local south facing valley which drains towards the process plant. The crushing plant, at elevation 860 m, and the beginning of the leach pad loading conveyors will be located on the west side of the small hill between the heap leach pad and the open pit.

Excerpts from the geotechnical investigations undertaken by Knight & Piesold over the project area generally indicate that:

- The near surface sand and gravel deposits will be suitable for concrete aggregates and borrow materials;
- Facilities should be located on well drained areas, surface and sub-surface, with foundations in ice-free rock or non-frost-susceptible soils due to the possible presence of permafrost;
- Numerous areas of poorly drained, frost susceptible soils and saturated active layers occur;
- Permafrost does not generally occur at higher elevations or on south facing slopes around the project site; and
- Where silty surficial soils are encountered under foundations they will be required to be removed to a depth of 2,500 mm and replaced with well-drained granular material around the foundations, this will minimize the chance of frost heave.

Knight & Piesold's detailed geotechnical field investigations should be referred to for further details and information.

3.2.7.2 Access

Access to the project site area is by public highway with the last 33 km from Carmacks via the gravel, all-weather, government maintained, Freegold Road. Access to the mine property will be by a new 13 km road (Figure 2-2).

The responsibility for upgrading and maintaining the Freegold Road, which forms part of the Yukon highway system, belongs to the Yukon Government. YG initiated a program to upgrade the route to 80 km/hr secondary road standards in 1991. The bridge over the Nordenskiold River, 1.5 km from Carmacks and the bridge at Crossing Creek, 25.5 km from Carmacks, are to be replaced to meet highway transport truck loadings. It is expected that the two bridges and the portion of the Freegold road that connects to the project site access road will be completely upgraded by YG and will commence upon Western's production decision.

Western Silver is responsible for 13 km of road, from the turnoff at the Freegold road to the project site, including the bridge crossing at Merrice Creek (km 7) and the culvert crossing at Williams Creek (km 11.5). The mine access roadway will be operated as a private controlled access road and maintained by mine personnel.

With reference to site access from Freegold road, it is proposed to complete construction of a new 13.3 km access road, just east of the property exploration roadway, from the intersection of the Freegold Road to the process plant area. Clearing and grubbing of the route was completed in 1997. The road will be constructed to resource road standards with a minimum 5 m wide all weather gravel surface (widened at curves and sharp corners or with 8 m wide turnouts at 250 m intervals). The maximum grade for the road will be 8% and the design speed 60 km/h. The route selected for upgrading will follow the existing exploration road as much as possible and will only depart from the existing right of way to comply with grade or road curvature requirements. A p-line survey and field cross-sectioning has been completed and incorporated into the detailed engineering drawings. Additional field information will be required to determine availability of granular surfacing material, (borrow pits), which has been assumed to be available along the route.

Drawing 100-13-46 shows a detailed plan for the mine access road, and Drawings 100-13-05 and 100-13-06 show typical road sections and details.

<u>Planned Road Maintenance</u>

The project site access road will be operated as a private controlled access and be maintained by mine equipment.

Summer maintenance activities are directed at preventative maintenance, correcting deficiencies, and preparing for the coming winter. These include:

- repairs to "breakup" or other damage to road base;
- culvert headwall, flume, apron, and marker post maintenance;
- maintenance of riprap bank protection;
- ditch, culvert, and creek channel clearing;
- removal of dangerous trees;
- scaling of rock faces;
- maintenance of riparian vegetation;
- brush cutting;
- sign maintenance;
- kilometre post maintenance;
- routine surface grading;

- regravelling per annual schedule;
- dust control measures; and
- stockpiling sand, gravel, and riprap for winter use.

Winter maintenance activities are mostly related to controlling the effects of snow and ice. These would include:

- snow removal;
- sanding;
- water/ice control (clear ditches, thaw culverts);
- remove fallen trees, rocks, slides; and
- sign maintenance.

Defined snow deposition areas with sediment traps will be installed to minimize sediment deposition into tributary streams

Culvert Maintenance

Regular maintenance is required to keep culverts functioning properly and free of accumulated sediment and debris. Culverts will be marked in a highly visible fashion such that operators of road maintenance equipment will be able to easily note culvert locations.

In addition to regularly scheduled inspection and maintenance, special measures will be instituted before the rainy season, before freeze-up, and just after spring break-up periods. In sensitive areas, culvert crossings will be checked regularly during high runoff periods. Maintenance personnel will be trained to identify environmentally sensitive situations. Debris or material removed during cleanup operations will not be deposited into a stream or any place from which it may enter the watercourse.

The following culvert maintenance checklist is adapted from Bonsor, Holmes and Sharpe (1877, pp. 10-13):

Culvert Entrance:

- Dispose of floating debris which could be lifted by the headwater pool during a high flood;
- Clear debris barriers (trash racks);
- Remove material from upstream settling basins or channels which may reduce capacity of culverts;
- Backfill scour holes with clean gravel or larger rock;
- Ensure that stream channel leads directly to the culvert entrance;
- Repair or replace riprap alongside pipe to retain fills;
- Tamp in material to prevent flow entering the fill surrounding the pipe;
- Straighten metal entrance aprons;
- Repair aprons and headwalls; and
- Cut brush and clear away debris at entrance.

Culvert Outlet:

- Check for excessive scour;
- Check pipes and endwalls for undermining; replace and protect bedding;
- Replace riprap and ensure that it is large enough and extensive enough to protect the exit channel; and
- Check the downstream channel for blockages and scour.

Culvert Barrel:

- Check for erosion of corrugated metal pipe, and replace damaged paved invert or coating, as necessary;
- Check corrugated metal pipe for corrosion; and
- Check culvert for vertical and horizontal alignment, for distortion and for open joints and leaks.

<u>Bridges and Maintenance</u>

The access road crosses two watercourses, one at Merrice Creek (km 7) and the other at Williams Creek (km 11.5). The Merrice Creek Bridge will be sized to convey peak flows from a 100-year return period event. Riprap and other erosion protection measures for culverts and bridges will be designed for the same event as the culvert or bridge. The proposed clear span bridge abutments are not expected to encroach on the creek wetted perimeter. A culvert crossing is planned for the upper Williams Creek road crossing.

Bridge construction will follow guidelines to ensure that the watercourses are protected and will include the following provisions:

- Machines are not to be serviced adjacent to the river. Waste oil, filters and other such refuse is to be properly disposed of;
- Skidding logs on steep slopes is to be avoided. Lift rather than skid fallen trees from the river channel or hand cut;
- Sediment control facilities are to be provided where runoff from approaches and stockpiled material is likely to erode in to the river;
- Only clean blasted rock or granular fill is to be used in construction of the causeway approaches;
- Disturbance at borrow sites is to be minimized and sediment control is to be provided;
- End dumping fill material is to be avoided. Dozing over from the leading edge of the approaches will minimize disturbance to the river;
- 2 m clearance between underside of the bridge span and the normal high water level is to be provided;
- Areas subject to erosion are to be rip-rapped with 1 m angular rock to above the normal high water level;
- Adequate cables and communication devices are to be available should a rescue of a piece of equipment be required; and
- If necessary, filter cloth will be used to reduce sediment from entering the stream from the bridge deck.

Bridges require frequent inspection and regular minor repairs to increase operational life and safety to users, as well as to reduce possible environmental effects due to improper functioning or failure. The maintenance program will include:

- Regular bridge inspections conducted to determine any changes in the stream channel or deterioration of bridge structure. A full inspection is required annually (just after peak flow) and spot checks are necessary before and during any high flows. The inspection will include, but not be limited to:
    - checking for and repairing superstructure damage;
    - checking for and repairing sub-structure damage;
    - checking for and repairing approach fill damage;
    - checking for and repairing training works damage;
    - replacing or repairing curbs, deck, and delineators when needed;
    - checking bolt tightness; and
    - repainting;
- Depth recordings will be periodically taken around abutments to assess scour and deposition. If excessive scouring or stream bank erosion is found, immediate action will be taken including scour hole filling with clean, coarse gravel and protection with riprap. Stream banks and riprap will be stabilized as required;
- Any debris caught on abutments will be removed to prevent upstream flooding and to reduce stress on the crossing structure; and
- Roadside drainage and bridge deck drainage will be maintained to prevent erosion of approach ramps and sediment transport into the stream.

Other controls include development and implementation of road maintenance schedules.

The conceptual design for the Merrice Creek bridge will be submitted prior to bridge construction.

3.2.7.3 Power Supply and Distribution

The primary source of electrical power for the project will be a diesel generating plant. The average electrical demand at a 0.9% power factor will be 7,860 kW in summer and 6,610 kW in winter. The winter demand is lower because the crushing plant will not be operating. There will be five diesel generating units, each with a minimum continuous operation rating of 1,650 kW. The generators will be equipped with waste heat recovery boilers to generate hot water (cogeneration). The process and laboratory will be serviced by the cogeneration system with back-up hot water boilers for building space heating diesel fired units.

The generator sets will come complete with air filter, lube oil system, starter system, associated diesel engine and generator control system and heat recovery system. The generators have been sized to suit the estimated site maximum electrical demand and relevant environmental emission standards. An assumption of 190^{o}F circulating water temperature was made for the determination of the thermal energy produced.

The units will be supplied in modular steel, weatherproof sound attenuated enclosures, insulated, and will be set on concrete slab foundations. The enclosure will be complete with fire protection, bridge crane, catwalks, lights and HVAC systems. The electrical switchgear/control equipment hot water storage and circulation system, fuel/lubrication systems will be integral with the engine modules or contained in separate insulated enclosures. The bulk diesel fuel and lubrication storage tanks will be located remote from the generators. The power plant will be located adjacent to the SX/EW building.

Distribution

Direct buried cable will be installed between the diesel generator plant and 4.16 kV switchgear housed in the EW building electrical room. The electrical room will also contain the 5 kV load break switches, 600 volt motor control centres, the programmable logic controllers (PLC) and the I/O system/marshalling cabinets.

A 4.16 kV feeder cable will be installed underground from the electrical room to the A and B overhead lines take-off pole. Overhead line A will supply power to the shops and warehouse/crusher areas, firewater pumps and mine. Line A will be constructed along the roadway west of the leach pad area to an electrical assembly trailer located at the crusher plant. Line B will provide power to the following:

- events pond pumps;
- fresh/fire water distribution pumphouses;
- water wells;
- sediment pond;
- acid plant;
- gatehouse first aid trailer; and
- fuel storage.

3.2.7.4 Explosive Storage

Explosive materials that will be stored on-site prior to consumption include: detonators, primacord, boosters and connectors. These will be stored in prefabricated magazines that will be selected and located in compliance with local and federal regulations. Non-classified ammonia nitrate (AN) prills will be stored in a silo facility provided by the explosives supplier. The explosives supplier is responsible for obtaining any necessary authorizations.

3.2.7.5 Maintenance Shops and Warehouses

The mining maintenance shop together with the warehouse will be housed in a “Sprung” fabric covered, insulated aluminum structure to be located near the primary crusher. The shop will be equipped to handle routine maintenance and most repair work on mine, mobile and process equipment. The warehouse will act as the main distribution centre for spare parts and supplies. Storage space for reagents will be provided at the process plant. A compound adjoining the warehouse will provide additional laydown area.

The buildings will be insulated, and vestibules will be provided to protect main doors from the weather.

An exterior truck ready line, serviced by electric block heating connections, will be provided adjacent to the shop.

Maintenance Shop

The drive-through mine vehicle service area has been sized to accommodate 86 tonne capacity trucks. A welding bay, a truck wash bay and an instrumentation/electrical bay have also been provided. An area adjacent to the drive-through heavy truck repair area has been designated light truck repair shop.

A sloping concrete apron will extend 3 m in front of the major entrances to the shops, and bollards will be provided to protect the building.

The 10 m clear height will allow sufficient clearance to pass a haul truck with its box raised.

A concrete floor will be provided throughout the truck maintenance area. The floors will also be sloped towards a dry sump, which will collect any wash solutions and petroleum products that result from the maintenance activities. Oil-absorbent products will also be used on the shop floors.

Any accumulated sump water will be separated and oils pumped to the waste oil tank or empty drums. All oily wastes from oil changes, including the sump separation products and absorbent, will be hauled off the site for disposal or recycling in accordance with applicable regulations (Transportation of Dangerous Goods Act, Yukon Environment Act, *Special Waste Regulations*).

The lubrication bay will have a vacuum evacuation system for waste oil. Hose reels will feed from the lubrication storage area and will dispense antifreeze, grease and various grades of oil to the lubrication bay. An air compressor and receiver will supply air for tools.

Strategically placed roof exhaust fans will ventilate the maintenance shops and repair bays. When necessary, these areas will be heated by propane fired unit heaters in conjunction with propeller type ceiling fans to prevent stratification.

Hose stations and hand held fire extinguishers will be provided for fire fighting purposes in the maintenance shops and repair bays.

Warehousing and Storage

The warehouse will serve as the main distribution centre for the mine and process facilities. It will have 390 m^2 of inside floor space and include the company tool crib; 360 m^2 of yard area adjacent to the building will be available for outside storage. These facilities will be supplemented by reagent storage containers at the process plant, plus explosives storage magazines located near the pits. A separate fenced-in area for oxygen and acetylene gas bottles will also be provided.

The warehouse will be serviced with a forklift truck. Storage shelving and racks will be provided. The warehouse will occupy part of a “Sprung” fabric structure, in common with the truck repair shop.

The heating and ventilation system in the warehouse will be similar to that for the maintenance bays. A sprinkler system will be installed in the warehouse for fire protection.

3.2.7.6 Offices

Administration

The administration office will be a single story prefabricated trailer structure with a total area of 390 m^2, located in Carmacks. The trailer will contain offices allocated to management, accounting, purchasing, employee relations, safety and engineering staff. A reception area, conference/training room, washrooms, lunch area, utility room, print room, photocopying room, records vault and storage space will also be provided.

The office will have air conditioning and electric heating. Chemical extinguishers will be used for fire protection.

Process

The process offices will be contained in a prefabricated trailer located directly adjacent to the SX building and laboratory trailer. The trailer will have a total floor area of 120 m^2 and contain offices for process supervisory and metallurgical staff, washrooms and lunch room space will be provided. The office will have independent HVAC and fire detection systems.

3.2.7.7 Laboratory

The metallurgical laboratories will be located next to the SX/EW facilities in a single story, prefabricated trailer with a floor area of 71 m^2. It will be equipped to perform daily analyses of pit and process samples, screen analyses and environmental analyses of solids and liquids. Sample preparation and column leach test equipment will also be provided in the laboratories.

Any environmental testing which cannot be handled in this facility will be sent off-site to a specialized laboratory.

The laboratory floor plan presented will allow a logical path for the samples to follow from receiving, preparation and analysis. Separate areas and rooms will be allocated to:

- receiving and logging;
- bulk sample preparation;
- drying;
- crushing room;
- splitting;
- pulverizing;
- sample weighing;
- flux mixing and storage room;
- furnace room;
- balance room;
- wet laboratory;

- reagent and supplies storage room;
- metallurgical laboratory; and
- sample storage area.

Bulk samples will be delivered to the laboratory receiving area for identification prior to testing. After testing is complete, the samples will be stored briefly within the sample preparation area and then relocated to a cold sample storage shed.

There will be offices for the plant metallurgist and chemist, plus a mechanical room.

To provide isolation between the SX/EW plant and laboratories access from the laboratory to the process plant will be through two sets of doors.

Areas which are sensitive to dust will be pressurized. In addition, dry type dust collection equipment will be installed to capture at source the dust from sample preparation and flux mixing. Fumes from the furnace room will be directed through a scrubber suitable for particulate removal. Air from the metallurgical and wet laboratories will be exhausted to atmosphere.

Makeup air, heated prior to entering the building with indirect fired propane equipment, will be supplied to the area to compensate for the exhaust air requirements.

Fire protection for the laboratory will be by hydrant stations and dry chemical fire extinguishers.

3.2.7.8 Mine Dry Offices

The dry offices will be a separate trailer complex in the southeast corner of the operations camp area, complete with separate women's dry offices and assembly areas. The dry offices will serve all employees. Showers, change rooms and individual lockers for 100 men and 20 women will be provided. Offices for the mine and maintenance shift supervisors, the drill and blast supervisor and the process maintenance supervisor will be included.

The dry offices will be heated with indirect propane-fired unit heaters. Air from the washrooms and showers will be exhausted to the atmosphere with makeup air being heated prior to introduction into these spaces.

Hose stations and hand held fire extinguishers will be provided in the dry offices for fire protection.

3.2.7.9 Building Heating, Fuel Storage and Distribution

Heating fuel will be supplied from a central propane storage system. Propane will be delivered to site by tank truck to the independent facilities. Currently, it is planned that the facilities, including tanks, will be the property of the propane supplier. The tanks, at the estimated demand, will have a month’s reserve when full. Drawing 100-13-23 and 100-13-24 shows the plan, sections and details of fuel storage, and fuel storage service complex, respectively.

3.2.7.10 Vehicle Fuel Storage and Distribution

Diesel fuel and gasoline will be delivered to the project site in tanker trucks for transfer to storage tanks. A permit under the Environment Act *Storage Tank Regulations* will be acquired for the fuel storage facilities.

The vehicle fuel storage compound will be constructed on the same graded pad as the truck wash facility, which will be located adjacent to the maintenance shop and warehouse.

This compound will contain a 190 m^3 diesel fuel tank and a 38 m^3 gasoline fuel tank. The diesel fuel tank will be a steel, above ground, vertical type, and the gasoline fuel tank will be a steel, above ground, horizontal or vertical type. The tanks will be located within the lined and bermed enclosure. Space within this enclosure shall also be allocated for a future, second 190 m^3 diesel fuel tank. The enclosure will be sized to contain 100% of the capacity of the largest tank, plus 10% of the volume of the remaining tanks, and 300 mm of freeboard. The tanks will be designed to NFPA Standards for atmospheric pressure, outside storage tanks. A facility will be provided to unload the tank trucks, which will be equipped with pumps to transfer the fuel into storage tanks. Diesel and gasoline dispensing stations will be provided adjacent to the tanks for filling mine and plant mobile equipment. A loading arm assembly, constructed on an elevated platform, will be provided to fill a top loaded 7.6 m^3 capacity tanker truck with diesel fuel. Diesel fuel for in-pit mine vehicles will be dispensed from the mobile tanker truck.

3.2.7.11 Site Accommodation

Construction personnel will be accommodated in the prefabricated camp located at the project site. The camp will be complete with kitchen, dining and recreational facilities. The layout of the camp and its relationship to the other process facilities is shown on Figure 3-1. Depending on the mining seasonal requirements for accommodation, a portion of the camp may be retained to meet any shortfalls in local housing availability. It is anticipated that the influx of operations personnel to the Carmacks area will prompt the construction of local affordable housing. Appendix A, Drawing 100-13-14 shows the layout plan for the camp.

3.2.7.12 Lighting

As all the pit equipment is equipped for nighttime operation, requirements for additional lighting is minimal. Areas that will require lighting are the digging areas and the active waste dump where trucks are dumping. Four portable self-contained lighting plants will be required. These units will be pulled and positioned by a pick-up truck.

3.2.7.13 Maintenance Facilities

Routine preventative maintenance and servicing of the open pit equipment will be carried out at their working place. Preventive maintenance on mobile equipment will be carried out in the shop.

The mine maintenance shop has sufficient floor area for four haul trucks at one time. Scheduled and breakdown repairs will be carried out in the workshops or in situ as appropriate.

3.2.7.14 Security and First Aid

Security at the project site will involve controlled access into the work areas.

In areas where vehicular passage could be accomplished easily, security style mesh fencing and a prefabricated trailer gatehouse will be installed and locked to deter unauthorized entrance to the mine site. This security fencing will extend to reasonably visible distances into the forest. Inaccessible areas will have perimeter fencing consisting of wood and/or barbed wire construction with the exception of the process area, which will be completely enclosed by a 2.4 m high wildlife fence. Additional security fencing will be installed around the warehouse storage yard and the cathode shipment door.

The first Aid station will be contained in the gatehouse, as well as the ambulance and fire truck.

3.2.7.15 Communications

An internal telephone network will serve the various facilities at the property, the cables being routed through conduit within the yard areas and along the overhead pole lines to the process plant and administration offices. Radios will also be installed in supervisor's vehicles and major items of mining equipment for communicating with the operators working in the pits.

Externally, the operation will be linked via a satellite link to provide data, fax, and voice communication. A satellite dish near the administration offices will be installed during the initial construction phase for this purpose. Satellite TV will also be provided for workers (construction and operation) at the camp.

3.3 PROJECT ACTIVITIES AND SCHEDULING

3.3.1 Mining Method Selection

The mining method selected is intended to maximize the recovery of the resource, and optimize production in the early years of production. Since the SX-EW plant capacity is fixed, the higher the ore grade the fewer the tonnes of ore, for a given copper production, have to be processed.

Having determined the mining method and estimated mining, G & A and processing costs a computer generated Lerchs-Grossmann pit optimization was developed. This ultimate pit was then scheduled manually and yearly plans developed. This schedule is approximate and it is recommended that an integrated computer graphics schedule be done prior to a production decision. The ultimate pit plan is shown in Figure 3-5.

3.3.2 Mining Strategy

In order to minimize start-up costs, the mine will start as a small pit focused on mining higher grade, lower strip ratio material. The pit will be expanded with successive push-backs which will allow for a gradual build-up of haul trucks to maintain production. The mine will start with a strip ratio slightly lower than the mine average. For the last few years of the mining operation, the strip ratio will decrease to below mine average hence allowing for aging equipment to be retired from the fleet.

3.3.3 Pre-production

Pre-production development of the open pit will include removal of waste rock from the area and the mining of low grade ore. This pre-production period for mining will last approximately 6 months at a production rate of approximately 12,000 tpd. Training of pit operations and maintenance personnel will be carried out during this period. Ore mined during the pre-production period will be crushed and utilized for padding the initial heap leach pad liner.

3.3.4 Production Mining

The 13.3 million tonne diluted reserve will be mined at a maximum rate of 9,872 tonnes per day for up to 200 days per year for eight years. After year 8, any marginal, low grade material that has been stockpiled in the vicinity of the primary crusher will be crushed and leached.

Mining and waste rock removal will be carried out over a 300-day period every year. Ore will be fed directly to the primary crusher where possible. Due to extreme winter conditions, no mining is scheduled in January and February. The mining season will be extended if weather permits.

The average life of mine strip ratio will be 4.6:1. In the first three years of production, the strip ratio will range from 2.8 to 4.8. The strip ratio reaches a high of 6.4:1 in year 4 and then drops to 2.5:1 by year 8. The increasing depth and haulage cycle times in the project's latter years are reflected in increased manpower and equipment requirements.

The pit will be started at the north end and developed in slightly higher grade material. The pit will then be expanded in a series of push-backs in order to mine the balance of the ore.

Table 3-3 and Table 3-4 show the Carmacks Copper Project schedule for the first year after project approval and the annual mining production schedule for the Carmacks Copper Project, respectively.

Table 3-3 Carmacks Copper Project Schedule

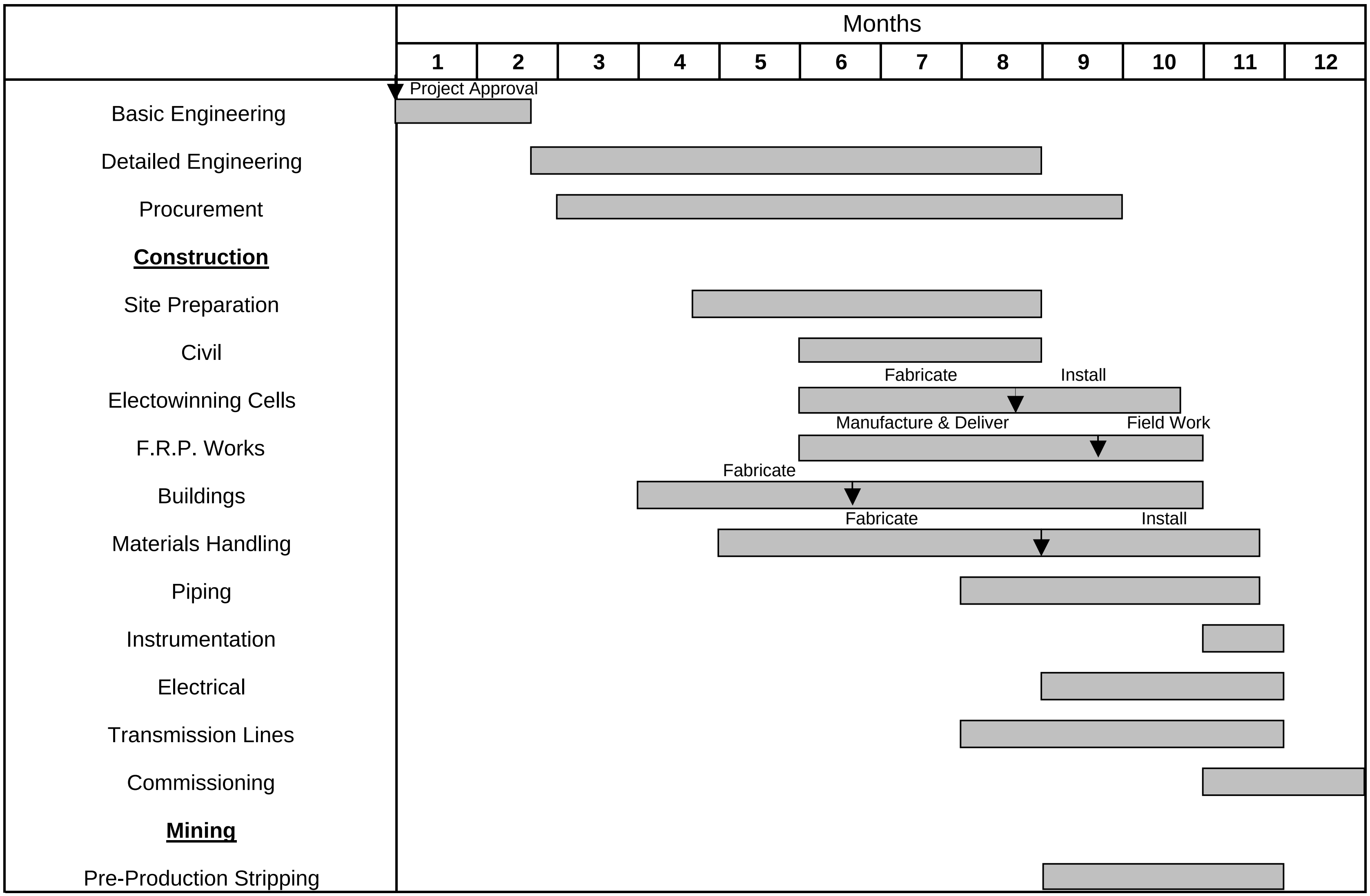


Table 3-4 Annual Mining Production Schedule

YEAR		-1	1	2	3	4	5	6	7	8	Total
Mine Production Schedule											
Available Days	days	365	365	365	365	365	365	365	365	365	**3,285**
Operating Days	days	180	300	300	300	300	300	300	300	180	**2,460**
Shifts/Day	shifts	2	2	2	2	2	2	2	2	2	**2**
Hours/Shift	hours	12	12	12	12	12	12	12	12	12	**12**
Available Hours	hours	4,320	7,200	7,200	7,200	7,200	7,200	7,200	7,200	4,320	**59,040**
Operating Delays Factor	%	83%	83%	83%	83%	83%	83%	83%	83%	83%	**83%**
Operating Hours	hours	3,600	6,000	6,000	6,000	6,000	6,000	6,000	6,000	3,600	**49,200**
Ore Production	tonnes	200,000	1,763,500	1,973,229	1,974,396	1,837,363	1,792,000	1,792,500	1,642,400	302,481	**13,277,869**
Total Copper Grade	%	0.906	0.912	0.907	0.907	0.974	0.999	0.999	1.090	1.180	**0.971**
Contained Copper	lbs	3,992,198	35,450,392	39,441,960	39,442,655	39,442,439	39,441,863	39,442,995	39,442,039	7,863,828	**283,960,369**
Waste Production	tonnes	2,000,000	5,000,000	7,800,000	9,500,000	11,800,000	10,300,000	8,000,000	6,100,000	753,236	**61,253,236**
Total Material	tonnes	2,200,000	6,763,500	9,773,229	11,474,396	13,637,363	12,092,000	9,792,500	7,742,400	1,055,717	**74,531,105**
Strip Ratio	(w:o)	10.0	2.8	4.0	4.8	6.4	5.7	4.5	3.7	2.5	**4.6**
Production Rate-Ore	tpd	1,111	5,878	6,577	6,581	6,125	5,973	5,975	5,475	1,680	**5,042**
Production Rate-Waste	tpd	11,111	16,667	26,000	31,667	39,333	34,333	26,667	20,333	4,185	**23,366**
Production Rate	tpd	12,222	22,545	32,577	38,248	45,458	40,307	32,642	25,808	5,865	**28,408**
Copper Recovery	%	80%	80%	80%	80%	80%	80%	80%	80%	80%	
Recovered Copper	lbs.		28,360,314	31,553,568	31,554,124	31,553,951	31,553,490	31,554,396	31,553,631	6,291,063	**223,974,537**
Copper Tonnes	t	1,448	12,862	14,310	14,310	14,310	14,310	14,310	14,310	2,853	**11,447**
Copper Tonnes Target	t		14,310	14,310	14,310	14,310	14,310	14,310	14,310	14,310	**14,310**

3.3.5 Decommissioning and Reclamation

Decommissioning and site reclamation will occur progressively where possible. The WRSA would be constructed in such a manner to allow for progressive reclamation and revegetation once areas are completed. Overburden stockpiles will be established during initial site construction and used for future reclamation. Generally slopes will be graded and covered with overburden material and revegetated. Infrastructure and hazardous materials will be removed from the site and reclaimed. The heap will continue to be leached and rinsed following the cessation of mining. An evaporative soil cover will be placed over the re-sloped heap and the heap rinsed with water. Effluent from the heap will be treated for release with final solution passing through an infiltration gallery at eventual closure. Carbon based nutrients will be added to the heap after rinsing is complete to enhance immobilization of metals in the infiltration gallery. Monitoring and maintenance will continue to demonstrate decommissioning and closure success. Appendix F presents details of the Conceptual Closure Plan.

3.4 MINE STAFFING

3.4.1 Mine Engineering

The mine engineering department will be directed by the Chief Engineer who will supervise both the engineering and geology staff. The engineering group will be responsible for short and long range mine planning, surveying and grade control. The Chief Engineer will report directly to the Mine Superintendent.

The geology department will be responsible for updating the geological model so that changes can be made to the mine plan as required. This department will also be responsible for assisting the engineering group with grade control. The Mine Geologist will map the ore and waste bench faces on a daily basis, recording both structural and geological data.

Environmental monitoring and compliance will be maintained by an environmental technician who will also report to the Chief Engineer.

3.4.2 Maintenance

The mine maintenance department will be controlled by the maintenance General Foreman who will report to the Mine Superintendent. The maintenance department will carry out the planning, supervision and implementation of maintenance work on the mine equipment and will work intimately with the mine engineering and mine operations departments.

3.4.3 Mine Surveying

Routine surveying will be conducted for setting survey control points, for recording as-built mine data and for setting out mine control points. Mine control points that will be typically set out include high-wall toes and crests, ramps, ore control points, etc. Typical as-built surveying will include high-wall toes and crests, blast hole locations, bench face advance, geologic control points, etc.

3.4.4 Personnel

General administration staff at the mine averages 8 employees per year (Table 3-5). An average of 109 individuals would be working on the mine each year, with 130 the maximum (Table 3-6). Process plant personnel averages 43 employees per year (Table 3-7). Total staff employed at the mine would average 160 employees per year.

During construction activities it is estimated that a peak of 226 construction staff would be employed at the mine.

Table 3-5 General Administration Staff

YEAR		PP	1	2	3	4	5	6	7	8
General Administration Staff										
General Mine Manager	no.	1	1	1	1	1	1	1	1	1
Administrative Secretary	no.	1	1	1	1	1	1	1	1	1
Chief Accountant	no.	1	1	1	1	1	1	1	1	1
Payroll Clerk	no.	1	1	1	1	1	1	1	1	1
Personnel/Safety Officer	no.	1	1	1	1	1	1	1	1	1
Chief Purchasing/Warehousing	no.	1	1	1	1	1	1	1	1	1
Purchasing/Warehouse Clerk	no.	1	1	1	1	1	1	1	1	1
Environmental Coordinator	no.	1	1	1	1	1	1	1	1	1
Total Staff		**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**

Table 3-6 Mining Manpower Complement

YEAR		-1	1	2	3	4	5	6	7	8
Staff										
Mine Superintendent	no.	1	1	1	1	1	1	1	1	1
Chief Engineer	no.	1	1	1	1	1	1	1	1	1
Mine Engineer	no.	0	1	1	1	1	1	1	1	1
Mine Geologist	no.	1	1	1	1	1	1	1	1	1
Mine Clerk	no.	0	1	1	1	1	1	1	1	1
Mine Surveyor	no.	1	1	1	1	1	1	1	1	1
Mine Technician	no.	1	2	2	2	2	2	2	2	2
Pit Foreman	no.	2	4	4	4	4	4	4	4	4
Maintenance Foreman	no.	1	1	1	1	1	1	1	1	1
Maintenance Shop Foreman	no.	0	2	2	2	2	2	2	2	2
Maintenance Planner	no.	0	1	1	1	1	1	1	1	1
Subtotal Staff		**8**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**
Mine Operations										
Shovel Operator	no.	4	4	4	4	4	4	4	4	4
Loader Operator	no.	0	4	4	4	4	4	4	4	4
Haultruck Operator	no.	8	12	16	20	28	28	28	24	8
Water & Sand Truck Operator	no.	4	4	4	4	4	4	4	4	4
Blasthole Drill Operator	no.	4	4	8	8	8	8	8	4	4
Grader Operator	no.	4	4	4	4	4	4	4	4	4
Bulldozer Operator	no.	4	8	8	8	8	8	8	8	8
Wheel Tractor Operator	no.	1	2	2	2	2	2	2	2	2
Excavator Operator	no.	1	2	2	2	2	2	2	2	2
Airtrack Drill Operator	no.	1	2	2	2	2	2	2	2	1
Blaster	no.	1	1	1	1	1	1	1	1	1
Helper/Labourer	no.	3	3	3	3	3	3	3	3	3
Subtotal Mine Operations		**35**	**50**	**58**	**62**	**70**	**70**	**70**	**62**	**45**
Mine Maintenance										
Mechanic - Heavy Duty	no.	2	4	4	8	8	8	8	8	4
Mechanic - LIght Duty	no.	2	4	4	4	4	4	4	4	4
Field Mechanic	no.	2	4	4	4	4	4	4	4	4
Apprentice Mechanic	no.	4	4	4	8	8	8	8	8	4
Welder	no.	2	2	4	8	8	8	8	8	2
Tireman	no.	1	2	2	4	4	4	4	4	2
Fuel and Lube Serviceman	no.	2	4	4	4	4	4	4	4	4
Tool Crib Attendant	no.	4	4	4	4	4	4	4	4	4
Subtotal Mine Maintenance		**19**	**28**	**30**	**44**	**44**	**44**	**44**	**44**	**28**
Total		**62**	**94**	**104**	**122**	**130**	**130**	**130**	**122**	**89**

Table 3-7 Process Plant Personnel

Position	# Personnel
Operating Personnel (12 months/year)	
Process Superintendent	1
Process Metallurgist	1
Crusher	
Crusher Operator (7 months/year)	3
Crusher Labourer (7 months/year)	4
Heap Leach Pad	
Heap Labourer	4
SX/EW Plant	
Operator	8
Labourer	4
Acid Plant	
Operator	4
Labourer	2
Laboratory	
Laboratory Technician/EMT	4
Subtotal	**35**
Maintenance Personnel	
Journeyman	3
Apprentice	2
Electrician	2
Instrument Technician	1
Subtotal	**8**
Total Personnel	**43**

3.5 WATER MANAGEMENT

3.5.1 Water Balance

3.5.1.1 General

Leaching and extraction processes have been designed to operate on the basis of 100% recycle of process streams. There will be no direct discharge of process effluents to Williams Creek, however, a water treatment plant is planned as a contingency measure should excess process waters require release. The only other releases to Williams Creek will be from the sediment ponds located below the events ponds and WRSA. Water recycling from these sediment ponds is planned along with wastewater from the open pit, which will be used as make-up water. The events pond will remain empty and will only be used during emergency storm events or pump failure. Discharges from the laboratory wastes and floordrains will be re-routed to the PLS stream and returned to the process stream in order to minimize losses.

<u>Site Drainage and Diversion</u>

The development of the mine, WRSA, leach pad and process facilities will require the altering of local surface water drainage patterns. Surface water quantities will also be affected by the changes in evapotranspiration and infiltration due to land clearing and open pit excavations.

The project will require the diversion of uncontaminated surface run-off from the drainage areas up-slope from the mine and process facilities by means of open, gravity ditching. North Williams Creek, which is north of the project facilities, will be the main drainage of uncontaminated surface water around the WRSA. Waters running through the waste rock will be routed away from North Williams Creek and collected in drainage ditches to a sediment pond. The majority of these waters will be routed into the process plant as make-up water. All leachate from the pad will be routed to the process plant and recycled onto the pad to maintain a closed loop without discharge to the surrounding environment.

Potentially contaminated run-off from the mine and process facilities will be collected in gravity interceptor ditches and directed to settlement ponds adjacent to Williams Creek. The settlement ponds will be provided to trap suspended sediment and contain any accidental spills of process solutions. Overflow spillways from the ponds will ultimately drain into Williams Creek at the lowest point of the property before release to the environment. Effluent released from the settlement ponds will be monitored to ensure that effluent discharge standards are met.

3.5.1.2 Heap Leach Pad

The water balance for the heap leach facility at the Carmacks Copper project was modeled using a spreadsheet analysis developed in Microsoft Excel. The analysis used monthly time steps to allow a continuous simulation of the water balance over the eight year mine operating life plus a period of five years (two years residual leaching plus three years heap rinsing) after the completion of ore placement. The model includes user-defined water inputs for the leaching process and for the site hydrology (precipitation, rainfall, snowfall and evaporation).

The hydrology of the leach pad area at an assumed nominal elevation of 850 m was presented in the Clearwater Consultants Ltd. Design Memorandum CCL-CC2 (March 12, 1998) and CCL-CC2A (April 23, 1998). Descriptions of the input data and assumptions and modelling methodology are presented in Clearwater Consultants Ltd. Design Memorandum CCL-CC4. A summary of water balance results from Design Memorandum CCL-CC4 follows.

General

The water balance results discussed following refer to ROM ore and are presented as a series of tables and figures in Appendices I, II and III of Design Memorandum CCL-CC4. Appendix I of the Memorandum contains the results of the base case average precipitation conditions water balance model:

- worksheet “Summary” (Table I.1, one page);
- worksheet “Input&Output” (nine pages) with the input data and assumptions (Table I.2, page 1), the leach pad monthly water balance (Table I.3, pages 2 to 5), and the Events Pond monthly water balance (Table I.4, pages 6 to 9); and
- worksheet “Graphs” (one page) with Figure I.1 (Events Pond Water Storage Variation) and Figure I.2 (Variation in Monthly Treat and Release Volumes).

Appendix II of Design Memorandum CCL-CC4 contains copies of the worksheet “Summary” for dry years (Table II.1, 20 year return period) and for wet years (Table II.2, 100 year return period). Table II.3 presents worksheet “Annual”, a comparison of the three hydrologic conditions on an annual basis. Table 3-8 and Table 3-9 summarize and compare annual make-up water volumes and treat and release volumes, respectively, for each stage of heap development.

Make-Up Water Requirements

The results show that, for average and 20 year return period dry year conditions of annual precipitation, the heap will be in a water deficit position until the end of Year 7. For 100 year return period wet years the heap will be in a water deficit position until the end of Year 3. No make-up water will be required after Year 8.

Table 3-8 Annual Make-Up Water Requirements (m^3/year)

Condition	Stage I	Stage II	Stage III (Years 4 to 7)	Stages IV to VI
Average	123 000	69 000	9 000 to 29 000 (2)	0
Dry Years	139 000	93 000	42 000 to 61 000	0
Wet Years	94 000	27 000	0	0

Notes for Table 3-7

1) Volumes shown represent average values for the indicated stage of operations rounded up to the nearest 1000 m^3. Year-to-year values will vary as shown in the Appendices.
2) Stage III make-up water demands will depend on the number of lifts of ore under leach. Table shows the estimated ranges for Years 4 to 7.

Treat and Release Requirements

As shown on Table 3-9 for all precipitation conditions, the system will not require the treatment and release of any excess water during the first three years of ore placement. Average and drier conditions will not require any releases until after Year 7. Some excess water may require treatment and release during Years 4 to 7 as a result of 100 year wet years.

Table 3-9 Annual Treat and Release Volumes (m^3/year)

Condition	Stages I & II (Years 1 to 3)	Stage III (Years 4 to 7)	Stage IV (Years 8 & 9)	Stage V (Note 2)	Stage VI
Average	0	0	91 000 to 112 000	145 000	113 000
Dry Years	0	0	58 000 to 79 000	113 000	80 000
Wet Years	0	29 000 to 49 000	149 000 to 170 000	203 000	171 000

Notes for Table 3-8

1) Volumes shown represent average values for the indicated stage of operations rounded up to the nearest 1000 m^3. Year-to-year values will vary as shown in the Appendices.
2) Stage V includes the controlled treatment and release of the draindown inventory.

After all ore has been placed but while leaching is still on-going in Stage IV, 91 000 to 112 000 m^3 per year of excess water may have to be treated and released during average conditions since moisture will no longer be lost to wetting of new ore. During the heap rinsing and detoxification phase (Stage V, Years 10 to 12), it has been assumed that pumping and recirculation rates will be progressively decreased such that draindown of the heap would be accomplished in a controlled manner over a three year period. About 145 000 m^3 per year will require treatment during this stage for average conditions. This volume would decrease significantly after placement of a soil cover on the heap. Volumes for Stage VI are shown in the table to provide an indication of the annual volumes of water expected to report to Williams Creek after heap rinsing has been completed.

Actual monthly treatment and release volumes will be optimized during operations so as to satisfy water quality criteria in the downstream receiving environment. Actual year-to-year treatment volumes will vary depending on the number of lifts of ore under leach, actual ore moisture conditions, and the actual magnitude of monthly and annual precipitation.

Normal Maximum Solution Storage Volumes

Table 3-10 summarizes normal maximum solution storage volumes, which would occur each year for average, 20 year dry year and 100 year wet year precipitation conditions. The volumes result from hydrological inflows only with no allowance for any additional process-related inflows.

Table 3-10 Normal Maximum Solution Storage Volumes (m^3)

	Stage I	Stage II	Stage III	Stage IV	Stage V
Average Precipitation					
In-Heap	500	500	500	500	500
Events Pond	28 000	42 000	58 500	58 500	500
Total Storage (Note 1)	28 500	42 500	59 000	59 000	1 000
Dry Years (20-year)					
In-Heap	500	500	500	500	500
Events Pond	20 000	30 000	41 500	41 500	500
Total Storage	20 500	30 500	42 000	42 000	1 000
Wet Years (100-year)					
In-Heap	500	500	500	500	500
Events Pond	43 000	64 000	88 500	88 500	500
Total Storage	43 500	64 500	89 000	89 000	1 000

Notes for Table 3-9

1) "Total Storage" corresponds to the maximum concurrent total of In-Heap (nominal 500 m^3) plus Events Pond storage for each stage. The Events Pond capacity will be 160 000 m^3.
2) Volumes are averaged over the respective periods and rounded to the nearest 500 m^3. Volumes for individual years in each stage are shown in Tables I.1, II.1 and II.2 of Design Memorandum CCL-CC4.
3) Stage V volumes correspond to nominal minimum pond volumes. The treatment plant capacity during this stage will be sufficient to treat and release water as fast as it reports to the Events Pond. Temporary storage of water, therefore, will not be required for normal operations during Stage V although the Events Pond facility will remain operational if needed during this stage.

Annual maximum volumes generally occur at the end of the snowmelt period and subsequently decrease during the summer and fall. Minimum volumes are attained by the end of October and maintained throughout the winter period.

The volumes in Table 3-10 represent averages for each stage of operations. The maximum solution storage volume experienced in a year will depend in part on the actual magnitude of the precipitation each month and year. Extreme hydrological events used for design and recommended total design solution storage volumes are presented in Design Memorandum CCL-CC4.

3.5.1.3 Waste Rock Storage Area

Provisions are included in the design of the waste rock storage area to control the surface inflows into the facility. This will be accomplished by constructing surface and collection drainage ditches that will collect and direct the surface runoff and near surface seepage water to the sediment control pond.

Surface Drainage and Collection Ditches

Surface drainage ditches will be constructed to channel the surface runoff to the surface drainage collection ditch. It is anticipated that additional surface drainage ditches in the footprint of the WRSA may be required to enhance the drainage. These ditches will mainly be of use in the early stages of the WRSA development as the foundation thaws and excess water is released. Eventually these ditches will be covered by waste rock material. The perimeter collection ditch surrounding the WRSA has been designed to intercept all surface run off and near surface seepage from the WRSA and convey this to the WRSA outlet channel, which ultimately drains into the sediment control pond. The perimeter collection ditch and the WRSA outlet channel will be riprap lined to prevent erosion and downcutting. The preliminary sizing of these ditches is based on conveying the peak runoff flow obtained from the 1 in 200 year 24 hour storm event. The peak design flows are estimated to be 1.25 m^3/s for the WRSA outlet channel and 0.65 m^3/s for the perimeter collection ditch.

Sediment Control Pond

The location and details on the design features of the sediment control pond are shown on Drawing 1785.218 in Appendix A. The sediment control pond design includes a sloping riser for pumpback and will be protected from overtopping by a spillway designed to pass the 1 in 200 year, 24 hour storm event estimated with a peak flow of 1.25 m^3/s.

The sediment control pond has also been designed to store a volume of 65,000 m^3, which comprises the following:

- 1 in 10 year, 24 hour storm event: 10,000 m^3
- Dead storage: 10,000 m^3
- Surface runoff storage from the WRSA: 45,000 m^3

Pumping of stored water for use at the process plant site will be accomplished using the sloping riser and a pipeline conveying water to the process circuit.

Water Balance

A linked annual water balance model was developed to estimate the monthly water sources to the sediment control pond. The water balance model accounts for runoff volumes derived from precipitation falling directly upon the waste rock storage area and associated runoff. For the snowmelt condition, a uniform depth of snow has been assumed to cover the entire area. The 20 year dry, average and 20 year wet annual precipitation conditions were modelled in the water balance to determine potential inflows and outflows on the facility. Assumptions used in the water balance model are presented in the “Report on Detailed Design of Waste Rock Storage Area” prepared by Knight Piesold in May, 1997.

The results of the water balance modelling for the WRSA are shown on Figure 3-9 for the end of years 1, 4, and 8. The modelling shows that the amount of runoff decreases as the size of the loaded portion of the WRSA increases. This is a direct result of the cleared, unloaded area having a higher runoff coefficient than the loaded area. The peak inflow volumes reporting to the sediment control pond occurs in the month of April with July generally being the second highest inflow month.

The 9 year average year linked water balance is presented within Knight Piesold’s “Report on Detailed Design of Waste Rock Storage Area” as Table 3.

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
WASTE ROCK STORAGE AREA
WATER BALANCE – END YEAR 1

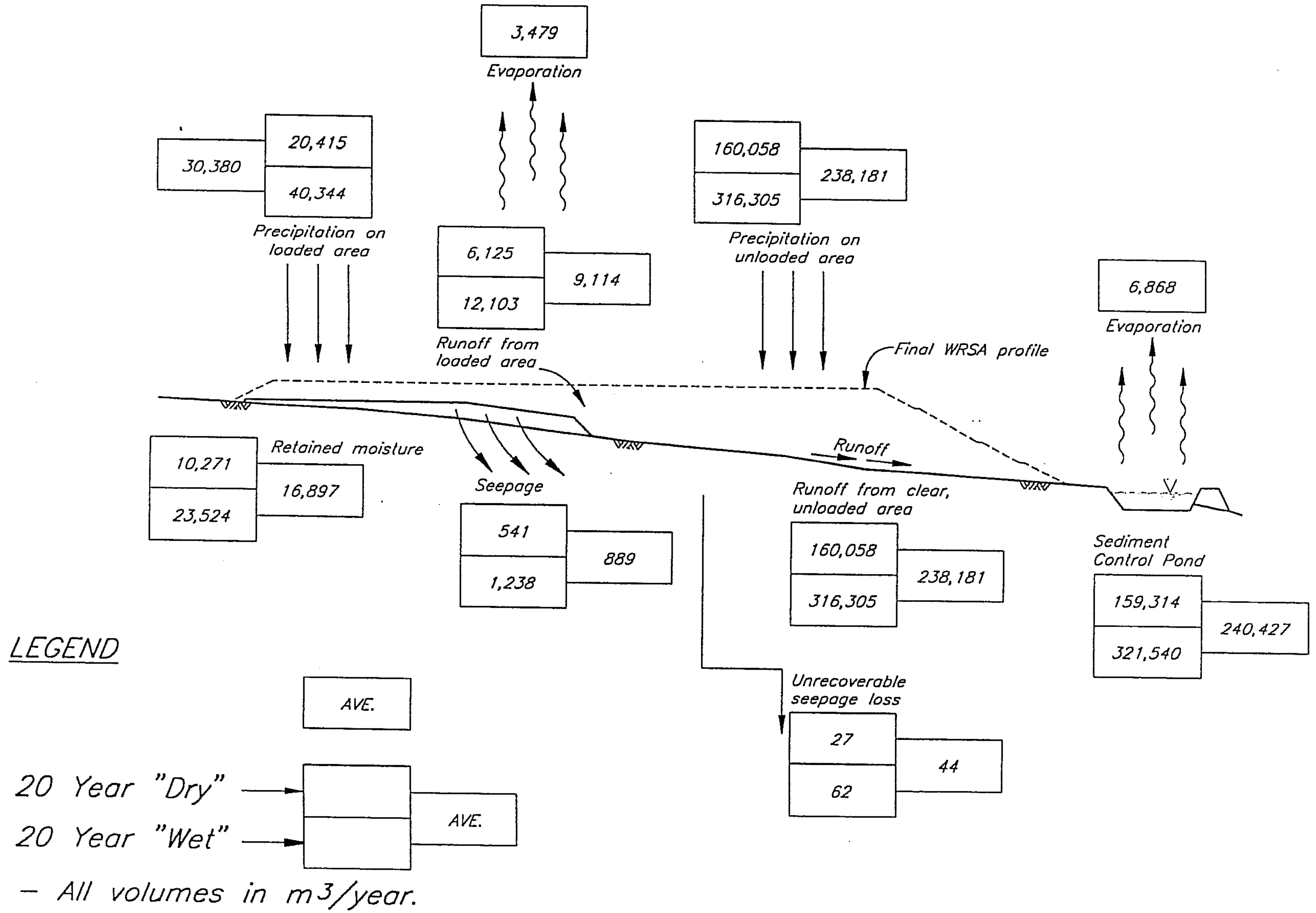


Figure 3-9

Based on Information from Hallam Knight Piesold Ltd., May 30, 1997

3.5.2 Water Supply

The use of recycled process solutions and contaminated run-off will be maximized to limit the use of makeup fresh water.

3.5.2.1 Water Requirements

The estimated water requirements are:

- Potable 45 m^3/day
- Process (daily average) 650 m^3/day
- Road (dust control) watering (peak dry weather) 190 m^3/day

Process makeup water will be sensitive to seasonal variations due to the net evaporation loss and ore wetting requirements.

The estimated peak hourly demand to satisfy fire water makeup requirements will be 250 m^3/hour.

The quality of process makeup, fire water makeup, and road watering water will be lower than that required for potable use. For example, water from sediment ponds would be used as source water for road dewatering. Potable water treatment packages will be installed at the plantsite pumphouse for local usage, and at the campsite pumphouse for the camp and shop/warehouse requirements.

3.5.2.2 Water Sources

In addition to the collection and storage of run-off, snow melt, and direct rainfall on the leach pad, events pond and settlement ponds, the following sources of water will be available:

- Wells: Water wells are located in the bedrock confined aquifer underlying the Williams Creek drainage. Each of the 8 wells is estimated to provide approximately 150 m^3/day of fresh water. Submersible well pumps, installed in the eight bedrock wells to be developed within the Williams Creek Valley, will be connected directly to the fresh water supply pipeline. The capacities and number of the wells will be confirmed by pump testing during detail design. The wells will be the primary source of fresh water for the project;

- Mine pit dewatering: Submersible pumps will be installed in the pit sump and the water will be used at the crusher, for truck washing and road watering. Excess mine water will be directed to the service complex settlement pond;

- Sediment Control Ponds: Storage ponds will be located, at the lowest point of the area, below the shop/warehouse leach pad and waste rock storage. Pumps will be installed in the ponds to pump the water to storage tanks around the project site. PVC, pipelines connected to the pumps will serve as a secondary water supply for the project.

This source of water will be seasonal. Drawing 1785.218 provides the location and plan for the sediment control ponds; and

- Events Ponds: Excess meteoric water from the events ponds will be used as make up water for the leaching process.

A mine water discharge pipeline will be connected to the maintenance shop/warehouse area from the open pit dewatering pumps for road watering, truck washing and dust suppression. A branch line off this pipeline will supply water to the crushing plant area.

All water pipelines will be buried or heat traced and insulated for freeze protection.

3.5.2.3 Water Distribution

The main water supply pipe from the sediment control ponds and the wells will supply the 265 m^3 capacity storage tank at the plant site. Of this, 165 m^3 will be reserved for the fire protection system. Two pumps, one a standby, at this tank will distribute water to the potable water system and the process. A water treatment package will be installed in the potable water line branch.

The same pumps will supply makeup water to the fire/fresh water storage tank at campsite. Tank capacity here will be 475 m^3, of which 375 m^3 will be fire water reserve. With a grade elevation of 879 m, this tank will supply the plantsite fire water system (grade elevation 766 m) by gravity.

The water distribution pumphouse will be located near the fire/fresh water tank. It will house the potable water system for the campsite and the repair shop/warehouse, i.e. the water treatment package, a small potable water storage tank; two fresh water pumps for the shop/warehouse and crusher area, and the fire water pumps.

Drawings 100-13-27 and 100-13-28 provide overall schematics of the water supply and distribution system, respectively. Drawing 100-13-29 shows the water supply pipeline plan and profile; Drawing 100-13-21 illustrates the water distribution pumphouse plan, section and details; and Drawing 100-13-20 shows the fresh water booster pumphouse plan and sections. Drawing 400-03-08 depicts a water and air flowsheet.

3.5.2.4 Fire Water System

There will be a buried fire water loop and hydrant system at plantsite, gravity fed from the fire/fresh water tank at the campsite.

A second fire water system of buried distribution pipes and fire hydrants will cover the campsite, crusher area, and services site. This system will be connected to the electric motor driven fire pump to be located at the distribution pumphouse. A diesel engine driven standby fire pump will be provided, as well as a jockey pump.

In all cases, the fire water hydrant system will be supplemented locally by portable fire extinguishers and hose stations.

A 690 m^3 fresh/fire water tank will be located adjacent to the water distribution pumphouse. The lower portion of this tank will be dedicated to storing 345 m^3 of fire water which will provide 1.5 hours of reserve at 230 m^3/h consumption. An additional supply of up to 345 m^3 could be available in the upper portion of the tank. The elevation of the fire water tank will not be sufficient to supply the required flow and pressure by gravity so booster pumps will be required. Around the area, there will be a buried ring main to supply water for hydrants and sprinkler systems in the maintenance shop and warehouse, and administration offices. The process plant will also be connected to the fire water system and will have a chemical foam system in addition to sprinklers for fire protection of the mixer settlers.

3.6 WASTE MANAGEMENT

Proper identification and management of various waste streams is important for worker health and safety and environmental protection. The following section describes planned waste management practices.

3.6.1 Process Fluids Management

An EMS will be developed to ensure that all liquids are accounted for in the operation of the mine. The overall management strategy is based on the following:

- maximizes the recycling and reuse of liquids;
- isolates non compatible or dangerous fluids;
- minimizes the quantity of liquids requiring handling;
- provide secondary containment where necessary;
- provides emergency mitigation measures; and
- monitors environmental effects.

Fluids that will be used at the proposed Carmacks Copper Project include:

- surface water;
- groundwater;
- waste rock runoff;
- mine water;
- site runoff;
- potable water;
- sewage and grey water;
- pregnant leach solution;
- raffinate (barren solution following processing);
- sulphuric acid;
- fuels; and
- reagents (petroleum organic, hydrated lime, cobalt sulphate, guar gum, kerosene).

Fluids management may be broken down into a number of topics found in the sections listed below:

- project and process description – Section 3.0;
- spill contingencies and emergency response plan – Appendix L;

- environmental effects assessment – Sections 7.0;
- environmental monitoring – Section 8.2; and
- closure and reclamation planning – Section 7.8, Appendix F.

Prior to operation the EMS will be finalized including the identification of waste streams, locations, safety and contingency plans, and monitoring plans.

3.6.1.1 Wastewater Treatment and Disposal

Water from the open pit and sediment ponds will be used for process makeup water to the fullest possible extent. Any excess pit water will be discharged to the environment in full compliance with the discharge performance standards (see Appendix C, Section 2.9); where possible this excess water will be recycled for process use.

The leach pad and process plant solutions are designed to be 100% recycled so there will be no release of process streams to the environment. Following mine closure, the Carmacks leach pad will be covered over to seal it from direct exposure to precipitation. However, a water treatment plant is presented as a contingency measure should the release of effluent be required. The design of the plant will be consistent with current regulations for effluent requirements. Details of the water treatment plant for emergency raffinate treatment is found in Appendix D of the Technical Issues Response Document.

Details of the water treatment plans for closure are presented in Appendix A of the Conceptual Closure and Reclamation Plan, found in Appendix F of this report.

The proposed emergency water treatment system utilizes known technology and will be a caustic precipitation plant for bulk removal of metals and for pH adjustment. The water treatment plant has been divided into 4 parts:

- Lime Storage System;
- Neutralization System;
- Filter Area; and
- Pond System.

Upon closure, the existing emergency raffinate treatment plant/neutralization tanks will be modified to act as water treatment reactors. The hydrated lime storage silo and screw feeder will be modified to make the reagent bin and feeder.

The filter press and pump, the sludge receiver and sludge bin/dryer will be provided by modifying the existing crud treatment and filter press system which form part of the flotation and organic treatment system.

The plant will include the following major facilities:

- Seepage collection system
- One collection pond;
- Two stirred treatment reactors;
- One Clarifier;
- One sand filter;
- One sludge filter press;

- One sludge dryer;
- Treated water retention pond;
- Utilities and ancillaries including reagent supply, air compressors, emergency and line power, drinking water, etc; and
- Support facilities, including office, control room and maintenance area.

Most of the process equipment will be enclosed in buildings.

The plant will have a treatment capacity sufficient to handle seepage and any contaminated run-off from the area of the closed leach pad. The flow rates will vary with the season and the weather.

Given sufficient capacity in the collection pond, the plant may be operated on a campaign basis, treating larger volumes of accumulated seepage as required.

This water treatment system is relatively simple, but allows flexibility for a number of process parameters, including:

- Aeration and sludge re-circulation;
- Reagent dosages of pH adjustment and flocculation;
- Alternate sludge collection and disposal methods; and
- Alternate & supplementary reagents including:
    - Caustic soda;
    - Soda ash;
    - Sodium phosphate;
    - Lime and limestone; and
    - Commercial precipitant.

Additional details on the water treatment plant are described in Appendix A of the Conceptual Closure and Reclamation Plan, found in Appendix F of this report.

3.6.2 Sewage Treatment

Sewage disposal facilities will include both permanent and portable facilities. The permanent facilities will occupy the maintenance shop and warehouse, dry camp, and administration buildings. Sewage disposal will consist of a conventional septic tank and drainage field. Sewage effluent will flow by gravity in buried 150 mm diameter PVC sewer lines to two 34 m^3 septic tanks located at the south side of the plant site area. Septic tank overflow will be dispersed to ground via a buried tile field.

The sewage treatment system for the ancillary facilities will be designed for an average daily flow of 22 m^3, which is based on 146 person shifts per day at 150 L per person shift.

3.6.3 Waste Rock

3.6.3.1 Waste Rock Storage

Mining operations will generate approximately 7.5 million t/year of waste rock per year over the 8 years of mining for a total waste production of approximately 60 million t, yielding a life of mine average stripping ratio of 4.6:1. This waste will be stored in a permanent location north of the open pit.

Trenching (Knight Piesold Ltd., 1992) indicates that overburden in the vicinity of the deposit and waste rock dump is not extensive: a typical soil profile consists of several inches of root and organic material, overlying up to 1 foot (0.3 m) of white volcanic ash which in turn overlies several inches of stratified dark brown/black organic silt on top of several feet of silty clay interlaced with some cobble and boulders.

Refer to Appendix G, Figure 5.1, which shows the metallurgical sample locations.

3.6.3.2 Mineralogy of Waste Rock

Three waste rock samples were thin sectioned and petrographically described: the first sample was a diorite, highly silicified and originally probably undersaturated in silica, accompanied by secondary epidote and almost compete chlorotization of biotite, although hornblende and sphene remain fresh. The second sample was identified as a quartz diorite. Relatively weak hydrothermal alteration is shown by partialbiotite breakdown with development of some epidote and chlorite. The third waste rock sample was identified as hornblende diorite. There was weak hydrothermal alteration of biotite noted and weak supergene montmorillonite alteration present. Minor limonite indicates slight permeability. There is less than 1% magmatic magnetite present and a small additional amount derived from partial alteration of sphene to carbonate, plus magnetite and /or rutile. Mineralogy of the three waste rock samples is presented in Appendix G, Table 5.1. Refer to the report prepared by Richard W. Lawrence in May 1996 entitled “Evaluation of the Mineralogy of a Sample of Carmacks Acid Leach Residue” for details on the neutralizing potential of the Carmacks ore.

3.6.3.3 Multielemental Scan of Waste Rock

A comprehensive waste rock characterization program was initiated by Western Copper Holdings Ltd. (1992) to determine the necessary design criteria for detailed waste management plan. A total of 23 discrete samples (0.6 m intervals) of waste rock obtained from 6 individual diamond drill holes representing the various waste types were submitted for detailed ICP analyses. Results (summarized in Appendix G, Table 5.2) indicate that waste rock is higher with respect to arsenic (average 197 ppm), bismuth (average 4.14 ppm), cadmium (average 0.92 ppm), copper (average 177 ppm) and silver (average 0.25 ppm), when compared to global crustal averages. Given the mineral composition of the ore, higher than normal levels of copper, cadmium, arsenic and silver would be expected. Major metals that were found to be equivalent to or significantly lower than crustal averages were barium, chromium, cobalt, iron, lead, magnesium, molybdenum, nickel and zinc. Although the concentrations of calcium (1.11 %) and magnesium (0.52 %) were low, so were concentrations of iron (1.75 %) and sulphur (2.28 ppm).

Combined, these data indicated that the waste rock would be expected to contain very little oxidizable sulphides or pyrite and very little propensity to generate acid leachate. Nevertheless, waste rock dump runoff settling pond releases should be monitored for soluble arsenic, cadmium and copper.

3.6.3.4 Acid Base Accounting of Waste Rock and Ore

Static Testing

Representative samples of composite ore used in metallurgical pilot plant studies and composite samples of ore from drill core were submitted for acid-based accounting, in part to determine the leachability and acid consumption characteristics. In addition, each of the 23 samples of waste rock submitted for ICP analyses were submitted for acid-base accounting.

Results (presented in Appendix G, Tables 5.3a and 5.3b) indicate that both the ore and the waste rock, which have long been oxidized, contain very little remaining oxidizable sulphur. Total sulphur in the trench sample composites, which is primarily chalcopyrite and bornite, averages 0.08%, yielding an average maximum acid generating potential of 2.6 t/1000 t H_2SO_4. The neutralization potential of the three metallurgical composites averaged 11.6 t/1000 t, yielding a net neutralization potential of 9.0 t/1000 t. This value is consistent with the projected acid consumption of 25 kg/t for leaching purposes.

Samples of ore from drill core averaged 0.06% sulphur and maximum acid generating potential of 2.00 t/1000 t H_2SO_4. The neutralization potential average 19 t/1000 t and net neutralization potential of 17 t/1000 t. Both the metallurgical composites and individual drill hole samples contained NP/AP Ratios of greater than 4:1 indicating that the ore falls in the upper left quadrant of a log/log scale and will not be acid generating.

Only one sample of the 23 waste rock samples tested was found to contain concentrations of sulphur above the detection limit of 0.01% (0.01 to 0.02%). Maximum acid generating potential using the detection limit as worst case was calculated to be 0.31 t/1000 t H_2SO_4. Average neutralization potential of waste rock was found to be 28 t/1000 t (10.1 to 89.8 t/1000 t) and a net neutralization potential of greater than 27 t/1000 t (9.8 to 89.5 t/1000t). The overall NP/AP Ratio averages 90:1. The waste rock material satisfies the Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia and Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia.

Data Analyses

All results from static acid-based accounting of high and low grade ore; spent ore and waste rock were plotted on a plot of sulphur content vs. NP/AP Ratios on a log/log scale. Quadrants are defined horizontally by an NP/AP Ratio of 4:1 and vertically by the sulphur content of 0.3%.

Sample results that fall below the 0.3% sulphur range are regarded as having insufficient sulphur content to sustain acid generation. Sample results located above NP/AP Ratio 4:1 are regarded as containing sufficient buffering capacity to neutralize any oxidation products of the contained sulphur. Samples which fell below an NP/AP Ratio of 4:1 and above the 0.3% sulphur boundary are regarded as being acid generating.

In the case of the Carmacks Copper samples, the two spent ore samples (leach tailings) are regarded as potentially acid generating. However, this is because the samples, although stripped of their sulphides and obviously non–acid generating, still contain residues of sulphuric acid.

Acid/Base Accounting (ABA) ARD Screening Criteria

No federal guidelines are currently in place with regards to testing protocols for acid rock drainage; however, as a reference the “Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (August 1998)” as well as the “Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (April 1997)” have been used for this assessment. Guidelines for minesites in the Yukon are currently being developed using the BC guidelines as a basis, with the first draft due March 31, 2005.

The “Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (April 1997)” outlines three ABA criteria, as follows:

1. No testing is required on unconsolidated materials such as glaciofluvial and fluvial deposits, derived from wide areas, and having little opportunity for either sulphides or trace element concentration or deposition;

2. Materials with a sulphides-S content less than 0.3% and a subsoil pH greater than 5.5 require no further ARD testing and, if there is no other metal leaching concern, will be considered safe to excavate. A cutoff of 0.3% sulphides-S is appropriate for most geological conditions. The exceptions are where the rock matrix consists entirely of base poor minerals (for example, quartz and sericite, in pervasive phyllic alteration) or where the sulphides minerals contain heavy metals, such as As and Zn, which are soluble in weakly acidic leachate.

   If the sulphides content is 0.3% or more, an ABA assessment is required. Due to the greater solubility of metals at low pH, if the pH is less than 5.5, the soluble metal content must be determined.

   This abbreviated ABA screening criteria is intended for situations, like road construction in non-mineralized terrain, where there is no reason to expect a low NP or significant trace element release. Where materials are likely to be mineralized or hydrothermally altered, a proponent is advised to carry out the full ABA/metal leaching analysis, and to use the NPR screening criteria listed in #3; and

3. Where materials are mineralized, the suite of ABA testing should be carried out. ARD Screening criteria based on the results of standard ABA test results are as follows:

Potential for ARD	**Initial Screening Criteria**	**Comments**
Likely	NPR<1	Likely ARD generating unless sulphide minerals are non-reactive
Possibly	1<NPR<2	Possibly ARD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	NPR 2-4	Not potentially ARD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
None	NPR>4	

The main conclusion to be drawn from the above is that samples with an NPR greater than 4 are judged to be of no ARD concern and no further ARD testwork is required, unless the materials are to be used as a source of alkalinity.

The ratio of 4:1 is a conservative screening criteria selected to ensure the detection of all sites where there is an unfavorable balance between acid generation and neutralization reactions or where the composition of the reactive fraction (for example, a waste rock's fine-sized fraction) varies significantly from the analysis of the entire sample. It is recognized that a 4:1 ratio is conservative and will be higher than the maximum NPR of acid drainage generating materials.

Kinetic Test Program

Kinetic tests consists of various forms of leaching to determine the rate of either acid, alkalinity, or metal releases under various simulated conditions and include column leach tests, humidity cell tests, B.C. Special Waste Extraction Procedure (SWEP) tests, and simulated rainfall leachability tests.

Given that the ore and waste rock contains little or no sulphur as confirmed by both ICP and acid based accounting tests, kinetic test using columns or humidity cells would not have produced any useable data, even in the long term, and were therefore deleted from the test program. The open pit mine walls will be also be composed mainly of waste rock which has been shown to be highly acid consuming with a NP/AP Ratio ranging from 20:1 to 200:1.

Special Waste Extraction Procedure (SWEP) Testing of Ore and Waste Rock

Special Waste Extraction Procedure (SWEP) tests were completed by Western Copper Holdings Ltd. (in 1994) on each of the three composite ore samples used in the pilot plant metallurgical tests in order to determine concentrations of metals liberated by weak acid leaching. Although SWEP tests resulted in the leaching of significant levels of copper, as would be expected from copper ore, the ore would not be classified as Special Waste. Concentrations of acceptable concentrations for SWEP leachate (B.C. Regulations) are presented in Appendix G, Table 5.4. Results, which are compared to the metal concentrations in pregnant leach solution (PLS) from the pilot plant

(Appendix G, Table 5.5), indicate that significantly more mineralization will be extracted from the ore in the leaching process than would be by the SWEP test.

SWEP testing was also conducted on six composite waste rock samples. Results are presented in Appendix G, Table 5.6. SWEP testing of waste rock resulted in the significant leaching of copper (2.05 ppm), aluminum (2.93 ppm), barium (2.91ppm) and iron (6.21 ppm), but levels were not above B.C. Regulations SWEP Leachate Quality Standards. Therefore, the waste rock is not considered a special waste.

Sequential Extraction of Waste Rock

Sequential extraction testing was conducted on waste rock composite to determine the potential of resolubilization of metals from the rock. The testing consists of five consecutive extractions that are increasingly more chemically aggressive. This test is designed to partition metals into five components: ion exchangeable metals, carbonate bound metals, iron and manganese oxide bound metals, organic matter and sulphides bound metals, and silicate and refactory iron oxide bound metals. Results are presented in Appendix G, Table 5.7.

Metals in fractions from Leach 1 and Leach 2 are made available by the presence of excess cations and in the presence of mild acid conditions, respectively. The metals present in these fractions have been considered to be the most available under natural environmental conditions for the purpose of this analysis.

The following metals were present as high concentrations in Leach 1 and/ or 2 fractions: aluminum (118.76 ppm), barium (83.35 ppm), cadmium (2.36 ppm), copper (43.62 ppm), iron (142.76 ppm) and lead (5.8 ppm).

A sediment pond is located down gradient from the WRSA. Runoff from the WRSA will be collected and directed to this pond. Water from this pond will be pumped back to the mine site for water recycle, however if wastewater is to be released, then the effluent quality will be monitored and tested for metal levels. If necessary the effluent would be treated using conventional lime treatment before release to the environment.

3.6.3.5 Nitrogen Loadings from Waste Rock and Ore

The use of explosives during operations can have a detrimental effect on water quality. The use of nitrogen-based explosives in the surface mining has the potential to impair water quality for drinking, aquatic life, and recreation due to potential toxicity of nitrates, nitrites, and ammonia, and their role in promoting algal growth.

Approximately 30% of the holes are anticipated to be wet as a result of thawing permafrost and discrete perched water tables. Eighty-three percent of these holes will be lined with plastic liners that will be used to keep the explosive dry, while the remaining 17% will be loaded with a water-resistant slurry. On the basis of the average mine production of 1.76 x 10^6 t ore per year and 7.50 x 10^6 t waste per year and powder factor of 0.20 kg/t, projected peak explosives use will total 1852 t/a. Approximately 20% (352 t/a) will be used in ore production and 80% (1,500 t/a) will be used in waste production.

Some of the residual nitrogen based compounds from blasting will report to the heap operation combined with the ore, a portion will be combined with the waste, and a portion is expected to report to open pit drainage. For the purposes of this evaluation, nitrogen losses from ore, waste, and mine water are prorated in accordance with tonnage of waste and ore and a loss of 15% from both sources to mine water is assumed.

Using the methods outlined by Pommen (1982) total losses in open pit operations are expected to amount to approximately 1% of the nitrogen content and AN/FO explosives and 6% for slurry. Based on a nitrogen content of AN/FO being 33% and slurry being 25%, projected annual losses of nitrogen to each of the mine rock reporting to the mill, waste rock dump, and mine water settling ponds are presented in Appendix G, Table 5.8. Methods to minimize losses of explosives will be employed. Approximately 15% (1.46 t/a) of the nitrogen from the open pit blasting will report to the in-pit-mine water settling pond and will be pumped out and directed to the process cycle to be used as make up water. Approximately 85% (1.59 t/a) of the nitrogen from the ore production will report to the processing plant.

Assuming that all residual nitrogen compounds reporting to the waste rock dump on an annual basis are solubilized and removed from the waste rock dump each year (i.e. no retention of nitrogen from year to year) and direct proportion to annual runoff, combined nitrogen loadings to and from the waste rock dump settling pond would total 6.75 t/a.

For modeling purposes, the losses to waste rock that would be discharged as waste rock runoff were estimated to be 54.88 mg/L (from 6.75 t/a N and 1.23 x 10^5 m^3/a). This would be broken down to comprise approximately 48% NO_3-N, 4% NO_2-N, and 48% NH_3+NH_4-N. In addition, ammonia was analytically measured in waste rock SWEP tests to be 0.61 mg/L, which was subsequently added to the estimated NH_3-N from explosives and entered as a total 25.31 mg/L NH_3-N effluent concentration into the model.

Concentrations of nitrogen are projected to increase by 1.612 mg/L NO_3-N (1.634 mg/L), by 0.144 NO_2-N (0.1443 mg/L) and by 1.65 mg/L NH_3-N (1.702 mg/L) immediately downstream in Williams Creek at site W4. Predicted nitrite nitrogen (NO_2-N) levels are expected to be above CCME guidelines for aquatic life; however, water from the waste rock sediment pond is planned for use as recycled process make-up intended for discharge to north Williams Creek.

Nitrogen concentrations were estimated to increase by 0.594 mg/L NO_3-N (0.700 mg/L), 0.053 mg/L NO_2-N (0.056 mg/L) and 0.61 mg/L NH_3-N (0.660 mg/L) at W10. All levels are below CCME guidelines for aquatic life.

3.6.3.6 Raffinate Characterization

Analyses of raffinate and neutralized raffinate and the percent reduction in metals after neutralization are presented in Appendix G, Table 5.9. As would be expected, analyses showed several metals were extremely elevated in the raffinate, including aluminum (574 ppm) and iron (1274 ppm). A substantial decrease in the levels of the following metals was noted after neutralization: antimony (89.8%) arsenic (83.3%), cadmium (87.7%), chromium (96.6%), copper (97.9%) iron (99.8%) and zinc (98.5%).

In order to further characterize and determine the mobility of neutralized raffinate precipitates, SWEP testing and sequential extraction was completed for the precipitates. Results from the SWEP and sequential extraction tests are presented in Appendix G, Tables 5.10 and 5.11, respectively.

Based on the SWEP data, neutralized raffinate precipitate is not classified as a special waste. Sequential extraction results indicate that high levels of the following metals were present in Leach Fractions 1 (ion exchangeable metals) and 2 (carbonate bound metals), and therefore may be considered available under natural environmental conditions: aluminum (12,182 ppm), cadmium (2.42 ppm), iron (750.6 ppm), manganese (319.12 ppm), mercury (5.82 ppm) and strontium (87.3 ppm). These levels are, of course, higher than found in raffinate and are not an indication of their levels in waste rock runoff, but indicate that they may be present.

3.6.3.7 Leach Pad Foundation Characterization

Acid-based accounting was completed for the foundations of the leach pad and events pond. Results are presented in Appendix G, Table 5.12. These materials, including the till layer which will be used as a soil liner contain 0.02 to 0.03% sulphur, have a net neutralizing potential of 8.9 to 41.5, and NP/AP ratios of 18.1 to 133.9.

In order to determine the solubilization of metals in the till layer resulting from seepages, ICP analysis was completed on acid leached till. Results are presented in Appendix G, Table 5.13. The samples were adjusted to pH 2.0 with H_2SO_4, leached for 24 hours and filtered. An ICP analysis was completed on the filtered supernatant. Levels of metals released from the till layer are low and are not considered to affect the surrounding environment in the event of a leak.

3.6.4 Heap Detoxification

The leaching of oxide copper from Carmacks samples has been studied over a number of years and the results have been reported previously:

> *Metallurgy of the Williams Creek Oxide Copper Deposit*
> Beattie Consulting Ltd.
> May 1994
>
> *Pilot Scale Column Testing of the Williams Creek Oxide Deposit*
> Beattie Consulting Ltd.
> February 1996

This previous decommissioning testwork consisted of rinsing of test columns with water followed by solutions containing base additions to various pH levels. It was demonstrated that the pH of the effluent from the columns could readily be raised to a value of about pH 4 but appeared to be buffered at this value and was resistant to further increases. In February 2001, Beattie Consulting Ltd. completed another study on the “Leaching and Decommissioning of Carmacks Samples” (Appendix E), which included various tests to improve the understanding of what was controlling the effluent pH and to investigate alternatives for effective decommissioning of the leach pads. The following summarizes the results of this most recent testwork.

- Previous column testwork indicated that the leached solids could be readily neutralized to result in an effluent of pH 4, which was buffered at this pH. Additional tests have indicated that when leached solids are freely mixed with a solution containing an excess of base, the solution readily achieves a neutral pH and this pH is stable. Subsequent column tests have shown that sodium carbonate is effective at altering the leached solids so that effluents have a neutral pH. This condition appears to be stable over extended time periods;

- The most effective rinsing procedure for the spent heaps appears to be to recirculate the solutions until the free acid is consumed and the copper concentration in solution becomes uneconomic to recover. At this point the leach solution should be neutralized out of the heap with lime to precipitate sulphate and other deleterious constituents before being discharged. The heap should then be rinsed with groundwater in a series of pulses with rest periods in between to allow dissolved sulphate, copper and other metals to diffuse from the rock particles. An effluent pH near 4 can be expected with this procedure. To achieve higher pH values, the addition of a base is required and sodium carbonate appears to be the most effective addition. The use of lime as a neutralizing agent will likely only be effective if the lime can be intimately mixed with the solids; and

- It has been observed that the leached solids tend to become less permeable due to both decrepitation and precipitation of secondary mineral phases. This loss of permeability will minimize the quantity of effluent to be treated with time. Consideration should be given to installing collection piping at least every few lifts to optimize the flow of solution from the heap during leaching and to minimize the inventory of dissolved copper in the heap.

Further column test work is planned to finalize heap detoxification methods including in situ nutrient to the heap to stabilize metals. Heap rinsing and neutralization is discussed in more detail in the Conceptual Closure and Reclamation Plan found in Appendix F.

3.6.5 Solid Waste

Industrial and camp solid waste generated by the proposed operations will be disposed of separately.

Industrial refuse consisting of inert material such as broken drill rods, bits, shop scraps and pipe discards, will be collected regularly by surface crews and buried within the waste rock dump.

Combustible industrial refuse and domestic or putrescible refuses from construction and operations will be disposed of by incineration using a forced air fired burner on regular basis. Incinerator ash will be disposed of in the waste rock storage facility.

Municipal refuse originating as camp and office waste, plus warehouse scrap will contain some organic wastes. This solid waste will be collected in covered metal containers located as strategic points around the operations. To minimize the attraction of wildlife, the refuse will be incinerated regularly and the incinerator ash will be hauled to the waste rock dump.

3.6.6 Special Waste

Any special wastes, as defined by the Yukon Environment Act, *Special Waste Regulations,* will be collected and stored in specially marked containers and then shipped to an appropriate treatment or disposal facility. Wildlife-proof rig bins will be used at the site. These bins provide segregated storage for solid waste that cannot be burned and special wastes in compliance with *Special Waste Regulations*.

Waste oil will be burned and used as a source of heat. Western Silver will obtain a Special Waste Permit for this project and will comply with the Yukon *Special Waste Regulations* and track wastes through the use of Transportation of Dangerous Goods Waste Manifests.

A concrete floor will be provided throughout the truck maintenance area. The floors will also be sloped towards a dry sump, which will collect any wash solutions and petroleum products that result from the maintenance activities. Oil-absorbent products will also be used on the shop floors.

Any accumulated sump water will be separated and oils pumped to the waste oil tank or empty drums. All oily wastes from oil changes, including the sump separation products and absorbent, will be hauled off the site for disposal or recycling in an environmentally acceptable manner.

The lubrication bay of the maintenance shop will have a vacuum evacuation system for waste oil. Hose reels will feed from the lubrication storage area and will dispense antifreeze, grease and various grades of oil to the lubrication bay. An air compressor and receiver will supply air for tools.

Laboratory wastes from sink and floor drains will be disposed of in the raffinate tank.

4.0 ALTERNATIVE MEANS AND ALTERNATIVES TO THE PROJECT

This section presents an evaluation of the alternatives considered for the project. Tables 4-1 to 4-7 provide an evaluation matrix for various project component alternatives.

4.1 PROCESSING CAPACITY AND PROCESSING ALTERNATIVES

Table 4-1 presents an evaluation matrix for the production capacity alternatives and processing alternatives. The selection of production capacity has been based primarily on a combination of economic and technical considerations, and associated socioeconomic implications, a reasonable return on investment and reasonable mine-life (8 years) expectancy. Environmental considerations have been dictated accordingly (Table 4-1).

Alternative methods of recovering copper were considered in early phases of the project, and included milling with flotation and heap leaching. Economic, environmental and operational factors were compared for each potential process option (Table 4-1).

While it was apparent from the metallurgical test work that overall copper recoveries could be attained using a number of processes, the capital requirement, the requirement for a tailings impoundment, higher operating costs due to power consumption and lower metals recovery were a major deterrent for conventional milling. Environmental consequences associated with the need for tailings facilities to ensure long-term physical and chemical stability were a major consideration.

The main considerations which favored the heap leach process were as follows:

- heap leaching has been proven to be environmentally sound technology with proper construction and operation procedures;
- the Brewery Creek mine has been successfully operated and demonstrated heap leaching in cold weather climates; and
- capital costs for a milling facility are significantly higher than for heap leaching – heap leaching allows low grade ore to be treated economically.

Generation of acid for copper leaching is an important processing requirement in the heap leaching process route. Acid generation and supply through an onsite sulfur burning and conversion plant is the primary process option. Alternatives include direct trucking of sulfuric acid and generation of acid through biological oxidation of elemental sulfur.

Trucking of sulfuric acid is discounted as a viable option due to excessive haulage distances from the source and haulage costs. As well, environmental considerations from large quantities of acid transported are not desirable.

Biological oxidation of elemental sulfur to produce sulfuric acid is a process option currently under investigation. Column testwork has recently been completed and demonstrated the potential viability of the process. The biological generation of acid would consist of a series of small reaction tanks and transportation of elemental sulfur. Agglomeration of elemental sulfur and bio-acid produced from bacteria would be required. Additional testwork and economic evaluation is necessary to demonstrate scale-up and commercial application and the company continues to optimize the process.

Given all of the above factors, a heap leach operation using an onsite acid plant was selected as the preferred alternative, and was based on a balance of environmental, technical, operational and economic considerations.

4.2 LOCATION OF THE MINE AND MINING ALTERNATIVE

There are no alternatives to the location of the ore body. Consequently, environmental and socioeconomic considerations play no part in the selection of the location of the mine site.

There are two basic mining methods, open pit bulk mining and selective underground mining, with open pit mining being on the order of 10 times less cost per tonne mined than underground mining. Underground mining is generally only applicable to narrow high grade vein or deep tabular type deposits, whereas open pit mining is generally applicable to widely disseminated, low grade type deposits like Carmacks Copper. Whereas underground mining generates relatively minor quantities of waste (low waste to ore ratio), open pit operations generate relatively large quantities of waste (high waste to ore ratio) (Table 4-2).

Because the Carmacks Copper mineralization consists of disseminated copper oxide minerals hosted in unmineralized hornblende-biotitie-quartz feldspar gneiss, it would not be technically feasible to mine the deposit using underground methods. The ore is rated as low grade, being 1.01 % copper, and of insufficient value to support underground mining. As the waste rock is acid consuming, there would be no environmental benefit to using underground mining techniques for ore extraction.

Consequently, the selection of the mine and mining methods are dictated almost exclusively by technical engineering and economic considerations. Beyond the implications of mine drainage, environmental and socioeconomic aspects have only minor roles in mine site and mining method selection. However, the fact that the project is based on open pit methods, limits the selection of waste and ore storage areas, and the fact that the ore is of relatively low grade, limits the selection of extraction and processing alternatives.

4.3 MINE WASTE ROCK STORAGE AREA ALTERNATIVES

Open pit operations typically generate larger quantities of waste (high waste to ore ration). The Carmacks Copper operation is projected to have an overall life-of-mine waste to ore stripping ratio of 4.6:1 and is projected to generate approximately 60 million tonnes of waste over the 8 year mine life.

Waste rock generated by the mining operations has been tested for comprehensive whole rock, multielemental scans, ABA testing and petrographic evaluation. On the basis of laboratory testing using acid-base accounting techniques and simulated weathering techniques, neither the waste rock nor the open pit wall rock was found to be capable of generating acid or liberating metals at concentrations which would be of environmental concern. Test results indicated that the runoff from the waste and open pit wall rock would not require any special treatment, other than settling to remove suspended solids, before it was released to the environment.

Given the large quantities of waste that have to be stored, it is the general practice to find suitable locations within close proximity to the ore body. Generally the shorter the distance, the lower the environmental effects. Topographical constraints and geotechnical stability are critical in that flat land or bowl shaped features large enough to accommodate the waste volume are preferred over side-hill dumps. In addition to control of acid generation, environmental protection of watersheds, area of disturbance, loss of vegetation and wildlife habitat are the next primary considerations. Haulage distances and costs are a significant consideration and did limit a couple of options in the selection process (Table 4-3).

A total of four locations were considered as alternative waste rock storage locations with the evaluation presented in a separate report (Western Copper Holdings Ltd. Carmacks Copper Project. Waste Rock Storage Area Evaluation and Detailed Design Report, June 30, 1997). Table 4-4 summarizes the options considered.

On the basis of environmental studies, upper Williams Creek and north Williams Creek were not found to contain fish (Section 5.2.1.1). Similarly, on the basis of baseline studies, all sites were found to have moderately to low capability for wildlife. Geotechnical evaluations indicate some concern with foundation conditions at most sites investigated. Alternative sites were unfavorable from a haulage perspective, conflicted with other mine site components, were too steep or have similar stability issues. As such, the preferred site located north of the pit on the south valley of North Williams Creek has been selected primarily on a balance of environmental, technical, engineering and economic considerations and incorporates mitigative measures to address stability and foundations concerns.

4.4 HEAP LEACH SITE ALTERNATIVES

A detailed discussion of the heap leach pad alternative site selection process is presented in the following reports. The reader is referred to these reports for a full discussion. Review:

- Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Conceptual layout of Mine; (Report No. 1781/1),* January 1992;

- Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Report on conceptual Design of Heap Leach Facility for Closure (Ref. No. 1783/8);* Initial Environmental Evaluation (IEE), Addendum No. 3, October 1995; and

- Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Updated Detailed Design of the Heap Leach Pad and Events Pond (Ref. No. 1785/1);* 23 April 1997.

4.5 SELECTION OF THE HEAP SOLUTION STORAGE SYSTEM

The heap leaching process with out of heap raffinate solution storage system was selected over the in-heap solution storage system primarily for operational, environmental and safety reasons (Table 4-5).

Review of the operational experience at the Brewery Creek Mine in Yukon indicates that heap leaching year round with external solution storage in an extremely cold weather climate is proven and practical. In addition, the acid leach is an exothermic reaction and produces heat which minimizes concerns with freezing conditions on the liner system and piping.

Leakage rates with in-heap storage and the potential for groundwater contamination is a concern due to relatively high hydraulic head on the liner system within the area of solution containment. External solution storage reduces the hydraulic head on the heap composite liner system and ensures that heap leakage rates are below the leakage guidelines and ensures the protection of local groundwater. Problems with heap liner integrity are more difficult to locate and fix once the ore has been loaded and the heap height advances. With external solution storage, liner problems within the storage pond can be identified and fixed through proper solution management.

Important concepts for successful solution storage in cold weather heap leaching incorporated into the engineering design include:

- Reducing solution inventories in winter and only using the pond in emergencies in winter;
- Burial of drip emitter lines directly into the ore surface prevents freezing during intermittent power or pumping interruptions;
- Proper solution management plans and operation training to prevent high pond solution inventories during winter operations;
- Sloping solution pipelines for drainage, burying and/or insulating and/or heat trace; and
- Providing redundant systems for power, pumps, and piping to ensure that solution flow is continuous and uninterrupted and low pond volumes are maintained.

Although there is increased land requirements and resultant increased disturbance of vegetation and wildlife habitat, the amount of area that must be ultimately reclaimed at the end of mining for an events pond is not considered significant. The benefits of not having in-heap storage are considered an environmental advantage as the hydraulic heads on the liner system are is reduced. As such, out of heap storage of raffinate solutions is the preferred alternative.

4.6 SELECTION OF SITE INFRASTRUCTURE

The number of options for site infrastructure (crushers, access roads, SX/EW plant, settling ponds, treatment plant and ore conveyance systems) are relatively wide, however site selection of these facilities is based primarily on economics once the process, mining method, waste rock storage areas and heap leach pad sites have been selected. The selection of site infrastructure is based primarily on efficiency of operations, economics and technical considerations, as they have limited potential for environmental effects.

An economic analysis of ore from the open pit to the leach pad, comparing truck haulage and overland conveyor was undertaken as discussed below. An access road is required regardless of the ore transportation method selected.

4.7 HEAP STACKING ALTERNATIVES

Two alternatives, truck and dozer, and conveyors, were considered for stacking ore on the heap leach pad. Table 4-5 provides an evaluation matrix for heap stacking alternatives considering economic, technical, environmental and socioeconomic considerations. The selection of heap stacking alternatives is driven by the necessity for size reduction of the ore prior to leaching. If Run of Mine (ROM) processing is selected, heap stacking by truck and dozer becomes a preferred option. If the ore requires crushing and agglomeration to provide acceptable copper recoveries, heap stacking by conveyors becomes the preferred alternative. The current testwork for copper recovery suggests crushing will be required and therefore a conveyor system has been selected as the preferred option for the project primarily on the basis of technical concerns. Additional process optimization, testwork and economic evaluation may change the necessity for crushing and provide ROM processing as a viable alternative. Please refer to Appendix A, Drawing 200-03-01 for a crushing and screening flowsheet.

4.8 MINE ACCOMMODATION ALTERNATIVES

Socioeconomic studies were undertaken by Western Silver in the early part of the planning process to select the best alternative for employee accommodations that would offset negative effects and enhance benefits wherever possible (Hallam Knight Piésold (HKP), IEE Volume II, “Community Profiles and Socioeconomic Impact Assessment”). The option of housing all employees in the existing local community of Carmacks and bussing personnel to site each shift was considered. Due to the comparatively high number of employees in relation to the size of the local communities, housing all employees within existing local centres would have resulted in the need for some construction of housing and related community infrastructure (Table 4-6).

In assessing socioeconomic effects, the existing socioeconomic conditions and trends in the regional communities were documented (Section 5.5). Projected changes that may be expected to occur were considered and an evaluation completed of the communities capabilities to absorb the affected changes. The principal considerations that were believed to have an overall bearing on the magnitude of effects were as follows:

- evaluation of surrounding communities to accommodate and assimilate the expected growth,
- size and life span of the proposed mine development, and the effects that might occur from a boom-and-bust economy;
- size and source of the operational work force, and the settlement patterns of people moving into the community;
- LSCFN land claims, cultural considerations, ethnographic and archaeological resources;

- work schedule and accommodations, location of the mine relative to the nearest communities, and
- equipment, supplies and services procurement.

The project-related population increases in Carmacks and Whitehorse were expected to be minimal to moderate. Socioeconomic studies incorporated an analysis of community populations, demographics, levels of employment and housing availability for those communities that would be most affected. Municipal and Territorial representatives were interviewed to determine the availability of community services (e.g. recreational facilities, water, sewer systems, solid waste disposal facilities, court services, transportation systems, police and fire protection, educational facilities, medical and health care). Information on community infrastructure, commercial and industrial sectors, communications, average incomes, taxes and transportation was also evaluated.

By providing an initial construction camp and modifying this camp to provide on-site accommodation and allowing the workforce to work on a shift rotation basis, workers will be able to live elsewhere in the Yukon, in addition to the local communities. This spreads the economic benefits of the project, reduces the impact on local communities to a manageable and beneficial level, and eliminates the boom and bust phenomenon associated with mining towns in the past.

Consequently, the on-site accommodation for the operational workforce for the project construction, and modifying this camp facility to provide some on-site accommodations during operations, and off workforce accommodation was selected as the preferred alternative almost exclusively on the basis of socioeconomic considerations.

It is expected that socioeconomic effects of the project can be distributed over a broader regional base of communities with developed, existing infrastructures, thereby reducing the impacts to any one community, particularly that of the LSCFN and the Village of Carmacks.

4.9 ALTERNATIVE POWER SUPPLY SOURCE

Project power supply sources were discussed in Section 3.2.7.3. In addition, Yukon Energy Corporation completed an environmental assessment and routing analyses for supplying power to the project (Yukon Electrical Company Ltd, 1995). On-site diesel generation of power has been calculated to be less expensive over the mine life of 8 years compared to the economics of constructing a powerline from Carmacks. In addition, the operations would require a supply of on-site, dedicated standby and back-up power for operation of critical environmental protection facilities such as heap leach pad recirculation pumps, leak detection and recovery systems, and the water treatment plant, as well as the camp accommodation.

The selection of on-site power generation over installation of a powerline has been based primarily on economics, being one of the most significant operational costs. Environmental, technical and operational considerations, such as utilization of waste heat, line and plant maintenance, access, reclamation and need for back-up power have been of secondary importance in the selection of power supply alternatives (Table 4-7).

The current preferred option for the company is diesel generation however, the underlying assumptions, particularly those in the economic analyses, used in the selection process may change as a result of discussions with Yukon Energy. If Yukon Energy proceeds with the construction of the Carmacks-Dawson extension of the grid, as they have indicated they may, tapping off that line, close to the plant site, may prove a viable option for Western Silver.

Table 4-1 Production Capacity and Process Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operational Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Production Capacity					
Low tonnage <1000 t/d	Incapable of supporting infrastructure capital costs given short annual operating period	Equipment requirements for low tonnage mismatch known ore reserves	Not applicable	National, regional and local benefits would be smaller and spread over extended period (30 years or more)	9,872 tonnes of ore per day, for 300 days, 1,700,000 tonnes ore per year selected as the preferred alternative production capacity over annual operating period
Moderate 1000 to 10,000 t/d	10,000 tonnes per day required to support viable rate of return, optimizes capital expenditure	Equipment requirements better match to known reserves, optimizes crusher capacity if required	Not applicable	Positive, well-matched benefits to national, regional and local economy more significant and more definite in short term	
High tonnage >10,000 t/d	Capital cost for significantly larger operations would be excessive with under-utilized equipment.	Known reserves and winter operations do not support high daily tonnage. Logistics complicated.	Not applicable	Larger project would have much larger but potentially negative impacts on small communities	
Processing Alternatives					
Grinding, gravity concentration followed by flotation	Moderate recovery (50 to 60%) high capital and operating costs	Moderate equipment requirements, year-round operations, tailings area, additional offsite processing required	Large tailings area, no liners or water treatment required. Wildlife and fisheries habitat impacts significant	Moderately large staff, on-site housing, year-round mining and milling operations.	Heap leaching preferred due to good recovery, absence of tailings area, lower power requirement, flexibility of operation. Company to optimize acid use.
Heap Leaching - Sulphuric Acid leach	A good recovery (60 to 80+%) depending on crush size. Low capital and operating costs	Small SXEW plant required, equipment requirements minimized, heap leach pad and water management, allows for flexible annual mine plan. Acid plant or trucking of acid required.	Lined heap leach pad and events pond. Water management with contingency water treatment. Impacts on fisheries and wildlife minimal. Potential accidents from acid trucking. Longer closure detoxification.	Moderately large staff, on-site housing, some flexibility in year round operations.	
Heap Leaching - Elemental Sulphur/Bacteria Leach	A good recovery (60 to 80+%) depending on crush size. Low capital and operating costs	Small SXEW plant required, equipment requirements minimized, heap leach pad and water management, allows for flexible annual mine plan.	Lined heap leach pad and events pond. Water management with contingency water treatment. Impacts on fisheries and wildlife minimal. Less aggressive closure detoxification.	Moderately large staff, on-site housing, some flexibility in year round operations.	

Table 4-2 Mining Method Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operationa Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Mining Method					
Open Pit	Economics of scale and Bulk mining methods relatively high capital but low operating costs.	Applicable to widely disseminated low grade, porphyry deposits.	Large waste to ore stripping ratio Waste is acid consuming.	Not applicable	Carmacks Copper ore body consists of low grade, oxide ore, widely disseminated. Mining by open pit methods is the only viable method economically. Waste is acid consuming and not a hazard to environment.
Underground	High capital and operating costs Selective mining methods.	Applicable to high grade, narrow vein or deep tabular ore bodies.	Low waste to ore stripping ratio Waste is acid consuming.	Not applicable	
Combined Open Pit and Underground	Economics of scale at surface High capital and operating costs to reach ore at depth.	Applicable when stripping ratio too high to reach mineable ore at depth.	Moderate waste to ore stripping ratio Waste is acid consuming.	Not applicable	

Table 4-3 Mine Waste Rock Storage Area Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operational Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Waste Rock Storage Area					
North Pit Area					
Option a North of pit, south side of valley - no foundation preparation	Immediately adjacent, haul distance very economical	Capacity limited, foundation problems, valley fill, possible stability concerns.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	Option b - North of pit, south side of valley. Adequate capacity & proximity. Foundations conditions allow remediation. and contingency buffer zone. Contingency buffer zone allows construction of stability berm as noted in Option d. Away from watercourse and fisheries habitat. Vegetation and wildlife capability moderately low to low.
Option b North of pit, south side of valley - foundation prepared no buffer area.	Immediately adjacent, haul distance very economical. Cost to prepare foundation.	Adequate capacity, foundation concerns mitigated, permafrost stripping, side hill dump.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
Option c North of pit, south side of valley - foundation covered with waste rock insulation	Immediately adjacent, haul distance relatively economical but costly ground preparation.	Adequate capacity, foundation concerns mitigated, side hill dump, winter construction of insulating layer, complicates sequencing.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
Option d North of pit, south side of valley - no foundation preparation. Stability berm.	Immediately adjacent, haul distance relatively economical. Cost to prepare stability berm.	Adequate capacity, foundation problems, side hill dump, construct keyed in stabilizing berm adds excavation.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
Option h North of pit, south side of valley - remove thaw unstable material	Immediately adjacent, haul distance relatively economical, but overall options highly uneconomic.	Adequate capacity, foundation problems, side hill dump, significant excavation of thaw unstable material	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
North Williams Creek Area					
Option e North of pit, into north Williams Creek. Use opposite valley to stabilize dump	Moderately adjacent, haul distance not as economical. Requires end dump from high lifts.	Adequate capacity, foundation problems, cross valley fill, rock across stream, flow through drain could plug - likely slumps during construction due to lift height.	No fish habitat, Vegetation and wildlife capability moderate to low. Stream crossed - potential chemical issues.	Not applicable	
Northwest Pit Area					
Option f Northwest of pit, north of leach pad - higher elevation	furthest removed, haul distance uphill, not as economical.	Adequate capacity, foundation problems, side hill dump.	No fish habitat. Vegetation and wildlife capability moderate to low Covers small streams, possible chemical issues.	Not applicable	
South Pit Area					
Option g South of pit on steep slope	Immediately adjacent, haul distance very economical	Capacity limited, foundation better but steep slopes problems, valley fill.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	

Note: Options as reported in Western Copper Holdings Ltd. Carmacks Copper Project Waste Rock Storage Area Evaluation and Detailed Design Report, June 30, 1997

Table 4-4 Process Solution Storage Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operational Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Solution Storage					
In-heap Solution Storage	Good economics. Capital savings on constructing storage capacity. Cost savings in conserving heat. Cost savings in wildlife protection.	Increased engineering and design costs. Spill prevention and safety concerns reduced. Cold weather operations improve. Greater hydraulic head on liner.	Minimizes area of disturbance by using available in-heap storage. Heat conservation minimizes winter spill concerns. Pregnant solution isolated from wildlife and water fowl, concern with groundwater contamination	Not applicable	Out of heap solution storage preferred, Economical, minimizes environmental, safety concerns during extreme cold weather. Solutions directed to SXEW. Reduces need for wildlife and water fowl protection. Reduces the need for more robust liner system and risk to local groundwater.
Out-of-Heap Solution Storage	Good economics - robust liner needed In-heap storage capacity not utilized. Heat losses not substantial. Capital cost and maintenance cost and problems for wildlife protection.	Increased engineering and design costs for events pond. Spill prevention and safety of operations concerns. Cold weather operations to SXEW plant. Lower hydraulic head on liner.	Required additional area of disturbance Avoids available in-heap storage and loss of waste heat in winter. Greater spill concerns. Wildlife and water fowl exposure to process solution is potential concern. Concern with groundwater contamination	Not applicable	

Table 4-5 Heap Stacking Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operational Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Heap Stacking Methods					
Truck and Dozer	Moderately high initial capital costs if extra trucks and equipment required. High operating costs for truck fleet.	Highly flexible. Allows thermal capping and irrigation installation at same time. Rubber tires cause compaction of surface. Area has to be ripped before placing next layer.	Not applicable	Not applicable	Conveyor stacking was selected as the preferred option. Although capital costs higher, compaction concerns were cited as a major consideration over truck and dozer.
Conveyor System	High initial capital costs for equipment.	Relatively inflexible. Interferes with capping and irrigation installation at same time. Compaction of surface not a concern. Ripping not required.	Not applicable	Not applicable	

Table 4-6 Workforce Accomodation Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operational Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Mine Accommodations					
Housing in Existing Communities With Bussing	High capital costs for housing allowance. High capital and operating costs for busses and bussing.	Work schedules lessflexible for crews. Small camp still required for differential shifting. Staffing for reduced winter work force difficult.	More road traffic. Higher incidence of wildlife road kills. Higher potential for vehicle accidents and reagent spills.	Local effects on Carmacks, and Whitehorse predicted. Lack of adequate housing. Community infrastructure adequate. More impact on First Nations Communities and life-style.	On-site construction camp was selected with community based housing and bussing. Less capital, operating costs. Reduced impact on local communities. Less impact on First Nations communities and life-style. Moderate flexibility for operations and shift schedules.
On-site Camp Accommodation (Construction Camp) with Limited Bussing	High capital costs for camp and High operating costs for camp accommodation. Moderate high operating costs for limited number of busses and bussing.	Work schedules more flexible. Accommodates 3 x 8 and 2x12 shifting. Reduce staffing for winter attractive to local residents.	Less road traffic. Lower incidence of wildlife road kills. Lower potential for vehicle accidents and reagent spills.	Moderate impact on Carmacks and Whitehose predicted.Community infrastructure adequate for expected population increase. Fewer impact on First Nations Communities and life-style. Boom and Bust impacts can be mitigated.	Less traffic and lower impact on families living in established communities. Reduced wildlife hazards on road.

Table 4-7 Power Supply Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	**Design, Engineering Construction and Operational Considerations**	**Environmental Considerations**	**Socioeconomic Considerations**	**Preferred Alternative**
Mine Accommodations On-Site Diesel Generation	High capital and operating costs. No capital costs for power line. On-site diesel back-up power required in any event. Savings in use of waste heat.	Increased engineering and design for generation, substation & distribution. Increased requirement for on-site fuel storage and spill prevention. Constant fuel supply required. Marginally less reliable than over head power.	Increased source of air emissions. Ability to use waste heat for solution heating winter. Increased risk of spills due to fuel storage and transport. Marginally less reliable than overhead increases risk of power failure and reliance on back-up systems.	Not applicable	On-site diesel generation of power was selected as the preferred alternative due to the overall lower capital and operating costs and use of waste heat for project. However, YEC has completed an EA for routing power to the project. Further discussion with YEC could revise perferred decision. Excess power is available on the WAF grid.
Overhead Supply from Whitehorse Aishihik Faro Power Grid with on-site back-up capacity (two routing options assessed by Yukon Energy Corporation)	High capital costs for line and sub station(cost share). No plant needed. Operating costs based on peak power demands year-round. Capital cost for Carmacks substation upgrade. On-site diesel back-up power required in any event. No advantage in use of waste heat.	Reduced engineering and design for generation, substation & distribution. YEC responsible for system. Much lower fuel requirement, and much lower requirement for on-site fuel storage and spill prevention. More reliable than on-site diesel generation.	No source of air emissions but greater impact at YEC generation sites. Lower risk of spills due to fuel storage and transport. More reliable than having it on-site and reduces risk and reliance on back-up power systems.	Not applicable	

5.0 ENVIRONMENTAL SETTING AND SOCIOECONOMIC CONDITIONS

P.A. Harder and Associates Ltd. conducted an initial assessment of baseline environmental conditions from 1992 to 1993, and additional work was completed by HKP in 1994. This information is found in Volumes I and IV, respectively, of the Initial Environmental Evaluation (IEE) compiled in 1994. Since the IEE was filed, four Addendums to the IEE were filed by HKP, Knight Piésold Ltd., and Kilborn to reflect additional information collected and changes to the IEE (Section 10 provides a listing of reports). The following sections summarize information from the IEE and Addendums and presents new data where available; specific reports should be referred to for further details and information respecting baseline environmental conditions.

A listing of the extensive physical, biophysical and socio-economic studies completed to document local environmental and socio-economic conditions and used to support project engineering and design for the Carmacks Copper project are below:

- Ground water and surface water quality sampling program at a number of sites within the Williams Creek drainage basin;
- Surface and ground water hydrology at a number of sites within the Williams Creek drainage basin;
- Detailed groundwater model of the heap leach pad area;
- Geology, foundation, geotechnical and hydrogeological studies for areas with proposed infrastructure, including the heap leach pad and mine waste rock storage areas;
- Waste rock and spent ore characterization including ABA analysis, SWEP testing and metal mobility testing;
- Metallurgical testing on the acid leaching of copper from the Williams Creek deposit;
- Water treatment performance and treatability testwork for heap leach detoxification;
- Water treatment plant effluent and toxicity testing;
- Petrographic and mineralogical reports;
- Terrain hazard analysis;
- Seismic hazard assessment;
- Meteorological studies including regional meteorological analyses, snow pack and snowmelt runoff analyses, and on site automatic climatic stations for precipitation, wind direction and speed, and temperature;
- Stream sediment survey in Williams Creek drainage basin;
- Fisheries studies (species distribution and abundance, habitat use and capabilities) for the project area drainages including drainages crossings along the access road;
- Benthic macroinvertebrate surveys in Williams Creek drainage basin;
- Vegetation survey within the project area;
- Wildlife surveys (species occurrences, habitat potential, traditional knowledge);
- Archeological and heritage resource assessments at the project location and along the access road;
- Traditional and cultural resource use assessment (traditional knowledge); and
- Socioeconomic impact assessment of the local and regional communities.

Details of most of these studies can be found in the references listed in Section 10. Many of these reports already exist in Yukon Government Public Registry for this project.

5.1 PHYSICAL ENVIRONMENT

5.1.1 Climate

The Williams Creek basin is located in an area characterized by moderate total annual precipitation and extreme variations in temperature. Precipitation and temperature data were collected during the summer of 1992, and in 1994 Water Resources Division of DIAND established an automatic meteorological station at the site. The station is still being run and continuous records are available from September 1994 to present, except where gaps occur due to equipment malfunctions.

Sources of hydrology data used in this study are summarized in Table 5-1. The data include summer rainfall data collected at the Williams Creek site and long-term precipitation (rainfall and snowfall) data reported by the Atmospheric Environment Service (AES) of Environment Canada for nearby regional stations at Carmacks and at Pelly River Ranch (previously referred to as Fort Selkirk). Regional snow survey data reported by the Water Resources Division of DIAND are available for several long-term stations in the area as shown on Table 5-1. Snow surveys were carried out at the Williams Creek site in 1992 and from 1995 to 1997. The YG Water Resources Branch (previously the Water Resources Division of DIAND) have been responsible for the operation of the Williams Creek meteorological station and collection of snow survey data at the site since 1995.

Table 5-1 Hydrological Data for the Williams Creek Area

	Average Monthly Conditions					
	Rainfall	Snowfall	Snowmelt	Evaporation	Number of Days/Month	
Month	mm	mm	mm	Mm	Total	Operating
March	**0**	**15.5**	**0**	**0**	31	**0**
April	**14.0**	**14.5**	**147.0**	**0**	30	**0**
May	**13.3**	**0**	**0.0**	**92.9**	31	**17**
June	**41.7**	**0**	**0**	**107.5**	30	**30**
July	**61.0**	**0**	**0**	**98.6**	31	**31**
Aug	**43.6**	**0**	**0**	**71.1**	31	**31**
Sept	**31.4**	**0**	**0**	**32.3**	30	**30**
Oct	**0**	**33.1**	**0**	**0**	31	**31**
Nov	**0**	**31.2**	**0**	**0**	30	**30**
Dec	**0**	**27.4**	**0**	**0**	31	**0**
Jan	**0**	**25.6**	**0**	**0**	31	**0**
Feb	**0**	**19.7**	**0**	**0**	28	**0**
TOTAL	205.0	167.0	147.0	402.4	365	200

% of Annual Snowmelt in	
April	**100%**
May	**0%**

Winter Sublimation Losses 20 mm

Table from Western Copper Holdings Ltd. Carmacks Copper Project – Heap Leach Facility Water Balance Design Memorandum CCL-CC4, Appendix I, Prepared by Clearwater Consultants Ltd., 1998.

Average annual precipitation is approximately 300 mm to 400 mm, with July being the wettest month. Average values for key hydrological parameters in the study area are shown in Table 5-2.

Table 5-2 Average Values for Key Hydrological Parameters

Parameter	Average Value, mm
Total Annual Precipitation	372
Total Annual Precipitation – 100 year return period wet year	541
Annual Rainfall	205
Annual Snowfall	168
Wet Period Precipitation	
One-Month Rainfall	78.8
Two Month Rainfall	124
Three Month Rainfall	159
Four Month Rainfall	183
Five Month Rainfall	196
Six Month Snowfalll	165
Seven Month Precipitation	181
Eight Month Precipitation	209
Maximum Snowpack, mm water	145
Annual Lake Evaporation	
Low	400
Average	460
High	520

*Average values for a typical elevation of 850 m.
Table from Western Silver Corporation Carmacks Copper Project Performance Standards and Design Criteria Parameters, 2004.

The average annual total precipitation is 372 mm with evaporation on average 402.4 mm, yielding a net loss of 30.4 mm. Almost half of the annual precipitation falls as snow as daily temperatures are below freezing from October through May.

Average monthly temperatures range from a low of approximately -30°C in January to a high of approximately 13°C in July. The following table presents a month-by-month breakdown of temperature in the Carmacks Area.

Table 5-3 Temperature Breakdown for the Carmacks Area

	Monthly Temperatures
	Mean (C)
January	-30.6
February	-20.2
March	-13.6
April	-2.1
May	5.2
June	10.9
July	12.8
August	10.5
September	4.9
October	-3.6
November	-16.7
December	-26.7
Annual	-5.8

Table 3.2.1-1 in Western Copper Holdings Ltd. Carmacks Copper Project 1997 Basic Engineering Report by Kilborn.

Winter conditions may be considered to extend over the period where daytime maximum temperatures average below zero. The extreme cold temperatures in the region make outside construction in the winter difficult. In general the working construction season will be from May to October. The ground is normally frozen in May, and earthworks such as leach pad grading and embankment fills cannot be started until June or July.

Refer to Design Memorandums CCL-CC2, CCL-CC2A, and CCL-CC4 prepared by Clearwater Consultants Ltd. for additional information on site hydrology conditions including: precipitation, maximum annual snowpack and snowmelt runoff, and evaporation.

5.1.2 Topography

5.1.2.1 Physiography

The Carmacks Copper Project area lies within the Klondike Plateau and is part of the Pelly River Ecoregion (Oswald et. al. 1997), which is comprised of portions of the Stewart, Macmillan, Lewes, and Klondike Plateaus and Tintina Valley physiographic subdivisions (Bostock, 1970). Surface drainage flows both north and east from the study area. A number of valley streams, of which Williams Creek is the largest, drain northeastward to the Yukon River.

A broadly rolling till plain forms the dominant glacial landform. Isolated pockets of fluvial and glaciofluvial sands and gravels, glaciolacustrine silts and organic deposits mantle the subdued till in places. Surface till is variable in color, moderately stony and has a silty sandy matrix. Volcanic ash forms a veneer from 5 to 30 cm thick in various locations throughout the area.

The Carmacks Copper Project area features a broad valley and rounded ridge crests. Relief is 480 to 900 m within the study area. Till deposits in the valley bottoms and on lower slopes are the result of direct glacial deposition. Tills with a silty sandy matrix reflect the regional glaciation; in the upper valleys a coarser, looser till may be found, which reflects deposition from ablating valley glaciers.

Large volumes of meltwater emanated from the retreating ice. Loose, surficial deposits were eroded from slopes, transported by meltwater streams and deposited as glaciofluvial terraces, outwash plains and ice-contact kames and eskers. These granular sediments infilled much of the valley lowlands. In places, they are associated with silt deposits laid down in glacial lakes formed by temporary ponding of meltwater.

In post-glacial time, deposition and erosion continues. Colluvial deposits are gravity-transported materials common to sloping ground. Angular bedrock fragments with interstitial sand and silt are ubiquitous on ridge crests and upper and mid-slope positions. Fluvial sediments and organic materials accumulate on floodplains, fans and adjacent valley lowlands. Fluvial erosion, lateral and vertical cutting through existing surface materials, is an on-going but generally imperceptible process; it is usually most dynamic in steeper-gradient channels and where unstable bank materials exist. Landsliding and debris flows are rapid mass movement processes which are modifying some areas of sloping terrain. Where surficial deposits are overlain by a blanket of organic materials, and on many north facing slopes, permafrost tends to occur. In these areas, ground-ice was encountered at depths of 40 to 50 cm.

General

Topography at the property area is subdued. Topographic relief for the entire property is 515 m. In the immediate area of the No. 1 zone, topographic relief is 230 m. Elevations range from 485 m at the Yukon River to 1,000 m on the western edge of the claim block.

Outcrop is uncommon because of the subdued topography and lack of glaciation. The major portion of the claim block lying north of Williams Creek is unglaciated above the 760 m elevation. The claim block area south of the Williams Creek valley and peripheral portions of the claim block, especially to the east, are covered by a veneer of ablation and lodgment bouldery till with a sandy to silty matrix, generally less than 1 m thick.

Williams Creek valley and its tributaries are the dominant topographic features of the study area. The main valley is characterized generally as a broad floodplain containing sands and silts that are covered by a blanket of organic accumulation. Ground ice occurs throughout this area at depths of 10 to 20 cm and peat plateaus are common. The Williams Creek channel becomes more confined downstream of the mine site area, where it has cut through bedrock and extensive deposits of fluvioglacial sands and gravels.

Near its confluence with Yukon River, Williams Creek is tightly confined in a canyon comprised of bedrock outcrop and steeply sloping outwash terraces. Due to the fact that much of the western portion of the study area was unglaciated during the Wisconsin Advance, the common surficial materials occurring up-slope of Williams Creek are a combination of coarse textured colluvium and medium textured glacial till, and minor fluvioglacial materials. Weathered bedrock is a dominant feature throughout much of the upland area, where soils exhibit a coarse sandy and rubbly texture. Minor side-slope drainages are usually incised into bedrock and exhibit infilling by fluvial sediments, capped by a veneer of organic accumulation. Extensive areas of the landscape, where slopes are generally less than 20% are poorly drained and covered by a veneer of organic accumulation. Loess and volcanic ash deposits (White River source) cover extensive portions of the study area.

Slope erosion processes are generally confined to minor gully erosion and landsliding. These processes are predominant on the terraces and steep slopes occurring on the north side of Williams Creek. The majority of the gulleys on the side-slopes are stable, exhibiting little erosion. The steeply sloping face on the south side of Williams Creek, upstream of its confluence with the Yukon River is exhibiting minor gullying and debris flow activity. The extensive terrace face at the confluence has and continues to undergo mass movement by gully and surface erosion processes.

The proposed heap leach pad site is a moderately sloping area characterized by a blanket of moderately well drained glacial till overlying bedrock. No erosional processes affect this area.

The study area lies within the discontinuous permafrost subzone. During field examinations, ground ice was encountered at depths of 40 to 50 cm on most north facing slopes where glacial till or medium textured colluvium is present. Ground ice is widespread in the main Williams Creek floodplain as well as the north facing tributary gullies.

5.1.2.2 Soils

On the basis of regional mapping and site test pitting, soils in the mine site area are dominated by Eutric Brunisols originating from dissected colluvial parent material. Soil texture is gravely sandy loam (Agriculture Canada 1992, Knight Piésold Ltd., 1993).

According to dominant morphological features and vegetation, well drained soils on south facing slopes are gravely sandy loam and are expected to be moderately alkaline and have moderate to high organic matter content and nutrients. Areas with moderate to poor drainage, dominated by lodgepole pine and black spruce, respectively, are expected to be more acidic with low to very low nutrient content. Lodgepole pine areas are expected to have much lower quantities of organic matter than the poorer drained areas of black spruce stands (Kennedy, 1993).

5.1.2.3 Permafrost

The Carmacks Copper project lies in an area of discontinuous permafrost, which corresponds to an area between the 0^oC and -10^oC mean annual temperature isotherms. The site mean annual air temperature was calculated from the estimated annual freeze and thaw indices. The mean annual air temperature was calculated as -5^oC for an elevation of 850 m at the Williams Creek site. Thermistor strings Th-1 and Th-2 were installed on a north and south facing slope respectively to measure the temperature as a function of depth. Thermistor Th-3 was installed in 1995. These thermistors have been measured intermittently since 1992 with the results tablulated in Appendix II of the “Baseline Data Compilation Report” prepared by Access Consulting Group in 1998.

The temperature measurements indicate that the permafrost temperatures are near 0^oC generally ranging between -0.1^oC and 0.3^oC which is classified as “warm” permafrost.

5.1.2.4 Seismicity

The Carmacks Copper project site is located within the interior of the Yukon Territory, an area that historically is of low seismicity. The site is located within the Northern B.C. source zone (NBC) bounded to the west by the Denali-Shakwak source zone (DSK) and to the east by the Mackenzie source zone (MKZ). In addition, beyond the Denali-Shakwak source zone lies the Fairweather-Yakutat source zone (FWY), a region which produces a high rate of large earthquakes (magnitude 7 and greater). These source zones have been defined in detail by Basham et. al (1982). Basham assigns a maximum earthquake magnitude to the following source zones:

Source Zone	**Magnitude**
NBC	5.0
DSK	7.0
FWY	8.5
MKZ	6.0

These values being one-half magnitude above the observed maximum magnitude, based on historical earthquake data.

Refer to Appendix C – Carmacks Copper Project Performance Standards and Design Criteria Parameters, for a summary of project seismic criteria.

5.1.2.5 Terrain Hazards

A terrain analysis of the Carmacks Copper property conducted by Westland Resources Group was presented in Volume IV of the IEE. Results of geomorphic conditions, land forms, and surficial materials were presented in the associated figure. This figure also indicated the location of the project facilities (open pit, heap leach pad, and waste rock stockpiles), as they were contemplated at that time.

Areas under the heap leach pad were designated as comprising M3 surficial materials which are categorized as being wet, subdued to moderately sloping till, featuring poor drainage, seepage, and/or shallow organic capping.

Areas of permafrost occur in the Williams Creek valley in the vicinity of the creek itself and in the north aspect tributaries contained occurrences of permafrost. Areas with evidence of active landsliding were observed on south facing steeply sloping scarps adjacent to Nancy Lee Creek and North Williams Creek. The potential for flooding in the area of the confluence with Williams Creek and the Yukon River, and within the creek valley to approximately 4 km upstream, was high. Flooding potential for Nancy Lee Creek is also high.

On the basis of comments on the IEE submission, the heap leach pad was relocated from the northwest side of the open pit to ground classified as comprising M4 and M5 surficial materials on the southwest side of the open pit. M4 and M5 surficial materials comprise shallow deposits overlying bedrock.

A Terrain Hazards Map (Figure 5-1) prepared by HKP in 1995, shows the location of the project facilities. Since the mapping covers the entire Williams Creek valley and features are difficult to discern in the mine site area, a larger scale map of the mine site area is given in Figure 5-2.

5.1.2.6 Geotechnical

Knight Piésold has carried out three site investigations at the Carmacks Copper Project area. The first program was a preliminary surficial geotechnical investigation completed between mid August and mid September 1992. This program examined the geotechnical and hydrogeological conditions for the open pit, four potential heap leach pad sites, process plant site, WRSA, and a water storage dam site.

The second geotechnical site investigation program was carried out between February 21 and March 10, 1995. This program examined the geotechnical and hydrogeological conditions at an alternative heap leach pad site, a possible water storage dam site, and identified potential material types for earthworks construction.

Knight Piésold between February 9 and March 4, 1996 carried out additional geotechnical and hydrogeological site investigation programs. The site investigation programs examined the geotechnical and hydrogeological conditions for the process plant site, the camp location, the crusher site, the heap leach pad site, the waste rock storage site, and the open pit. In October 1997 EBA Engineering Consultants (EBA) performed additional site investigations. The information obtained from the site investigation programs has provided the geotechnical and hydrogeological information necessary to characterize the site for detailed design work. EBA undertook a review of available geotechnical information to determine fundamental geotechnical parameters and recommendations for the conceptual heap leach design facilities for the Carmacks Copper Project (EBA, 2005).

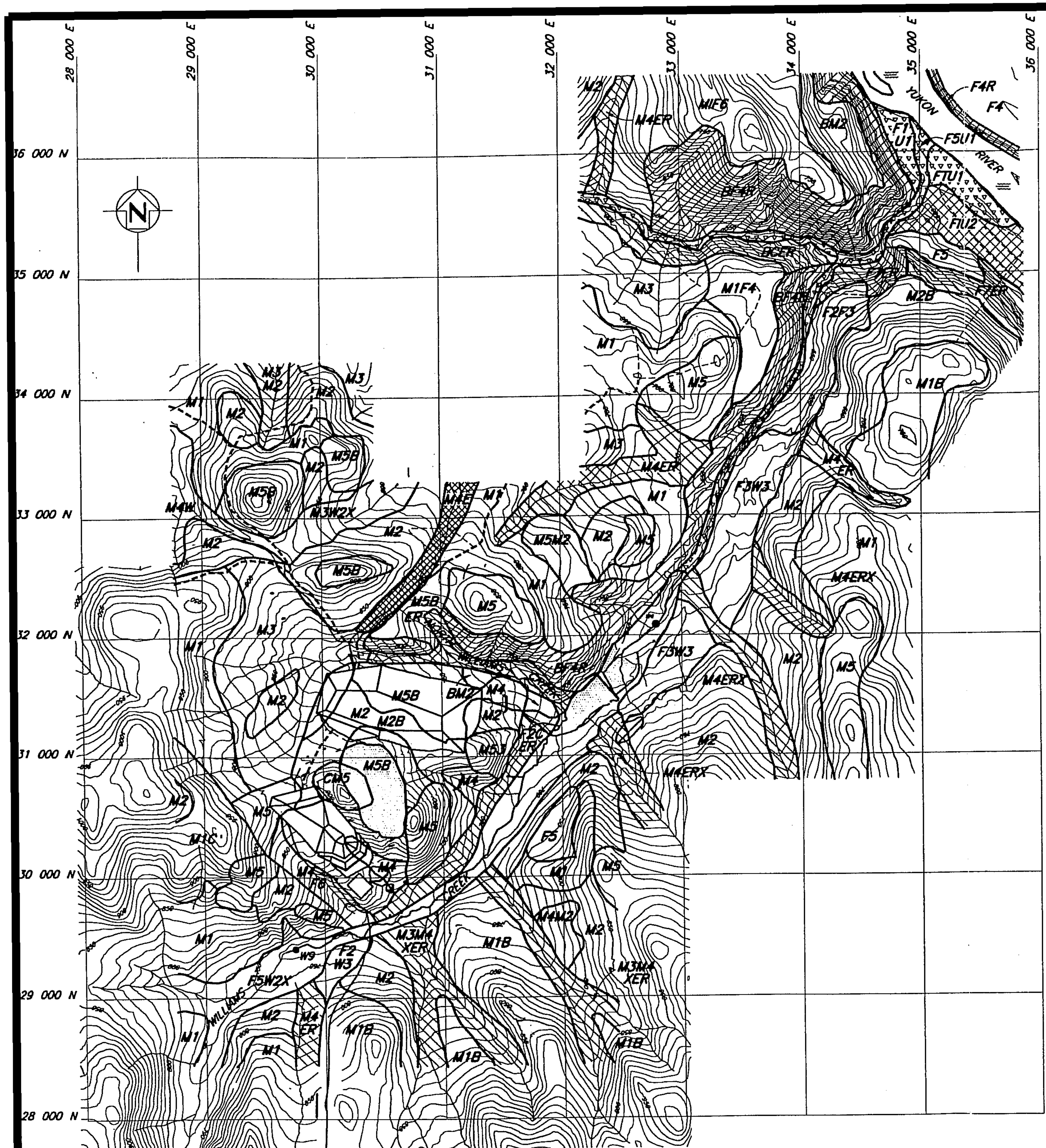
The boreholes and test pit locations for various geotechnical investigations are shown in Figure 5-4 and Drawing 1784.100. The types of surficial materials found across the project area have been grouped into the following categories:

- Organic / Ash Layer;
- Glaciofluvial / Glaciolacustrine Deposits;
- Well Graded Glacial Till;
- Weathered / Decomposed Bedrock; and
- Bedrock.

Overburden is generally thin; a few centimetres of moss and organic material overlie 5 to 20 cm of white felsic volcanic ash (White River ash approximately 1,250 years old). In unglaciated areas, the white ash is underlain by 10 cm of organics or peat, and 15 to 50 cm of soil. Bedrock is extensively weathered, particularly the gneissic units. At the eastern end of Trench 91-6, bedrock is 7 m below surface, the deepest recorded in the unglaciated area. In the glaciated areas, the white ash is underlain by tills, generally 1 m thick, except along Williams Creek valley where an undetermined depth of till and colluvium has collected. Permafrost is present at varying depths in most north facing slope locations and at depth in other areas. Facilities will be located to avoid frost susceptible, poorly drained soils.

Borrow pit locations were previously identified in the Knight Piésold document “Report on Detailed Design, Ref No. 1784/2” and will provide the materials necessary to satisfy the Stage I construction items. Additional borrow areas for soil liner material and LDRS drainage material for ongoing construction activities will be delineated as part of the Stage I construction activities.

Refer to Knight and Piésold’s report on “1996 Getotechnical and Hydrogeological Site Investigations” for detailed descriptions of the material types, and foundation conditions encountered at the process plant site, camp site, crusher site, leach pad site, and waste rock storage site.



LEGEND TERRAIN INTERPRETIVE MAP Geotechnical and Environmental Considerations	
LANDFORMS and MATERIALS	COMMON VEGETATION TYPE
Morainal Landforms – valley bottom and lower slope glacial till: mainly a dense sandy silty matrix, but may be closer and looser in upper valleys.	
M1 mainly thick subdued till landforms; average depths exceed 2m and slopes are usually less than 25%; in places there may be a thin veneer of silt and gravel.	Aspen, Kinnikinnick, minor Lodgepole Pine
M2 sloping till blanket overlying bedrock; depths range from 1–3m; slopes are mainly less than 40%.	Lodgepole Pine, Aspen, Black Spruce
M3 wet, subdued to moderately sloping till; features poor drainage, seepage, and/or shallow organic capping on slopes usually less than 30%.	Black Spruce, Willow, Labrador Tea
M4 Gullied till on valley sides; may contain fluvial and/or colluvial deposits; usually incised into bedrock.	Black Spruce, Willow, moss
M5 Shallow deposits of till overlying besrock; dominantly south and east facing slopes; slopes greater than 40%.	Aspen, Lodgepole Pine, grass
Colluvial Landforms – lower slope, gravity transported debris derived from bedrock.	
C accumulation of deep colluvial fans, cones and aprons (1–3m); blocky and rubbly debris may provide a source of coarse aggregate or ballast.	Black Spruce, Willow, moss
Bedrock Landforms	
B areas of bedrock outcrop and shallow colluvium	Open stands of Lodgepole Pine, Aspen and grasses.
Fluvial–Glaciofluvial Landforms – valley-bottom and lower-slope granular material; texturally variable from clean, coarse sand and gravels to dirty, silty gravels with variable interlayers; in places, may be capped with thin veneer of silt or minor wet areas may occur; potential sources of aggregate depending on thicknes of deposit and texture.	
F1 level to gently subdued surface, thick deposits	White and Black Spruce, Willow, moss
F2 subdued to moderately sloping (15–30%), thick deposits	White and Black Spruce, Willow, moss
F3 hummocky and ridged, moderately to moderately steeply sloping (30–65%), thick deposits.	Aspen, Kinnikinnick, grass
F4 steeply sloping scarps (greater than 65%), thick deposits, south facing.	Aspen and grasses
F5 subdued fluvial fans and low lying terraces; high water table and occassional floodeing may occur near channels and in depressions.	White Spruce, Birch, Willow, moss
F6 variable thickness (.5–2m) of sand and gravel overlying subdued to moderately sloping till surface; well-drained.	Lodgepole Pine, Willow, Labrador Tea
F7 steeply sloping scarps (65%)	Black Spruce, Willow, moss
Wetlands – valley-bottom and depressional areas which are wet for most of the year; inundation from high water table or flooding is the main constraint, but soft compressible soils are also common.	
W1 dominantly organic materials greater than 1m thick.	Black Spruce, Labrador Tea, Willow
W2 variable extent and thickness of organics (40–150cm) overlying wet floorplain sediments.	Willow, sedge, moss
W3 thin organics (less than 1m) and poorly drained mineral soil on floodplains and in large depressions; overbank silts and fine sands occur on floodplain lacustrine silts and till usually underlie depressions.	Black Spruce, Labrador Tea, moss

GEOMORPHIC CONDITIONS AND PROCESSES

Permafrost – perenial frozen ground.

X areas of potential ground ice occur on poorly-drained till slopes and floodplain areas where organic soils predominate.

Terrain Hazard Units

R slopes which show evidence of active landsliding; mass movement and erosion hazard.

ER slopes which have the potential for mass movement and/or have high erosion potential.

E slopes which have moderate erosion potential.

D toe-slope areas actively receiving deposition from upslope landslides or on-going erosion.

U1 areas highly susceptible to flooding, channel shifting, or inundation by high water table.

U2 areas potentially susceptible to flooding, channel shifting, or inundation by high water table.

NOTE:
Map units are defined by one or more symbols representing the occurence of significance terrain features and conditions and/or geomorphic hazards which may have a beneficial or constraining effect on mine-facility and access-road development.

LEGEND

- Index Contour
- Intermediate Contour
- Depression Contour
- Stream
- Intermittant Stream
- Indefinite Stream
- Single Tree
- Brush / Scrub
- Swamp
- Paved Road
- Dirt Road
- Water Quality Monitoring Station

Seed Mix (kg/ha)

1) Yukon wheatgrass (3), Violet wheatgrass(6), Northern fescue(4), Artic lupine(1), Yellow locoweed(1), Glaucous bluegrass(3).
2) Meadow foxtail(5), Tufted hairgrass(4), Polargrass(1), Bluejoint reedgrass(1), Altai fescue(6).
3) Meadow foxtail(3), Tufted hairgrass(4), Bluejoint reedgrass(1), Fowl bluegrass(8).
4) Yukon wheatgrass (3), Violet wheatgrass(8), Northern fescue(3), Artic lupine(2), Glaucous bluegrass(3), Sheep fescue(3), Snowy locoweed(1).

Scale 1000 500 0 1000 2000 Metres

Terrain Hazards
Figure 5-1

Based on information from Hallam Knight Piesold Ltd., July 5, 1995

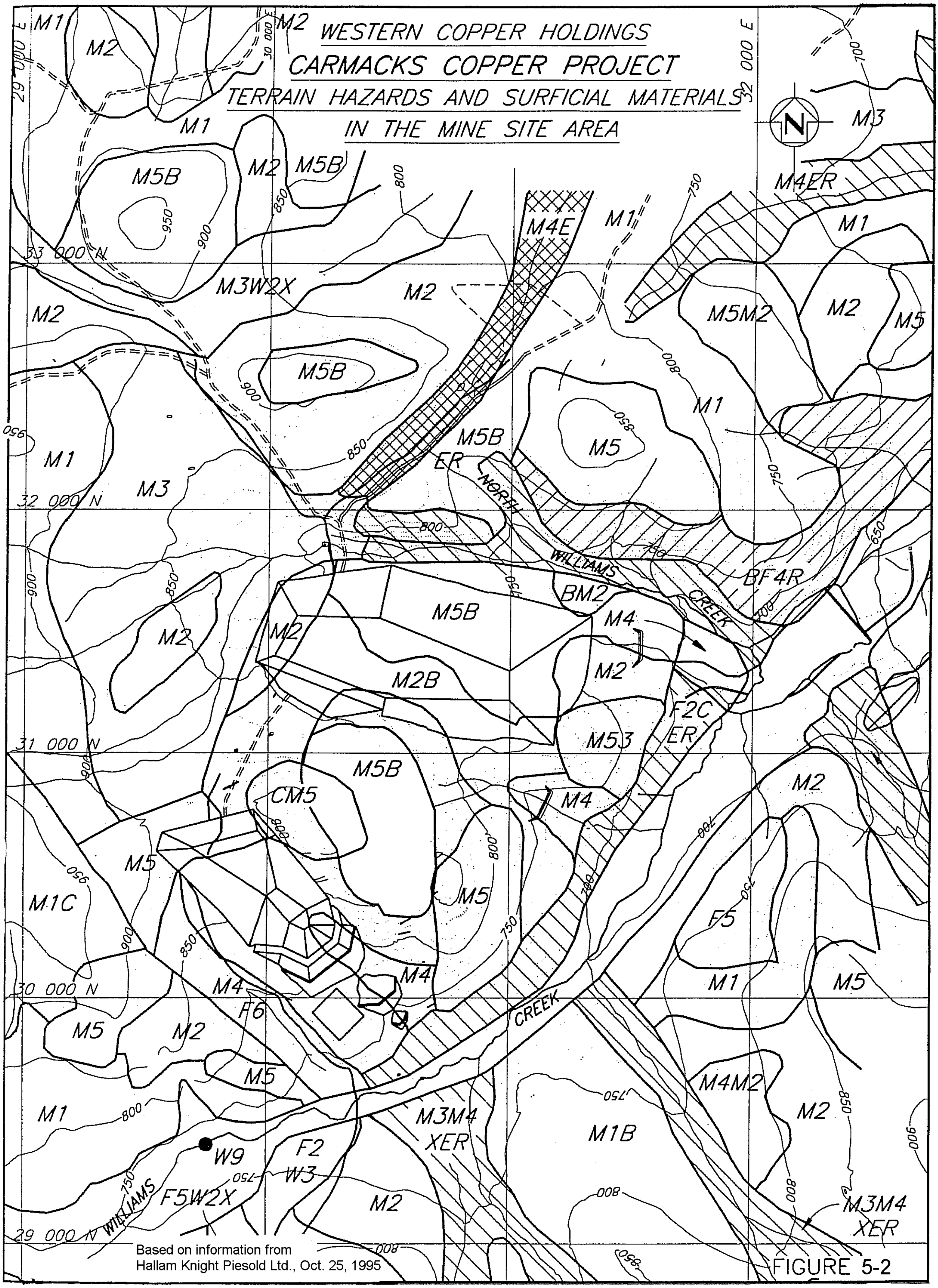

WESTERN COPPER HOLDINGS
CARMACKS COPPER PROJECT
TERRAIN HAZARDS AND SURFICIAL MATERIALS
IN THE MINE SITE AREA
N
29 000 E
30 000 E
32 000 E
33 000 N
32 000 N
31 000 N
30 000 N
29 000 N
NORTH WILLIAMS CREEK
WILLIAMS CREEK
M1
M2
M3
M4ER
M5B
M4E
M3W2X
M5M2
M5
M1C
M2B
BM2
M4
F2C
ER
M53
CM5
BF4R
F5
F6
M4M2
M3M4
XER
M1B
F2
W3
W9
F5W2X
650
700
750
800
850
900
950
Based on information from
Hallam Knight Piesold Ltd., Oct. 25, 1995

FIGURE 5-2

5.1.3 Water Resources

5.1.3.1 Surface Hydrology

General

Stream flows in the Yukon are generally characterized by peak flows in the spring and low flows in the winter. Maximum discharges typically occur during the spring as the result of snow melt or rain-on-snow events, with flows gradually decreasing following the disappearance of snow. Sizeable flood events may also occur in the late summer due to intense rainstorms. These rainfall events are particularly significant on small basins. The smallest discharges of the year occur in mid-winter. Ice develops on all rivers and many streams freeze entirely, reducing their winter flows to zero.

Description of Watershed

The orebody is located in the upper reaches of Williams Creek, approximately 9 km upstream of the confluence with the Yukon River (Figure 5-3). Williams Creek is a small tributary originating in the Dawson Range and draining northeast into the Yukon River downstream of Carmacks.

The Williams Creek watershed is comprised of two principal basins, Williams Creek and its tributary, Nancy Lee Creek. A summary of basin characteristics is presented in Table 5-4. Each creek drains approximately half of the 88 km^2 drainage area. Williams Creek has a main channel length of approximately 15.5 km, an average slope of 3%, and a basin elevation range of approximately 500 m to 1,000 m. The creek is typically a straight, deeply incised, narrow channel about 1 to 4 m in width and 0.5 to 1.5 m in depth with occasional meanders or side channels. Williams Creek flows into the Yukon River about 40 km northwest of the Village of Carmacks. Nancy Lee Creek has a channel length of approximately 13 km, an average gradient of 2.8% and a basin elevation that ranges from 518 to 882 m. It flows east into Williams Creek, approximately 1.3 km upstream of the Yukon River confluence.

Table 5-4 Summary of Basin Characteristics

Parameter	Location				
	Williams Cr. Above Ore Body	William Cr. Above Nance Lee Cr.	Nancy Lee Cr. Above Williams Cr.	Williams Cr. Above Yukon River	Yukon River Above Williams Cr.
Basin Area (km^2)	13.0	42.4	44.3	88.0	90,600
Maximum Elevation (m asl)	823	823	960	960	-
Minimum Elevation (m asl)	680	511	511	488	-
Elevation Difference	137	312	449	472	-
Channel Length (m)	3,500	11,000	14,000	15,500	-
Average Channel Slope (m/m)	0.0395	0.0285	0.0321	0.0304	-

Table 3.4.1 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site prepared by P.A. Harder and Associates Ltd.

Please refer to the IEE Addendum prepared by HKP in June 1995 for information on regional stream flow stations, site stream flow records, mean annual runoff, seven-day average low flow, and peak instantaneous flows. The "Baseline Data Compilation Report" prepared by Access Consulting Group in 1997 also presents hydrological data, including a summary of stream flow measurements recorded between 1991 and 1997.

The site hydrological characterization for the proposed Carmacks Copper heap leaching project was reviewed again in 1998 by Clearwater Consultants Ltd (CCL). Sources of hydrology data used in this study are summarized in CCL's Table 5-5.

Table 5-5 Hydrology Data Sources

Data Type	Station Name	Elevation (m)	Distance from Site	Years of Record
Precipitation	Williams Creek	850	-	1994-97
	Carmacks	525	35 km SE	1964-97
	Pelly River Ranch	454	70 km NNW	1951-97
Lake Evaporation	Pelly River Ranch	454	70 km NNW	1964-90
	Whitehorse A.	703	190 km SSE	1974-90
Snow Surveys	Williams Creek	739	-	1992
	Williams Creek	755	-	1992
	Williams Creek	876	-	1992
	Williams Creek	914	-	1995-97
	Pelly Farm	472	70 km NNW	1986-97
	Mt. Nansen	1021	50 km SW	1976-97
	Mt. Berdoe	1035	50 km SE	1975-97
	MacIntosh	1160	80 km SW	1976-97
	Satasha Lake	1106	90 km S	1987-97
	Casino Creek	1065	120 km WNW	1977-97

NOTE : Williams Creek station reports only summer rainfall. Regional stations report rainfall, snowfall, and total precipitation.

Detailed information with respect to site hydrology is presented in the Clearwater Consultants Ltd. Design Memorandum CCL-CC2 (March 13, 1998) and CCL-CC2A (April 28, 1998) and summarizes the most recent site hydrology data used for project design purposes.

5.1.3.2 Surface Water Quality

Water quality data from samples collected from eleven stations (W-1 to W-11) between 1989 and 1999 on the Williams Creek watershed are presented in Appendix H. Sampling programs within this time frame and their results are discussed below.

1989 – 1992 Investigations

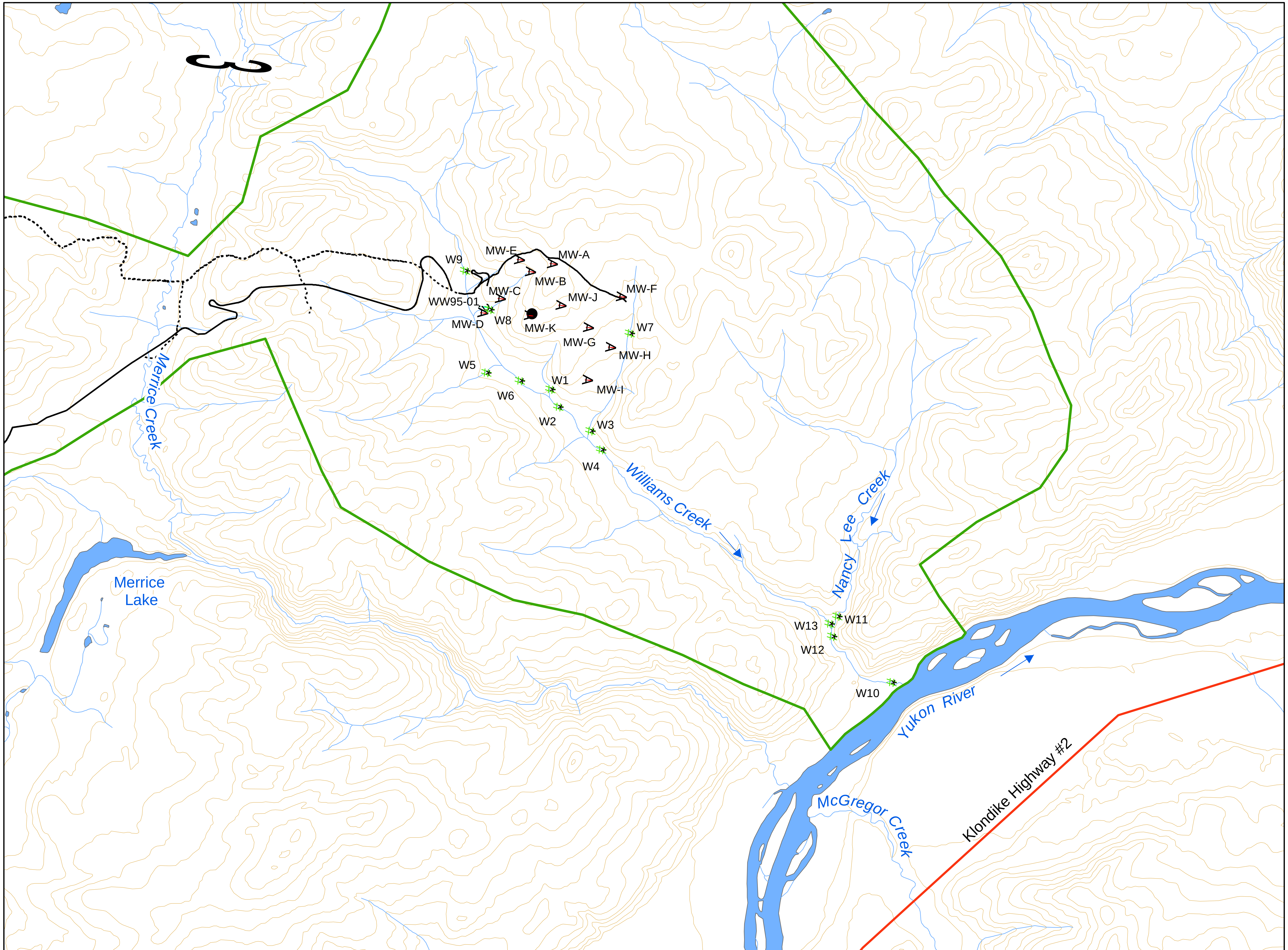
The following presents a summary of surface water quality data collected quarterly between October 1989 and October 1992 from the Williams Creek watershed. The information has been drawn from the IEE Volume I "Biophysical Assessment of the Williams Creek Mine Site" prepared by P.A. Harder and Associates in 1994. Sample station locations are described in Table 5-6 and shown in Figure 5-3. Samples were not collected from every location shown in the figure due to the intermittent stream flow at some of the sites. Water samples were collected from Sites W-1, W-5, W-7, and W-9 on six occasions between October 1989 and October 1992. Sites W-3 and W-10 were sampled twice during this period while single samples (October 1989) were collected from Sites W-2 and W-6. Site W-11 on Nancy Lee Creek was sampled four times. Additional samples were collected from two sites in lower Williams (W-12 and W-13) during the August 1992 fish survey.

At each site, samples were collected and analyzed for various parameters including suspended solids, turbidity, pH, conductivity, alkalinity, total hardness, nitrate, nitrite, sulphate, ammonia, total phosphorus, and total and dissolved metals.

Samples were taken from the mainstem of Williams Creek (W-4, W-9 and W-10) and from several tributaries (W-1 to W-3, W-5 to W-8, and W-11). Due to the intermittent stream flow of sites W-2, W-6, and W-8, only one sample was obtained each for sites W-2 and W-6, and no samples were collected from W-8. Therefore, the water quality data from these sites have not been included when average values are discussed.

Table 5-6 Water Quality and Hydrology Monitoring Stations

Station	Description / Location
Water Quality	
W-1	Tributary to Williams Creek
W-2	Williams Creek Downstream of W-1 Tributary
W-3	Tributary to Williams Creek - North Williams Creek (from Waste Rock Storage Area)
W-4	Williams Creek downstream of Confluence with W-3 Tributary
W-5	South East Tributary to Williams Creek
W-6	Williams Creek downstream of South East Tributary
W-7	Waste Rock Storage Area Tributary Near Road (Upstream of W-3)
W-8	Tributary to Williams Creek Near Access Road
W-9	Williams Creek Upstream of Access Road
W-10	Williams Creek Upstream of Yukon River
W-11	Nancy Lee Creek (Tributary of Williams Creek)
W-12	Williams Creek Downstream of Confluence with Nancy Lee Creek
W-13	Williams Creek Upstream of Confluence with Nancy Lee Creek
Hydrology Stations	
W-9 (Staff Gauge)	Staff Gauge Site (1991) on Williams Creek Immediately Downstream of Access Road (Immediately Downstream of Water Quality Site W-9)
W-2 (Recorder No. 2)	Data Logger Site No. 2 on Williams Creek Upstream of Waste Rock Tributary
W-4 (Recorder No. 3)	Data Logger Site No. 3 on Williams Creek Downstream of Waste Rock Tributary
W-10 (Recorder No. 1)	Data Logger Site No. 1 on Williams Creek Upstream of Yukon River



Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

Legend:

- Monitoring Well
- Water Well (by Others)
- Ore Deposit
- Water Quality Station
- Road
- Proposed Access Road
- Exploration Road
- Contour
- Water Course
- Water Body
- Environmental Assessment Study Area

Reach and Sample Site Locations obtained from:
"Western Copper Holding Williams Creek Copper Oxide Project Volume 1 Biophysical Assessment of the Williams Creek Mine Site"
Figure 2.5.1 Location of water quality and benthic invertebrate sites in the Williams Creek drainage.

UTM Zone 8 NAD83 Meters
NTS Sheet 115I/07

Water Quality Sample Station Locations

Figure Number:
5-3

Scale:
1:50,000

ACCESS CONSULTING GROUP

Drawn by: HD | Checked by: DC

Date: April, 2005

Our File: D:\Project\AllProjects\WCH-01\gis\mxd\Fig5_3_WQ.mxd

Physical Parameters, Nutrients and Major Ions

A summary of average values for physical parameters, nutrients and major ions is presented in Table 5-7.

Alkalinity

Average alkalinity for the Williams Creek mainstem sites (W-4, W-9, and W-10) for the sample period was between 107 and 149 mg/L $CaC0_3$. Seasonal variation ranged from 38 to 255 mg/L $CaC0_3$ with highest values detected in December 1991.

Average alkalinity values for the tributary sites (W-1, W-3, W-5, W-7, and W-11) ranged from 84 to 130 mg/L $CaC0_3$. Seasonal trends in the tributary sites were similar to the mainstem sites. The highest value (140 mg/L $CaC0_3$) was detected at site W-6 in October 1989.

Water Hardness

Average water hardness for the Williams Creek mainstem ranged from 125 to 161 mg/L $CaC0_3$. The highest values were observed during the low flow winter period when the relative contribution of ground water was highest. Water hardness values were lowest during the spring freshet period.

Average water hardness values for the tributary sites (W-1, W-3, W-5, W-7, and W-11) ranged from 102 to 206 mg/L $CaC0_3$. Seasonal trends in water hardness were similar between the mainstem sites and tributary sites, with the exception of W-1, which had relatively high water hardness throughout the year.

pH

Williams Creek mainstem pH values ranged from 7.4 to 8.2 with relatively little variation between individual sample sites for the sample period. Values were lowest during the May sample period due to a dilution effect from high flows. Tributary pH values ranged from 7.2 to 8.2 and exhibited a relatively high degree of variation between sites for the same sample period.

Suspended Solids

Suspended solids values were low during all sample periods. Average mainstem values ranged from below detection level to 258 mg/L with average values of 7, 94 and 13 mg/L for sites W-10, W-4, and W-9, respectively. The highest suspended sediment level (1,825 mg/L) occurred in August 1991 at Site W-5. This high level of suspended solids was likely due to a temporary site disturbance.

Nitrates, Nitrites and Ammonia

Total ammonia concentrations were frequently below detection for at all sample sites. Average values ranged from below detection levels at W-11 to 0.12 mg/L at W-9. The maximum value was observed at site W-9 (0.44 mg/L) in December 1991.

Nitrate and nitrite values were generally below or close to detection levels at all samples sites.

Table 5-7 Summary of Physical Water Quality Parameters for Williams Creek Oct. 1989 to Oct 1992

Average Values									
Sample Site	**Number of Samples**	**pH**	**Alkalinity** (mg/L CaCO3)	**H2O Hardness** (mg/L CaCO3)	**SO4** (mg/L)	**Suspended Solids** (mg/L)	**NO4** (mg/L)	**NO3** (mg/L)	**NH4** (mg/L)
Mainstem									
W10	5	7.9	113	125	15	13	0.01	BD	0.25
W4	6	7.8	107	146	37	37	0.02	BD	0.05
W9	6	7.8	149	161	30	30	BD	BD	0.12
Tributary									
W11	3	7.8	109	128	27	27	BD	BD	BD
W1	6	7.8	116	206	103	103	0.5	BD	0.06
W3	5	7.7	130	138	12	12	BD	BD	0.06
W5	6	7.5	84	102	4	4	BD	BD	0.07
W7	6	7.5	126	135	11	11	BD	BD	0.05
W2	1	7.7	100	133	76	76	BD	BD	0.06
W6	1	7.9	140	169	51	51	BD	BD	0.05

Total and Dissolved Metals

Twelve of the 32 elements included in the ICAP analysis were consistently below detection levels for total and dissolved metals samples at sites W-1, W-2, W-3, W-5, W-6, W-7, W-10, and W-11 throughout the sampling period. Included were antimony, beryllium, bismuth, cadmium, lead, lithium, molybdenum, selenium, silver, thorium, uranium, and zirconium. Elements which were frequently below detection included arsenic, chromium, cobalt, copper, phosphorous, and vanadium. Average total and dissolved values for selected elements commonly occurring in Williams Creek and its tributaries are summarized for the sample period in Table 5-8 and Table 5-9, respectively. Highlighted cells indicate that the value exceeds the Canadian Council of Ministers of the Environment (CCME) (2003) fresh water aquatic life guidelines. Selected elements are discussed below.

Aluminum

Aluminum was detected in 10 of 17 mainstem (W-4, W-9, and W-10) total metals samples and ranged from 0.026 to 3.89 mg/L. Levels were above CCME guideline values in five samples. The average total aluminum concentration for the lowermost Williams Creek mainstem site (W-10) was 0.18 mg/L. Dissolved aluminum was detected in 10 of 15 samples from mainstem sites and ranged from 0.007 (W-4) to 0.08 mg/L (W-10). All levels detected were below CCME guidelines.

Aluminum was detected in 14 of 28 tributary total metals samples and values ranged from 0.03 to 9.58 mg/L. The highest value was detected at site W-5 in August 1991, during a period of heavy precipitation. Aluminum levels were above CCME guidelines in five samples. Dissolved aluminum was detected in 11 of 22 samples and values ranged from 0.017 to 0.084 mg/L. All detected values were below CCME guidelines for aquatic life.

Arsenic
Arsenic was detectable in 3 of 17samples collected from Williams Creek mainstem total metals water samples and ranged from 0.04 to 0.16 mg/L. The average concentration of total arsenic at the lowermost Williams Creek mainstem site (W-10) was 0.05 mg/L. Dissolved arsenic was detected in 3 of 13 samples and ranged from 0.06 to 0.16 mg/L. All detected levels, which were above CCME guidelines, were sampled at sites W-4, W-9, and W-10 in December 1991. Arsenic was detectable in 6 of 28 total metals samples collected from the tributary sites and 5 were above the CCME guidelines (0.11 to 0.16 mg/L). The highest observed total concentrations were detected at Sites W-1 and W-7. Dissolved arsenic was detected in 4 of 22 samples and ranged from 0.09 to 0.12 mg/L. All four samples were collected in December 1991 and were above CCME guidelines.

Barium
Barium was detectable in all total metals and dissolved metals mainstem samples and ranged from 0.013 to 0.175 mg/L. The average concentration of total barium at the lower most Williams Creek mainstem site (W-10) was 0.057 mg/L. Dissolved barium levels ranged from 0.009 to 0.066 mg/L. Barium was also detected in all tributary water samples. Concentrations of total barium at these sites ranged from 0.012 to 0.455 mg/L with the highest values occurring at Station W-1 and W-5. Dissolved values ranged from 0.010 to 0.067 mg/L.

Cadmium
Total and dissolved levels of cadmium were below detection for most water quality samples. A total concentration of 0.0004 mg/L was observed at site W-9 during May 1992.

Total cadmium was detected at levels greater than CCME criteria at sites W-1 and W-5, with values ranging from 0.004 to 0.006 mg/L.

Chromium
Chromium was detectable in 10 of 17 total metals samples collected from mainstem Williams Creek sites. Concentrations of total chromium ranged from 0.0005 to 0.012 mg/L in the mainstem sites. The average concentration for the lowermost site was 0.003 mg/L with a maximum value of 0.009 mg/L. Dissolved chromium was detected in 4 of 15 samples and ranged from 0.002 to 0.005 mg/L.

Chromium was detectable in 16 of 28 total metals samples collected from the tributary sites and ranged from 0.0012 to 0.05 mg/L. The highest observed total concentration was detected at Site W-5. Dissolved chromium was detected in 4 of 22 samples and values ranged from 0.001 to 0.007 mg/L.

Cobalt
Cobalt was detectable in 9 of 17 total metals samples collected from mainstem Williams Creek sites. Concentrations of total cobalt ranged from 0.001 to 0.004 mg/L in the mainstem sites. The lower most mainstem site on Williams Creek had an average value of 0.001 mg/L and a maximum value of 0.002 mg/L. Dissolved cobalt levels were detected in 5 of 15 samples and ranged from 0.001 to 0.004 mg/L.

Cobalt was detectable in 10 of 28 total metals samples collected from the tributary sites and ranged from 0.002 to 0.016 mg/L. The highest observed total concentration was observed at Site W-5. Dissolved cobalt was detected in 10 of 22 samples and ranged from 0.001 to 0.007 mg/L.

Copper

Copper was detectable in 9 of 17 total metals samples collected from mainstem Williams Creek sites and ranged from 0.001 to 0.014 mg/L. The lowermost Williams Creek mainstem site had an average value of 0.003 mg/L and a maximum value of 0.005 mg/L. Dissolved copper was detected twice during the sample period. In October 1992, levels of detectable dissolved copper were 0.002 and 0.005 mg/L at sites W-4 and W-10, respectively.

Copper was detected in 14 of 28 total metals tributary samples with a range of 0.001 to 0.059 mg/L. The highest observed total copper concentration for the tributary sites was observed at Site W-5. Dissolved copper was detected in 7 of 22 samples with a range of 0.001 to 0.009 mg/L. Total copper levels were intermittently above the CCME guidelines at sites W-1, W-3, W-4, W-5, W-7, W-9, W-10, and W-11 (0.002 to 0.004 mg/L).

Iron

Iron was detectable in all total metals and dissolved metals samples from Williams Creek mainstem sites. Total iron and dissolved iron levels ranged from 0.07 to 6.6 mg/L and 0.022 to 1.24 mg/L, respectively. The average concentration of total iron in Lower Williams Creek (W-10) was 0.354 with a high value of 0.824 mg/L.

Iron was detected in 27 of 28 total metals samples from the tributary sites and ranged from 0.037 to 31.4 mg/L. The highest detected levels occurred at sites W-5 and W-7. Dissolved iron was detected in 19 of 22 samples and values ranged from 0.054 to 9.4 mg/L. Total iron levels were occasionally above CCME criteria at water quality sites W-2, W-4, W-5, W-6, W-7, W-9, and W-10 (0.3 mg/L).

Zinc

Zinc was detectable in 15 of 17 total metals samples collected from mainstem Williams Creek sites and values ranged from 0.003 to 0.195 mg/L. The average value at the lowermost mainstem site was 0.045 mg/L with a maximum value of 0.195 mg/L. Dissolved zinc was detected in 12 of 15 water quality samples and ranged from 0.002 to 0.008 mg/L to 0.01 mg/L.

Zinc was detectable in 27 of 28 total metals samples collected from the tributary sites and zinc levels ranged from 0.002 to 0.108 mg/L; the highest observed total zinc concentration for the tributary sites was detected at Site W-6 in October 1989. Dissolved zinc was detected in 19 of 22 samples and ranged from 0.002 to 0.010 mg/L. Total and dissolved zinc values averaged over the sample period are compared for mainstem and tributary sites in. Total zinc concentrations were periodically above CCME guidelines in water samples from Sites W-1 to W-6 and W-10 (0.03 mg/L).

Table 5-8 Summary of Total Metal Concentrations for Williams Creek, Oct. 1989 to Oct. 1992
(Harder and Associates, 1994)

Element	Mainstem			Tributary							CCME Guidelines Freshwater Aquatic Life
	W10	**W4**	**W9**	**W11**	**W1**	**W3**	**W5**	**W7**	**W2**	**W6**	
n	*5*	*6*	*6*	*3*	*6*	*5*	*6*	*6*	*1*	*1*	
Al	0.18	1.14	0.03	0.06	0.02	0.04	3.23	0.06	ND	ND	**0.005 - 0.1**
As	0.05	0.05	0.06	0.07	0.06	ND	0.06	0.06	ND	ND	**0.005**
Cd	ND	ND	0.003	ND	0.0003	ND	0.0004	0.0003	ND	ND	**0.000017**
Ca	37.0	37.7	41.1	36.8	60.6	41.2	26.1	40.9	44.2	43.8	
Cu	0.003	0.006	0.002	0.003	0.002	0.005	0.018	0.005	ND	0.001	**0.002 - 0.004**
Fe	0.35	2.16	0.66	0.14	0.14	0.15	8.43	2.10	0.37	0.64	**0.3**
Pb	ND	0.004	ND	ND	ND	ND	0.007	0.004	ND	ND	**0.001 - 0.007**
Mg	7.7	10.2	14.1	8.7	13.3	7.9	7.0	8.3	12.8	13.9	
Na	6.19	9.66	11.9	8.7	9.0	6.5	6.6	6.2	12.8	14.3	
Zn	0.045	0.018	0.006	0.006	0.012	0.014	0.035	0.010	0.033	0.108	**0.03**

Notes: Units are in mg/L; ND = Not Detectable; No Data for W8

Table 5-9 Summary of Dissolved Metal Concentrations for Williams Creek, Oct. 1989 to Oct. 1992
(Harder and Associates, 1994)

	Mainstem			Tributary				
Element	**W10**	**W4**	**W9**	**W11**	**W1**	**W3**	**W5**	**W7**
n	*5*	*5*	*5*	*3*	*5*	*4*	*5*	*5*
Al	0.04	0.02	0.18	0.05	ND	0.03	0.04	0.02
As	0.05	0.06	0.05	0.06	0.06	ND	0.005	0.06
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Ca	35.4	34.0	39.5	34.9	59.4	35.0	23.6	37.5
Cu	0.002	0.001	ND	0.002	ND	0.001	0.002	0.002
Fe	0.11	0.37	0.38	0.10	0.05	0.14	0.62	1.98
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Mg	7.1	9.1	12.9	8.4	12.8	7.3	5.9	7.3
Na	5.7	8.7	10.2	6.9	9.5	6.0	5.6	6.2
Zn	0.005	0.004	0.004	0.003	0.004	0.004	0.005	0.005

Notes: Units are in mg/L; ND = Not Detectable; No Data for W2, W6 or W8

Summary of Background Water Quality (1989-1992)

The water quality data collected in this study will provide a baseline from which potential effects can be assessed once the mine is operational. Baseline data will also be important to regulatory agencies setting the mine discharge limits for the project. The CCME guidelines for fresh water aquatic life in Canada are generally considered to be a conservative limit set for the protection of fish and aquatic ecosystems based on available data for acute and chronic toxicity responses of aquatic organisms. These guidelines are for the protection of aquatic receiving environments.

Baseline data on total metal concentrations in Williams Creek have been compared to the recommended guideline values established by CCME for the purposes of documenting baseline water quality prior to project development. Of the ten elements compared in Table 5-8, lower Williams Creek, average background concentrations (October 1989 to October 1992) of total aluminum, arsenic, copper, iron, and zinc exceeded the recommended CCME guidelines. The upper site (W-4) also exceeded the CCME guideline for aluminum, arsenic, copper, iron, and zinc.

Water hardness values ranging from 75 to 225 mg/L $CaC0_3$ for Williams Creek indicate a moderate degree of natural buffering capacity. In lower Williams Creek, water hardness, and therefore buffering capacity, is generally lowest during periods of high stream discharge when the relative contribution of surface water is high compared to the ground water component (Gibson 1991).

Further discussion of water quality investigations in Williams Creek between 1989 and 1992 is presented in the IEE Volume I "Biophysical Assessment of the Williams Creek Mine Site" prepared by P.A. Harder and Associates in 1994.

1994 Investigation

Indian and Northern Affairs Canada also undertook water quality sampling of Williams Creek in May 1994 at five of the established sample sites: W-3, W-4, W-5, W-7, and W-9 (MDA Consulting, 2000). The results of this investigation are found in Appendix III.B of the "Baseline Data Report" prepared by Access Consulting Group in 1998.

1997 Investigation

In 1997 surface water quality samples were collected as part of a site investigation conducted by Access Consulting Group. Samples were taken from stations W-3 (Tributary to Williams Creek); W-4 (Williams Creek downstream of confluence with W-3 station); and W-9 (Williams Creek upstream of access road). Most surface water quality parameters for the samples taken during this event were below CCME freshwater aquatic life guidelines. Two parameters exceeded the guidelines: aluminum and iron. Stations W-3 (tributary to Williams Creek) and W-9 (Williams Creek) both reported aluminum concentrations above the guideline. Iron exceeded the guideline at all three stations.

1999 Investigation

Water samples were also collected from Williams Creek in 1999 by MDA Consulting. The samples were taken at the culvert for the access road near the west end of the camp and at the mouth of Williams Creek. These sample station locations are comparable to W9 and W10, respectively. Samples collected in October 1999 had total metals levels consistently lower than the metals concentrations reported for samples collected between 1989 and 1992. None of the metals measured in October 1999 exceeded the CCME (1999) surface water quality objectives (MDA Consulting, 2000). The dissolved metals for the 1999 samples are also consistently less than previously reported during the 1994 investigation. Even copper is non-detectable in the 1999 samples (MDA Consulting, 2000).

Refer to Appendix H of this report for a summary of water quality data from the Williams Creek watershed between 1989 and 1999.

5.1.3.3 Hydrogeology

General

Standpipe piezometers wells were installed at the Carmacks Copper site in 1992, 1995, and 1996 to measure groundwater levels and allow for the collection of water quality samples. In total, 36 piezometers were installed at the site between 1992 and 1996. The 1996 site investigation work included a program to investigated and establish the site hydrogeologic conditions. Standpipe piezometers were installed in drill holes to measure the water levels within specific intervals.

The one inch diameter standpipe piezometers (DH-11, 12, 14, and 15) installed at the process plant site are summarized in Table 5-10, and shown in Figure 5-4. The two inch diameter groundwater monitoring wells (MW-A to K) installed at the leach pad, waste rock storage site, and open pit sites are summarized in Table 5-11, and shown in Figure 5-3. Completion details, monitoring record sheets, and falling head permeability calculation sheets for these piezometers are included in Knight and Piésold's report on "1996 Geotechnical and Hydrogeological Site Investigations."

The locations of the piezometers are also shown on Drawing 1784.100 and hydrogeologic information is shown on section on Drawing 1784.101 to 103.

Table 5-10 Summary of Stand Pipe Piezometers at the Process Plant Site

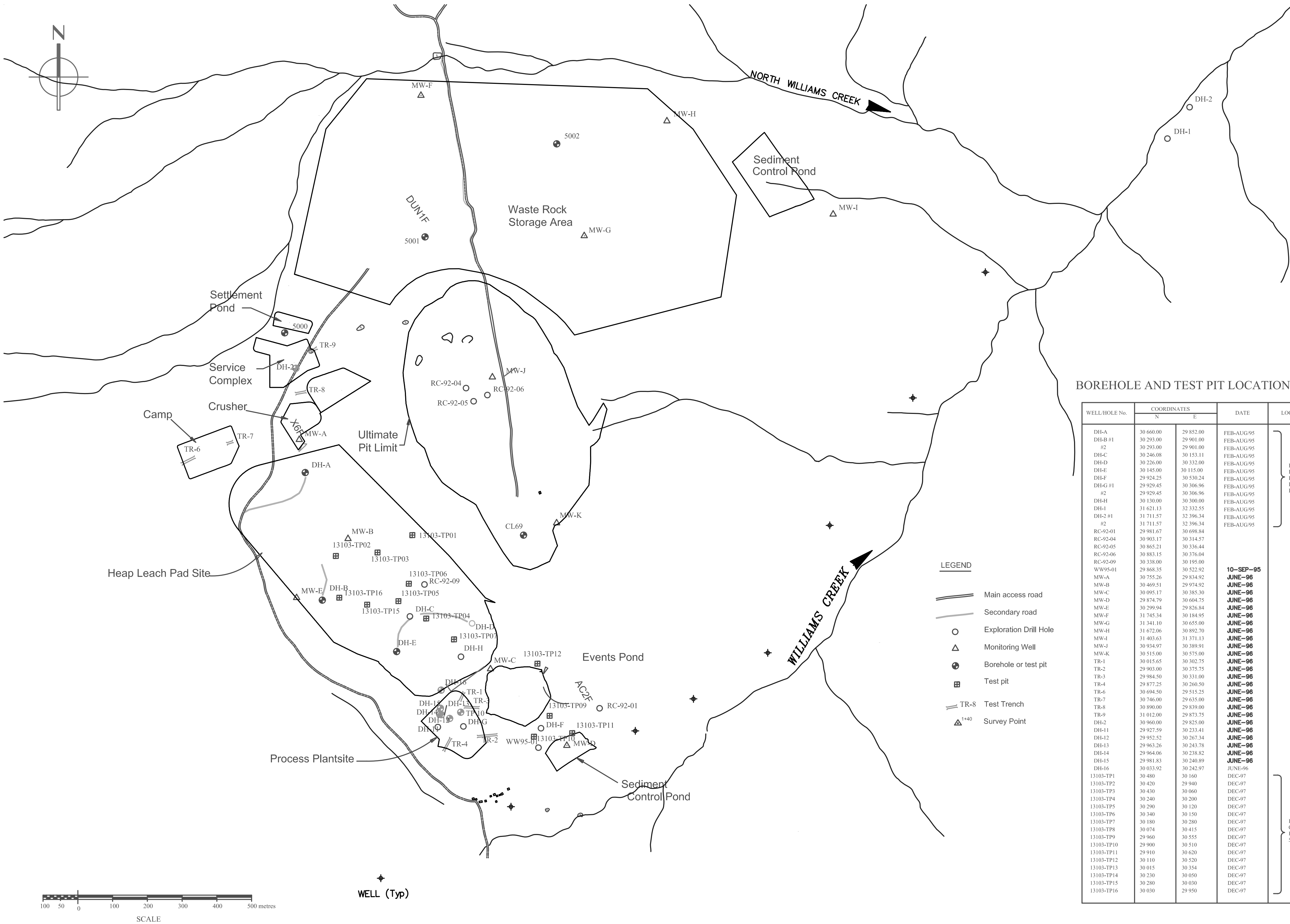
DRILL HOLE NUMBER	PIEZOMETER DESIGNATION	LOCATION			WELL INFORMATION				GROUNDWATER INFORMATION		
		NORTHING (m)	EASTING (m)	GROUND ELEVATION (m)	GEOLOGY OF MONITORING ZONE	PIEZOMETER DEPTH (m)	TIP ELEVATION (m)	PIEZOMETER STICKUP (m)	DEPTH TO WATER (m)	WATER ELEVATION (m)	DATE
DH96-11	Stand Pipe	29,929	30230[1]	766	Bedrock	15.9	750.1	0.3	Dry well	Dry well	21-Feb-96
DH96-12	Stand Pipe	29,953	30,267	769	Bedrock	17.1	751.9	0.3	Dry well	Dry well	21-Feb-96
DH96-14	Stand Pipe	29,964	30,239	768	Bedrock	14.4	753.6	0.3	7.3[2]	768	23-Feb-96
DH96-15	Stand Pipe	29,982	30,241	769	Bedrock	16.3	752.7	0.3	14.3[2]	769	23-Feb-96

Note: 1. Easting coordinate for DH96-11 was scaled from drawing.
2. No goundwater was intersected. The water level measurements were monitoring drilling induced water.

Table 5-11 Summary of Groundwater Monitoring Wells 1996 Drill Program

DRILL HOLE	WELL INFORMATION										
NUMBER	LOCATION	NORTHING (m)	EASTING (m)	GROUND ELEVATION (m)	GEOLOGY OF MONITORING ZONE	PIEZOMETER DEPTH (m)	TIP ELEVATION (m)	PIEZOMETER STICKUP (m)	DEPTH TO WATER (m)	WATER ELEVATION (m)	DATE
MW96-A1	Leach Pad Site	30,755	29,835	861	Bedrock	45.7	815.3	0.60	45.4	816	3-Mar-96
MW96-A2	Leach Pad Site	30,755	29,835	861	Bedrock	91.4	769.6	0.60	60.6	801	3-Mar-96
MW96-B	Leach Pad Site	30,470	29,974	833	Bedrock	91.4	741.6	0.30	41.6	792	3-Mar-96
MW96-C	Leach Pad Site	30,094	30,382	755	Bedrock	50.0	705.0	0.40	40.3	715	3-Mar-96
MW96-D	Leach Pad Site	29,875	30,605	717	Bedrock	41.1	675.9	0.30	12.4	705	3-Mar-96
MW96-E	Leach Pad Site	30,300	29,827	831	Bedrock	91.4	739.6	0.45	53.4	778	3-Mar-96
MW96-F	Waste Rock Storage Area	31,745	30,185	785 [1]	Coarse Sand	62.5	722.5	0.30	13.4	772	3-Mar-96
MW96-G	Waste Rock Storage Area	31,341	30,655	777	Bedrock	74.7	702.3	0.30	48.4	729	3-Mar-96
MW96-H	Waste Rock Storage Area	31,670	30,975	738	Bedrock	55.2	682.8	0.30	16.9	721	3-Mar-96
MW96-I	Waste Rock Storage Area	31,404	31,371	715	Bedrock	54.9	660.1	0.30	18.0	697	3-Mar-96
MW96-J	Open Pit	30,935	30,390	846	Bedrock	90.5	755.5	0.55	dry well	dry well	3-Mar-96
MW96-K	Open Pit	30,515	30,545	849	Bedrock	92.96	756.04	0.30	dry well	dry well	3-Mar-96

Note: 1. Elevation for BH96-F was scaled from drawing.



BOREHOLE AND TEST PIT LOCATION

WELL/HOLE No.	COORDINATES N	COORDINATES E	DATE	LOGS & TEST RESULTS
DH-A	30 660.00	29 852.00	FEB-AUG/95	KNIGHT PIESOLD REPORT ON PRELIMINARY DESIGN DATED 1 MAY, 1995
DH-B #1	30 293.00	29 901.00	FEB-AUG/95	
#2	30 293.00	29 901.00	FEB-AUG/95	
DH-C	30 246.08	30 153.11	FEB-AUG/95	
DH-D	30 226.00	30 332.00	FEB-AUG/95	
DH-E	30 145.00	30 115.00	FEB-AUG/95	
DH-F	29 924.25	30 530.24	FEB-AUG/95	
DH-G #1	29 929.45	30 306.96	FEB-AUG/95	
#2	29 929.45	30 306.96	FEB-AUG/95	
DH-H	30 130.00	30 300.00	FEB-AUG/95	
DH-1	31 621.13	32 332.55	FEB-AUG/95	
DH-2 #1	31 711.57	32 396.34	FEB-AUG/95	
#2	31 711.57	32 396.34	FEB-AUG/95	
RC-92-01	29 981.67	30 698.84		
RC-92-04	30 903.17	30 314.57		
RC-92-05	30 865.21	30 336.44		
RC-92-06	30 883.15	30 376.04		
RC-92-09	30 338.00	30 195.00		
WW95-01	29 868.35	30 522.92	10-SEP-95	
MW-A	30 755.26	29 834.92	JUNE-96	
MW-B	30 469.51	29 974.92	JUNE-96	
MW-C	30 095.17	30 385.30	JUNE-96	
MW-D	29 874.79	30 604.75	JUNE-96	
MW-E	30 299.94	29 826.84	JUNE-96	
MW-F	31 745.34	30 184.95	JUNE-96	
MW-G	31 341.10	30 655.00	JUNE-96	
MW-H	31 672.06	30 892.70	JUNE-96	
MW-I	31 403.63	31 371.13	JUNE-96	
MW-J	30 934.97	30 389.91	JUNE-96	
MW-K	30 515.00	30 575.00	JUNE-96	
TR-1	30 015.65	30 302.75	JUNE-96	
TR-2	29 903.00	30 375.75	JUNE-96	
TR-3	29 984.50	30 331.00	JUNE-96	
TR-4	29 877.25	30 260.50	JUNE-96	
TR-6	30 694.50	29 515.25	JUNE-96	
TR-7	30 746.00	29 635.00	JUNE-96	
TR-8	30 890.00	29 839.00	JUNE-96	
TR-9	31 012.00	29 873.75	JUNE-96	
DH-2	30 960.00	29 825.00	JUNE-96	
DH-11	29 927.59	30 233.41	JUNE-96	
DH-12	29 952.52	30 267.34	JUNE-96	
DH-13	29 963.26	30 243.78	JUNE-96	
DH-14	29 964.06	30 238.82	JUNE-96	
DH-15	29 981.83	30 240.89	JUNE-96	
DH-16	30 033.92	30 242.97	JUNE-96	
13103-TP1	30 480	30 160	DEC-97	EBA ENGINEERNG CONSULTANTS LTD. REPORT DATED 5 DEC 1997
13103-TP2	30 420	29 940	DEC-97	
13103-TP3	30 430	30 060	DEC-97	
13103-TP4	30 240	30 200	DEC-97	
13103-TP5	30 290	30 120	DEC-97	
13103-TP6	30 340	30 150	DEC-97	
13103-TP7	30 180	30 280	DEC-97	
13103-TP8	30 074	30 415	DEC-97	
13103-TP9	29 960	30 555	DEC-97	
13103-TP10	29 900	30 510	DEC-97	
13103-TP11	29 910	30 620	DEC-97	
13103-TP12	30 110	30 520	DEC-97	
13103-TP13	30 015	30 354	DEC-97	
13103-TP14	30 230	30 050	DEC-97	
13103-TP15	30 280	30 030	DEC-97	
13103-TP16	30 030	29 950	DEC-97	

Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

Note: Drawing is for illustrative purposes only, NOT FOR CONSTRUCTION

Original drawing from Kilborn,
The engineering data on this drawing is solely for the purpose and project for which this drawing is issued.
"Borehole and Test Pit Location Plan",
Drawing #100-13-35

Borehole and Test Pit Locations

Figure Number:
5-4

ACCESS CONSULTING GROUP

Revised by: HD | Checked by: DDC

Date: April, 2005

File: D:\Project\AllProjects\DEV-04-02\dwg\figures\Fig5_4_BH.dwg

Regional Groundwater System

The Carmacks Copper project site is located adjacent to the Williams Creek drainage. The regional drainage pattern in the area has evolved into a contorted pattern influenced by complicated structural features associated with the intrusive and metamorphic rock types. The regional groundwater flow system at the Carmacks Copper project is further complicated by the presence of permafrost in the valley bottoms, which produces a confining effect and possibly perched water tables. Regional groundwater occurs as an unconfined deep flow system within bedrock in which groundwater is recharged at higher elevations in the upland areas and flows toward the valleys at lower elevations. The groundwater table forms a subdued replica of topography whereby the depth to groundwater increases with increasing elevation. The result of exploration drilling and recent geotechnical site investigations indicate that the groundwater table lies at significant depths over most of the project area. In some areas the presence of discontinuous permafrost has resulted in the development of perched water tables, however, these are isolated and are discontinuous. In addition, minor groundwater flow occurs in the active zone just below the ground surface on a seasonal basis resulting in the development of local swamp areas. The discontinuous permafrost also acts as a barrier inhibiting infiltration in some areas thereby significantly reducing recharge resulting in the overall depression of the region groundwater table. Refer to Knight Piésold's "1996 Geotechnical and Hydrogeological Site Investigations" for details on the site groundwater conditions. Knight Piésold's "Report on Updated Detailed Design of Heap Leach Pad and Events Pond" includes figures showing hydrogeological modelling.

5.1.3.4 Groundwater Quality

In 1997 a field reconnaissance was undertaken that included conducting piezometric measurements at the existing monitoring stations and collecting groundwater quality samples. The in situ and laboratory water quality data from the 1997 field trip for piezometers RC-92-01, DH95-B, MW96-B, and MW96-F are contained within the "Baseline Data Compilation Report" prepared by Access Consulting group in January 1998. Selected parameters, and the applicable guidelines for the protection of freshwater aquatic life (CCME, 2003) where applicable are presented in Table 5-12. Highlighted cells indicate that the value exceeds the CCME (2003) water quality guideline. The locations of the groundwater wells are shown on Drawing 1784.100, and Figures 5-3 and 5-4.

Table 5-12 Groundwater Quality for Selected Parameters

Well	RC92-01	MW96-B	MW96-F	DH95-B	CCME Guidelines Freshwater Aquatic Life
Sample Date	**27-Sep-97**	**28-Sep-97**	**28-Sep-97**	**28-Sep-97**	
Hardness ($CaCO_3$), mg/L	273	131	189	140	
Aluminum	0.068	1.35	0.231	26.1	**0.005-0.1**
Arsenic	0.0003	0.0005	0.0011	0.002	**0.005**
Cadmium	<0.00005	0.00006	0.00025	<0.0005	**0.000017**
Chromium	<0.0005	0.001	0.001	0.011	
Copper	0.001	0.0018	0.0147	0.009	**0.002-0.004**
Iron	0.06	1.14	0.4	3.52	**0.3**
Lead	0.00024	0.00173	0.0036	0.0121	**0.001-0.007**
Mercury	<0.00005	<0.00005	<0.00005	<0.00005	**0.0001**
Nickel	0.0014	0.0011	0.0094	0.005	**0.025-0.15**
Selenium	0.002	<0.001	<0.001	<0.01	**0.001**
Silver	<0.00001	<0.00001	0.00002	<0.00001	**0.0001**
Zinc	0.004	0.007	0.047	0.09	**0.03**

Notes: Units are in mg/L

As can be observed from Table 5-12, the groundwater quality parameters were generally below CCME guidelines for freshwater aquatic life. Total aluminum and iron concentrations were above the guideline at wells MW96-B, MW96-F and DH95-B. Piezometers DH95-B and MW96-F reported total copper levels above the guideline. Piezometer DH95-B had total lead levels above the guideline. Total zinc concentrations were above the guideline at MW96-F and DH95-B.

5.2 BIOLOGICAL ENVIRONMENT

5.2.1 Aquatic Resources

5.2.1.1 Fisheries

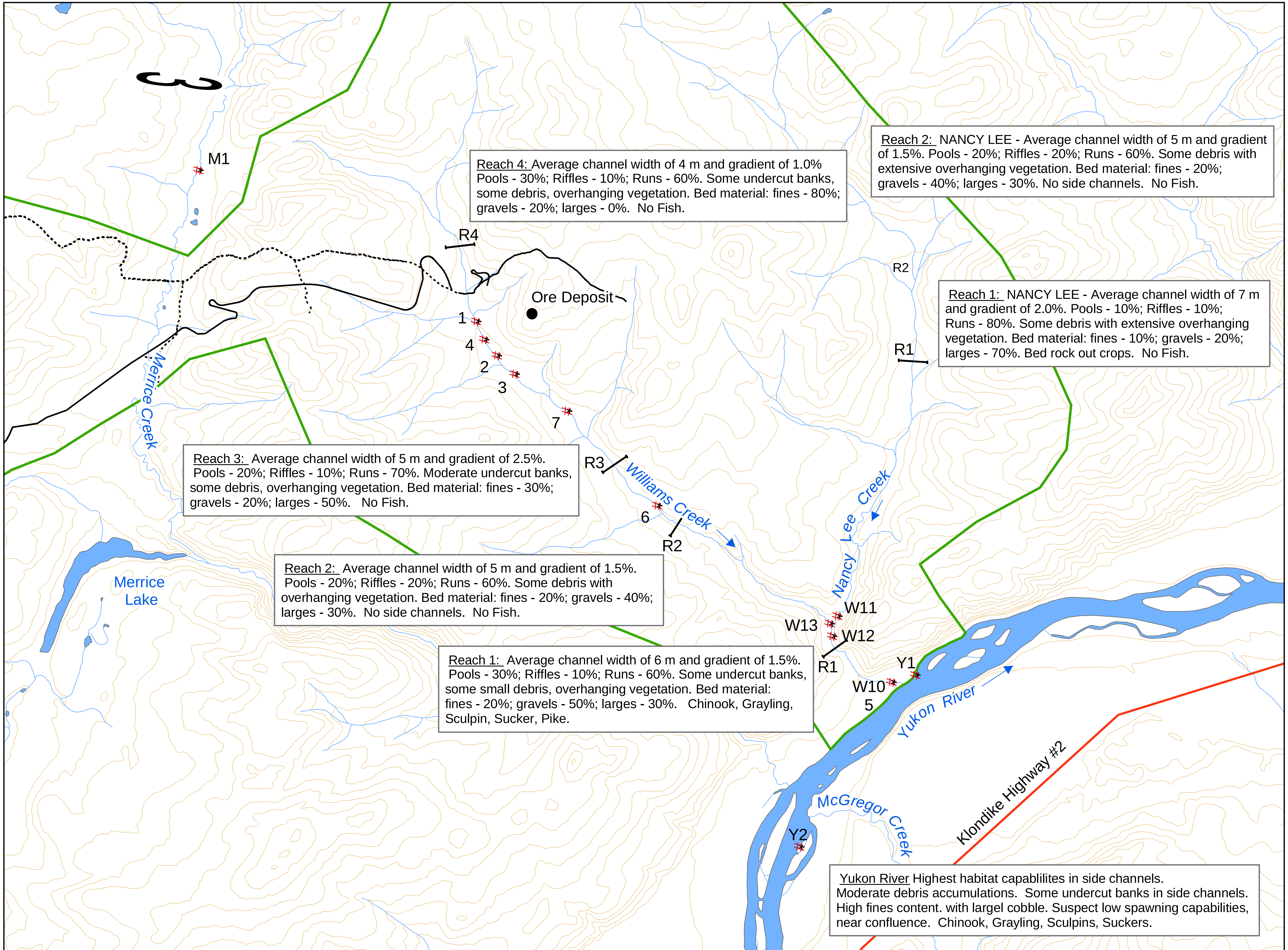
An "Initial Assessment of Aquatic Resources in Williams Creek" was conducted by P.A. Harder and Associates Ltd. in 1992. This assessment of aquatic resources is superseded by the 1994 IEE Volume I entitled "Biophysical Assessment of the Williams Creek Mine Site" by P.A. Harder and Associates Ltd. The following summarizes data from the assessments; please refer to these documents for further details and information.

Between August 1991 and August 1992 three fisheries investigations, including biophysical inventory, electrofishing, minnow traps, and spawning surveys, were completed to determine the distribution and abundance of fish in the project area.

Williams Creek has been classified into four reaches based upon differing habitat characteristics. Figure 5-5 shows the location of reach boundaries and provides descriptions of the physical habitat characteristics for each reach. Table 5-13 summarizes results of the three surveys.

Of the thirteen fish species typically found in the Yukon River Drainage (Table 5-14), six species were identified in the lower section of Williams Creek to the confluence with Nancy Lee Creek, during the 1991 and 1992 assessments. These species include: juvenile Chinook salmon (*Oncorhynchus tshawytscha*), arctic grayling (*Thymallus arcticus*), slimy sculpins (*Cottus cognatus*), longnose suckers (*Catostomus catostomus*), burbot (*Lota lota*), and northern pike (*Esox lucius*). Other species, such as inconnu, round whitefish, and broad whitefish may also be found in small tributary habitats of the Yukon River system at certain times of the year.

No fish were observed or captured in Williams Creek above the Nancy Lee Creek confluence. Spawning was not observed in the Yukon River near the Williams Creek confluence during the October 1991 survey and based on traditional knowledge no spawning in Williams Creek has been observed by local residents (HKP, 1995).



Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

Legend:

- Sample Station
- Ore Deposit
- Proposed Access Road
- Exploration Road
- Road
- Contour
- Water Course
- Reach
- Water Body
- Environmental Assessment Study Area

Reach and Sample Site Locations obtained from:
"Western Copper Holding Williams Creek Copper Oxide Project Volume 1 Biophysical Assessment of the Williams Creek Mine Site"
Figure 3.6.1 Location of reach boundaries and summary of physical habitat chacteristics for the Williams Creek study area.

UTM Zone 8 NAD83 Meters

Reach Boundaries & Fisheries Investigation Sample Stations

Figure Number:

5-5

Scale:

1:50,000

ACCESS CONSULTING GROUP

Drawn by: HD	Checked by: DC

Date: April, 2005

Our File: D:\Project\AllProjects\WCH-01\gis\mxd\Fig5_5_Fish.mxd

Table 5-13 Summary of Fish Sampling Results for Three Sample Periods between August 1991 and August 1992 in the Williams Creek Study Area

Sample Period and Location	Sample Area (m^2)	Sample Difficulty	Total Fish Catch					
			Chinook	Grayling	Sculpin	Burbot	Sucker	Pike
August 1991:								
Site Y1	102	Mod	6	0	2	0	0	0
Site W10	240	Low	0	0	0	0	0	0
Sites 4, 6, 7	285	Low	0	0	0	0	0	0
Sites 1, 2	17 traps	Low	0	0	0	0	0	0
October 1991:								
Site Y2	110	Low	8	3	1	0	8	0
Site W10	154	Mod	10	1	1	0	0	0
August 1992:								
Site W10	81	High	55	1	16	0	2	1*
Site W12	72	Low	0	0	0	0	0	0
Site W13	51	Low	0	0	0	0	0	0
Site W11	92	Mod	0	0	0	0	0	0
Site 1	50	Low	0	0	0	0	0	0
Site M1	90	High	0	0	0	0	0	0

* Angled near the Yukon River confluence.
** Seven more adult grayling were observed at this site.

Table 3.6.3 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site prepared by P.A. Harder and Associates Ltd (less site C1)

Table 5-14 List of Fish Species Found in the Yukon River Drainage and Summary of General Life History Requirements

Family	Species	Common Name	Life History/ Requirements
Salmonidae	*Onchorhynchus tschawytscha**	Chinook salmon*	anadromous; 1 year fresh water residence as juvenile; occasionally 2; mainstem and tributary spawners - August
	Onchorhynchus keta	Chum salmon	Anadromous; juvenile fish migrate seaward as fry; mainstem spawners - August
	Salvelinus namycush	Lake trout	Non - anadromous; rear in lakes and large rivers; Fall spawners
	Coregonus clupeaformis	Lake whitefish	Generally lake dwelling; Fall spawning along shallow lake shores
	Coregonus nasus	Broad whitefish	Generally lake dwelling; Summer to Fall spawner - downriver migration of adults in mid- winter
	Coregonus sardinella	Least cisco	Migrating and non-migrating populations; Fall spawners - lake shore or river margins
	Prosopium cylindraceum	Round whitefish	Northern populations are found in rivers as well as lakes; Fall spawning - lake shores and river mouths
	Stenodus leucichthys	Inconnu	Anadromous and non anadromous forms; juveniles rear in rivers up to 2 years; spawn in Summer to Fall
	*Thymallus arcticus**	Arctic grayling*	Inhabit clear cold water - rivers, streams, lakes, and ponds; Spring spawning; complex seasonal migrations are common
Esocidae	*Esox lucious**	Northern pike*	Spring spawner - in shallow vegetated areas of rivers and lakes; generally sedentary; predacious
Gadidae	*Lota lota**	Burbot*	Spawns during mid-winter in rivers, streams, and lakes; migrates into rivers after spawning
Catostomidae	*Catostomus catastomus**	Longnose sucker*	Spawns during Spring in streams and along lake shores
Cottidae	*Cottus cognatus**	Slimy sculpin*	Occupy a wide range of lake, stream, and river habitats; Spring spawning; nest builders; usually feed on aquatic invertebrates, other fish are also taken

* Indicates species has been recorded in lower Williams Creek drainage.
Table 3.6.4 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site prepared by P.A. Harder and Associates Ltd.

5.2.1.2 Benthic invertebrates

Benthic invertebrate samples were collected from site W-10 in lower Williams Creek approximately 250 m upstream of the Yukon River confluence in 1991. This site was relocated approximately 1.2 km further upstream (W-12) during the 1992 study and two additional sites were also established; one site (W-13) was upstream of the Nancy Lee Creek confluence and the other site was in the lower reach of Nancy Lee Creek (W-11). Sample station locations are presented in Figure 5-3.

A summary of the benthic invertebrate data collected in Williams Creek during 1991 and 1992 is presented in Table 5-15. Total and average number of invertebrates collected at each of the three sample 1992 sites, including one site in lower Nancy Lee Creek (W-11), were similar with a range in total numbers from 751 to 910 invertebrates. A total of 23 different taxonomic groups were identified in the drainage. Taxonomic richness (number of taxa represented relative to the population size) of the 1992 samples varied between 14 and 19 taxa with the highest number found at the lowermost Williams Creek site (W-12) below Nancy Lee Creek. Plecopterans were the dominant order present in the William Creek sites (W-12 and W-13) representing between 50 and 79% of the community. Plecopterans were co-dominant at the Nancy Lee Creek site during 1992 representing 34% of the total community. Dipterans were the sub-dominant order at all three sites during 1992 with Chironomidae (Orthocladiinae) representing between 10 and 35% of the total insect community.

Table 5-15 Summary of Total Insect Numbers and Taxonomic Richness for Triplicate Samples collected at Sites in the Williams Creek Drainage during 1991 and 1992

Sample Site Location and Date	Total Invertebrates *	Number of Taxa	Dominant Taxa	Sub-Dominant Taxa
W-13 Williams - 1992	910	17	Plecoptera: Nemouridae	Chironomidae: Orthocladiinae
W-11 Nancy Lee - 1992	763	14	Plecoptera: Nemouridae	Chironomidae: Orthocladiinae
W-12 Williams - 1992	751	19	Plecoptera: Nemouridae	Chironomidae: Orthocladiinae
W-10 Williams - 1991	266	25	Chironomidae: Orthocladiinae	Plecoptera: Perlodidae

* Total invertebrates numbers refers to number of individuals collected in three basket samplers.

5.2.1.3 Stream Sediment Quality

<u>Sample Collection</u>

Sediment samples were collected from six stations (W-4, W-9, W-10, W-11, W-12, and W-13) during the July 1992 survey. Duplicate sediment samples were collected from Sites W-11, W-12, and W-13. Samples were collected from exposed portions of the bank, selecting the finest grained sediments available and analyzed for metal levels and particle size. A composite sample was collected for three points of the channel cross section at Site W-10. The W-4 and W-9 samples were collected by selecting a composite of available sediments within a 10 m stretch of the stream bank.

Results

The analysis of sediments collected from Williams and Nancy Lee creeks during July and August 1992 indicate that the major constituents are iron, aluminum, calcium, and magnesium. The minor constituents include, in decreasing order of relative concentration, zinc, chromium, copper, nickel, lead and cadmium. Of the 32 elements analyzed, seven were below detection in all samples including: antimony, arsenic, bismuth, molybdenum, selenium and uranium. Samples collected from the mainstem of Williams Creek during July 1992 indicated relatively small variation in the concentration of all components between upstream and downstream sites. A second set of samples collected from Williams and Nancy Lee creeks during August 1992 generally indicated the same sediment composition with respect to the relative concentration of major and minor constituents.

A summary of the range of concentrations found for each element is presented in Table 5-16. Sediment samples from the site near the Yukon River (W10) were mostly comprised of 250 µm (50%) and 500 µm (40%) particles. The 150 µm particles represented 5% of the sample. Sediments from the Williams Creek mid-reach (W4) and headwaters (W9) sites were of similar composition. The mid-reach sample was comprised of approximately 30% 150 µm particles, 25% 63 µm particles and 10% 125 µm particles. The headwater sample was composed of 30% 63 µm particles, 20% 150 µm particles and 10% 125 µm particles.

Results of the sediment analysis for the major constituents from the Williams and Nancy Lee creek samples were compared to results from Big Creek located 60 km west of Williams Creek. In all cases, the concentrations of aluminum, calcium, iron and magnesium are substantially lower in the Williams Creek sites than the Big Creek sites.

The CCME (1999) sediment quality guidelines for the protection of aquatic life for arsenic, cadmium, chromium, copper, zinc, and lead are presented in comparison to the observed range in metal concentrations for the Williams Creek sites in Table 5-17.

Sediment concentrations of arsenic, cadmium, chromium, zinc, and lead at the Williams Creek mainstem and Nancy Lees sites were all below the CCME sediment quality guidelines. One of the mainstem Williams Creek samples collected from below Nancy Lee Creek during August 1992 had an unusually high copper value, which was above the CCME guideline value (Table 5-17).

Table 5-16 Summary of Sediment Metals Concentrations - Williams and Nancy Lee Creeks

Parameter	Concentration Range (ug/g)	Parameter	Concentration Range (ug/L)
Aluminum	6750 - 9980	Potassium	
Barium	67 - 201	Lead	5.0 - 9.0
Beryllium	0.2 - 0.3	Lithium	BD - 200
Calcium	6550 - 9770	Selenium	BD
Cadmium	BD - 0.3	Silicon	270 - 760
Cobalt	5.2 - 7.4	Sodium	230 - 540
Chromium	16.4 - 22.4	Strotium	46.6 - 70.7
Copper	10.1 - 75.8	Thorium	BD - 7.0
Iron	13300 - 21800	Titanium	539 - 704
Potassium	940 - 1400	Uranium	BD
Magnesium	3730 - 5370	Vanadium	30 - 52
Manganese	184 - 412	Zinc	30.8 - 48.0

Note: Sampled collected during July and August 1992.

Table 5-17 CCME Sediment Quality Guidelines Compared to Range of Metal Concentrations -Williams Creeks Sites

Element	CCME Guideline		Williams Creek Drainage	
	Interim Freshwater Sediment Quality Guidelines (ug/g)	Probable Effect Levels (ug/g)	Williams Creek Mainstem (ug/g)	Nancy Lee Creek (ug/g)
Arsenic	5.9	17.0	BD	BD
Cadmium	0.6	3.5	BD - 0.3	0.3
Chromium	37.3	90	16.4 - 22.4	17.7
Copper	35.7	197	10.1 - 75.8	11.4
Zinc	123	315	30.8 - 48.0	30.8
Lead	35	91.3	5.0 - 9.0	7.0

Note: Sampled collected during July and August 1992.

5.2.2 Wildlife

5.2.2.1 Wildlife Occurrence

The wildlife field inspection was conducted in mid-August (1992) in order to optimize logistics within the environmental program. This is a suitable time to describe habitat, but not the best time to encounter wildlife. Ungulates and large carnivores are best surveyed in winter, and birds in May or June. In addition, this inspection was done one year after the lynx population crash in the 10-year cycle, further reducing the abundance of wildlife and sign.

Ungulates

Moose (*Alces alces*):
Moose were not seen during the field visit, and moose sign was relatively scarce; willow stands showed minimal browse. Exploration camp records reported only two moose sightings in the previous two summers. Aerial surveys in the Casino Trail area immediately west of Williams Creek gave an estimate of 0.04 moose/km^2 of habitable moose range, the lowest density found in the Yukon to date (Markel and Larsen, 1988). Markel and Larsen (1988) concluded that forage was not limiting, and speculated that the area could support a larger moose population than presently exists there. Snow depth is not believed to limit moose use of this area. In parts of the Yukon, moose populations are held below carrying capacity by grizzly predation on calves, wolf predation on all age classes, or human harvest. It is not known which if any of these factors apply to moose in the Casino Trail-Williams Creek area. The Williams Creek area previously provided winter range for the 40-mile caribou herd. Range abandonment of this area has occurred and it is possible that this niche has not yet been filled by other ungulates (T. Hunter, pers. comm.).

Caribou (*Rangifer tarandus*):
Single caribou tracks in two locations along an exploration road north of the Williams Creek camp were observed. Although some good winter range habitat exists, there were no caribou sitings in the project area. The Klaza caribou herd is known to range as far west as Victoria Mountain, approximately 30 km southwest of Williams Creek (Farnell et al. 1991) and individuals could presumably range farther west.

Large Carnivores

Wolf (*Canis lupus*):
One probable wolf scat was observed. This species is presently of a sporadic occurrence due to low moose numbers and the decline phase of the hare cycle. Exploration personnel sighted the occasional wolf, and they are reported to be taken by trappers. Markel and Larsen (1988) indicated that wolf densities in the general area were likely to be low.

Grizzly Bear (*Ursus arctos horribilis*):
A probable grizzly scat was observed near the Williams Creek/Yukon River confluence during the wildlife survey and grizzly tracks were noted on the Williams Creek access road in the spring. Grizzlies occur more commonly in the Dawson Range west of Williams Creek, where alpine-subalpine habitats occur, but occasionally descend to low elevations. Dr. M. Hoefs (pers. comm.) stated that grizzlies had recently frequented the Village of Carmacks. Grizzly densities may approximate 10 to 16 animals per 1,000 km^2 in the general area (Markel and Larsen, 1988). Being wide-ranging, none are expected to reside entirely within the Williams Creek watershed.

Black Bear (*Ursus americanus*):
Black bear sign was noted in August, 1992, including old scats and recent ones. Habitat in the project area is moderately good for this species, and several individuals are probably present, however, population densities are not known.

Furbearers

Lynx (*Lynx canadensis canadensis*):
Lynx were probably common here at the peak of the hare cycle (winter 1990/91) and the following year, when tracks were regularly seen. The species is important in the regional trapline catch, and Yukon densities of up to 9 per 100 km^2 have been estimated in years of snowshoe hare abundance (Slough and Ward, 1990).

Coyote (*Canis latrans*):
Coyote sign was moderately common in the Williams Creek area in August 1992. Most scats were old, but two fresh ones contained squirrel feet. Coyotes likely move to lower elevations within the study area during the winter. The species is of some importance in the trapline catch for this area.

Red Fox (*Vulpes fulva*):
One probable fox dropping was observed within the Williams Creek Project area. Foxes are a minor component of the trapline catch for this region.

Wolverine (*Gulo luscus*):
Although this wide-ranging species is never abundant it does occur within the study area. Tracks were noted twice. Wolverines are a small component of the trapline catch, but are economically important because of the price they fetch.

Marten (*Martes americana*):
Marten are apparently uncommon in the immediate area of Williams Creek, although they are taken by local trappers. No sightings were reported and population levels in this area are not known.

Mink (*Mustela vison*):
One set of mink tracks was reported near the exploration camp. Mink are expected to occur primarily along the Yukon River and large streams and wetlands, but it is expected that this species is rare in the study area.

Ermine (*Mustela ermineamuricus*):
Based on trapline catch records ermine are expected to occur in the Williams Creek area, but they are of little economic impact. No sightings of ermine were reported.

River Otter (*Lutra canadensis*):
River otter are expected to occur along Yukon River and possibly in lower Williams Creek, but are not expected elsewhere in the watershed. No sightings of river otter were reported in the project area.

Beaver (*Castor canadensis*):
The beaver have a similar distribution to the river otter. No sightings of this species were recorded.

Other Mammals

Snowshoe Hare (*Lepus americanus*):
No hares or fresh sign were seen in August, 1992, however old sign in the form of runways, carpets of droppings, and browsed shrubs were widespread and abundant.

The population apparently crashed in this area in the spring of 1991. This species is an important food base for several predators.

Red Squirrel (*Tamiasciurus hudsonicus*):
Red squirrels were very common throughout the study area in August 1992.

Ground Squirrel (*Spermophilus* sp.):
Two apparent ground squirrel burrows were noted within the study area, but the species was not observed. Suitable habitat appears to be present, and reason for its rarity here are not known.

Porcupine (*Erethizon dorsatum*):
Porcupine sign was noted in two locations within the study area, but the species was not observed.

<u>Birds</u>

Waterfowl:
No standing water habitat is present and no waterfowl use the watershed. Waterfowl were not observed.

Grouse:
Occasional spruce grouse (*Dendragapus canadensis*) droppings were noted, but no birds were seen, and the species appeared to be at a low ebb. Populations may be cyclic, and higher at other times. Suitable habitat occurs through most of the study area. Ruffed grouse (*Bonasa umbellus*) may occur in rich aspen or willow sites along streams, but such habitats are not extensive. This species is also cyclic, and may have been at its cyclic low.

Raptors:
Golden eagle (*Aquila chrysaetos*) nests were seen on cliffs at two locations near the Yukon River. No eagles were seen during the field inspection (August, 1992). It is likely that the birds had completed nesting by this time. Another option is that nesting was minimal or did not occur at all due to low snowshoe hare numbers. Several other species of raptors are also known to occur in the area, but only the American kestrel (*Falco sparverius*) was observed.

5.2.2.2 Habitat Potential

Seven wildlife habitat units have been identified in the project area including the Yukon River floodplain, willow dominant wetlands of the Williams Creek watershed, spruce dominant wetlands, aspen dominant uplands, conifer dominant uplands, steep grassy slopes, and cliffs. Table 5-18 summarizes the habitat potential for various wildlife within each habitat unit.

Table 5-18 Carmacks Copper Project Wildlife Habitat Potential

Habitat Unit	Habitat Potential	Species	Notations
Yukon River Floodplain	High	Moose	Sightings and signs are low
		Snowshoe Hare	Widespread, abundant, but presently at low numbers
		Red Squirrel	Common
		Black Bear	Observed
		Wolf	Sporadic occurrences
		Lynx	Common but presently low numbers due to hare population
		Golden Eagle	Good nesting on slopes; nests observed on Yukon River
		Peregrine Falcon	
	Moderate	Marten	Not common
		Grizzly Bear	6 -10 animals per 100 km^2 during foraging season
		Beaver	
		Ruffed Grouse	
		Small Mammals	
		Forest Birds	
Willow Dominant Wetlands	High	Moose	Sightings and signs are low
		Snowshoe Hare	Widespread, abundant, but presently at low numbers
		Wolf	Hare predation
		Lynx	Hare predation
		Coyote	Hare predation; moderately common
	Moderate	Black Bear	Early summer herbaceous foraging
		Birds	Nesting
Spruce Dominant Wetlands	Moderate	Moose	Sightings and signs are low
		Snowshoe Hare	Widespread, abundant, but presently at low numbers
		Wolf	Hare predation
		Lynx	Hare predation
		Coyote	Hare predation; moderately common
		Black Bear	
		Red Squirrel	
		Spruce Grouse	
Aspen Dominant Uplands	Moderate	Moose	Sightings and signs are low
		Snowshoe Hare	Widespread, abundant, but presently at low numbers
		Wolf	Hare predation
		Lynx	Hare predation
		Coyote	Hare predation; moderately common
		Black Bear	
		Ruffed Grouse	
Conifer Dominant Uplands	High	Red Squirrel	Common
		Spruce Grouse	Presently at low numbers
	Moderate to low	Snowshoe Hare	Widespread, abundant, but presently at low numbers
		Wolf	Hare predation
		Lynx	Hare predation
		Coyote	Hare predation; moderately common
		Moose	
Steep Grassy Slopes	High	Snowshoe Hare	In areas with abundant shrub and juvenile aspen
		Moose	Sightings and signs are low
		Groundsquirrel	Rare
		Mule deer	Fresh sign, calf and adult
Cliffs	High	Golden Eagle	Nesting

[1]Where a species is not noted, habitat potential is expected to be low. Other species noted included fox, ermine, river otter, porcupine, and American kestrel.
[2]Based on studies completed by D.A. Blood and Associates Ltd.
Table 4.1 in IEE Volume IV, Environmental Mitigation and Impact Assessment, prepared by HKP. in 1994.

The above table shows that the Yukon River floodplain and cliffs were rated as high to very high for habitat use and importance. Habitat use and importance of the valley slopes and willow dominated wetlands were rated as moderately high to high while spruce dominated wetlands and aspen dominated uplands were rated as moderately important (HKP, 1994). An overall importance rating of low has been assigned to the conifer dominant uplands.

For a detailed description of habitat types, refer to the IEE Volume 1, "Biophysical Assessment of the Williams Creek Mine Site" prepared by P.A. Harder and Associates in 1994.

5.2.2.3 LSCFN Fish and Wildlife Management Plan

The "Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009" identified a need to protect the Yukon River from Tatchun Creek to Minto as important habitat for moose, salmon, and other wildlife. This section of the Yukon River contains a number of sloughs and islands, and was identified as important habitat for moose during calving, summer, and winter. Moose were commonly seen in this area back in the 1960s, but fewer have been seen in recent years. One area, located approximately 2.5 km downstream of the confluence with Williams Creek and the Yukon River, named "Dog Salmon Slough", was noted as an important habitat area. Bears use this area for fishing. Moose might be staying away from river corridors now with the increased river travel traffic during summer.

The Fish and Wildlife Management Plan states that some people feel that moose are being pushed away from the Yukon River by the many river travellers. In the last ten years, moose numbers have dropped along the river. Hunting does not seem to be the problem, as few people are hunting along the river, and licenced harvests are low.

5.2.2.4 Wildlife Key Areas

Two wildlife key areas have been identified in the EA study area based on information provided on YG mapping. A key area for golden eagles is considered to be in the northern portion of the study area, near the Yukon River. The southern portion of the study area, where a portion of the access road is located, is considered to fall within a key area for moose. No wildlife key areas have been identified in the central portion of the study area, where the main project activities will occur. Wildlife key areas are shown in Figure 5-7.

5.2.2.5 Species at Risk

A review of the species at risk in Yukon was considered in accordance with the Species at Risk Act (2002) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2004). Species at risk in the Yukon and all of Canada, as listed on the YG, Department of Environment web site (http://www.environmentyukon.gov.yk.ca/fishwild/specrisk.shtml), and whose ranges could conceivably overlap within the study area include:

- wood bison, peregrine falcon Anatum subspecies (Threatened);
- grizzly bear, wolverine, short-eared owl (Special Concern); and
- mule deer, elk, cougar (At risk in Yukon but not elsewhere).

No wildlife species at risk were observed within the study area during the wildlife surveys that were conducted in 1992 nor were any key habitats for these species at risk encountered.

5.2.3 Vegetation

White spruce (*Picea glauca*) and black spruce (*Picea mariana*) are the common tree species in the project area. Black spruce is dominant in poorly drained areas whereas white spruce tends to occur mainly in better drained areas, and in particular, near the Yukon River. Paper birch (*Betula papyrifera*) is present throughout the forest stands with trembling aspen (*Populus tremuloides*) and poplar (*Populus balsamifera*) often occurring on disturbed sites. Lodgepole pine (*Pinus contorta var. latifolia*) occurs throughout the study area, particularly on areas that have been influenced by fire.

Where black spruce occurs as a continuous forest stand, feathermoss tends to dominate the understorey and form a complete ground cover. Willows (*Salix spp.*) and ericaceous shrubs occur where the stands of trees are less dense. In floodplain and poorly drained areas, sedge and sphagnum tussocks are common. On south facing slopes, sagewort (*Artimesia sp.*) grasses and forbs occur as a continuous cover with trembling aspen stands occupying protected draws and gulleys.

In July 1994, a vegetation survey of the Carmacks Copper Project area was conducted by HKP. Sampling consisted of eight 20 m^2 transects of understorey and ground cover species. Refer to the IEE “Addendum to Volume 1 – Biophysical Assessment of the Carmacks Copper Mine Site” for a listing of tree and plant species encountered during the survey. No unique or endangered vegetation is known to occur in the mine site area (HKP, June 1995).

5.3 HERITAGE RESOURCES

An archaeological impact assessment was conducted in the Williams Creek Valley for the proposed project by Antiquus Archaeological Consultants Ltd. (AAC) in August 1992. AAC also conducted “An Archaeological and Heritage Resource Overview Assessment of the Proposed Carmacks Copper 138 kV Transmission Line Project Route Options Near Carmacks, Yukon Territory” in September 1994. The following sections summarize relevant aspects of these archaeological assessments.

Valued cultural components include heritage sites, spiritual areas, and those important to maintaining current land use patterns (trapping cabins, existing trails, hunting and gathering areas, etc.). Heritage sites include archaeological sites as well as sites which are of value for cultural reasons. They can represent sites with “moveable heritage resources” (artifacts) or designations without material evidence that are culturally significant such as spirit places or traditional trails.

Traditional knowledge (TK) provides an important source of knowledge in identifying cultural sites as well as key ecological areas. The proposed program area is located within the traditional territories of the LSCFN and SFN. As part of archaeological assessments of the Williams Creek Valley and the proposed transmission line, interviews were conducted with Johnny Sam and Wilfred Charlie from the LSCFN to acquire information about First Nation use in the project area. Previously documented historic, ethnohistoric and ethnolinguistic research has also been used to reconstruct traditional Native land use practices in the Williams Creek valley.

5.3.1 Williams Creek Valley Archaeological Assessment

5.3.1.1 Historic Use

In the 20th century, the Williams Creek Valley was used by Natives for winter trapping (J. Sam). Snowmobiles permitted the entire trap line to be checked in one day (12 hours) from a base camp on the opposite shore of the Yukon River (J. Sam). Dogsleds would have allowed similar practices at an earlier date. The valley continued to be used as a hunting area for moose and caribou, but most hunting was done by single Native hunters in the winter while in the area for trapping (J. Sam). These activities would have produced small, scattered kill and/or butchering sites in the valley.

Fishing sites used to catch salmon, as well as, pike, sucker, whitefish, and graylings were constructed along the bank of the Yukon River where deep water with currents and eddies forced the fish close to shore (J. Sam). The river bank was also used as a travel corridor. The “Old Dawson Trail” from Whitehorse to Dawson City followed either the eastern or western bank of the river, while the “Old Telegraph Trail” built in 1899 between Whitehorse and Klondike crossed the mouth of Williams Creek (J. Sam; W. Charlie). Other trails constructed before and since (such as the Toboggan-Dog Race Trail) probably followed the same routes. Small transit and campsites should be expected at the mouth of Williams Creek where these trails were located.

5.3.1.2 Traditional Use

Moose is the most common ungulate now hunted in the Williams Creek Valley, but caribou are also present on occasion and were probably more common in the past before the large migratory herds of caribou in the region were reduced to the current small scattered populations (J. Sam). In the summer (May to October) these animals could have been hunted from fishing base camps on the Yukon River, while in the winter they may have been hunted, as they are now, while trapping in the valley (J. Sam). Given current estimates of ungulate populations, individual hunts rather than communal hunts were probably the norm for the valley. Other wildlife that may have been hunted or trapped in the valley include: grizzly bear, black bear, marten, weasel, mink, otter, red fox, coyote, woodchuck, ground squirrel, wolf, beaver, muskrat, rabbit, pika, and porcupine. Lynx and wolverine are two other important species trapped in the valley (J. Sam). A few waterfowl may also have been caught in the spring and fall at the small ponds. These traditional activities would have produced small scattered kill and/or butchering sites throughout the drainage, and a few small base camps in the creek valley.

Salmon, whitefish, pike and graylings spawn in the Yukon River and summer fish camps were probably constructed along the shore of the river to catch these fish. Unfortunately archaeological remains from these sites may have been buried or destroyed by flooding and ice flows on the river. Any raised beachlines may afford better site preservation. Early trade and travel routes (predecessors to the historic routes) probably followed the Yukon River and crossed the mouth of Williams Creek. As a result, small transit camps may be expected in this area. All sites in the study area are expected to be small and on flat, well-drained locations.

5.3.1.3 Historic Archaeological Sites

No archaeological sites were identified within the areas proposed for the open pit mine, leach pads and waste rock dumps. However, two historic archaeological sites were identified and recorded during the 1992 assessment. The first site (115-I/07/005) is located at the confluence of Williams Creek and one of its tributaries, located approximately 1.25 km southwest of the confluence of Williams Creek and the Yukon River (Figure 5-1). At this site there is a partially collapsed log cabin, a partially collapsed log barn, and associated domestic and mining related refuse and artifacts. A mine adit was also identified on the north side of the creek, about 400 m west of this site along a well-defined trail. It is believed that the area was occupied during the 1930s and 1940s.

The second site (115-I/07/001) is located along the bank of the Yukon River about 1.25 km southeast of the confluence with Williams Creek (Figure 5-1). This location lies along what has been referred to as the old “Dawson Trail” and consists of the collapsed remains of a historic log cabin. This site is connected to the first site by a horse trail and appears to be a supply and ore transfer station for the mine, which was facilitated by river transport.

These sites are known and documented and will not be disturbed.

Refer to the report entitled “An Archaeological Impact Assessment for the Proposed Williams Creek Copper Oxide Project” prepared by Antiquus Archaeological Consultants Ltd in August 1992 for further discussion on the archaeological impact assessment

5.3.2 Proposed Transmission Line Archaeological Assessment

In September 1994, AAC conducted an archaeological/heritage resource “Overview Assessment” study for two proposed route options for a transmission line to the mine site on behalf of Yukon Energy Corporation. Although the preferred option for supplying power to the project is on-site diesel generation, the possibility of constructing a transmission line has been considered. The information gathered during the 1994 assessment is particularly relevant as route option 1 for the transmission line corresponds closely with the proposed access road to the mine site.

There are three locations near the proposed mine access road considered to have medium heritage site potential. One large medium heritage site potential area is located on both sides of Crossing Creek between the bridge over the creek on the existing Freegold Road and the turnoff to the mine access road (Figure 5-6). The remains of prehistoric or historic camps may be located in this area. The other two medium heritage site potential areas are located where the mine access road crosses Merrice and Williams Creeks (Figure 5-6).

Antiquus Archaeological Consultants recommends that areas identified as having medium heritage site potential be subjected to further study prior to the initiation of any land-altering activities.

5.4 CURRENT LAND USES

This section summarizes information about current land uses and land ownership status in and adjacent to the project area. Western Silver is the 100% owner of 206 claims on the Carmacks Copper property (Figure 5-6).

As mentioned previously, the property is located in the LSCFN and the SFN Traditional Territory. The LSCFN has one land claim selection in the vicinity of the project: R-9A. R-9A is located west of the project area and extends into the environmental assessment and project area (Figure 5-6). No project activities are expected to occur on the LSCFN R-9A land selection. As the land selection is located upstream of the Williams Creek project area, no downstream effects to water quality or quantity are predicted.

5.4.1 Traditional and Cultural Resource Use

5.4.1.1 Wildlife

Assessment of wildlife capabilities in the Williams Creek drainage indicates that hunting opportunity and activity would be minimal. Densities of moose and caribou in the area are low. Discussions with members of the LSCFN indicated that there had been no moose or caribou kills in the Williams Creek watershed in recent years (P.A. Harder, 1994), but that the area is part of the traditional hunting grounds.

Trapping and outfitting concessions within the project area provide employment benefits and sustenance for area users. The proposed Carmacks Copper mine site is located within Registered Trapline #147, held by a member of the LSCFN, Ms. Kathleen Sam of Carmacks. The Williams Creek watershed is trapped more than once a year during most years (Mr. J. Sam, pers. comm.). Lynx, coyote, wolverine, mink, beaver, fox, marten, and squirrel are the key furbearers expected to be caught in the area

The proposed Carmacks Copper Project is located within the boundaries of Registered Outfitting Concession #13, held by Mervyn Yukon Outfitting. The project area is also within Game Management Zone 5, Subzone 524.

As discussed previously, two Wildlife Key Areas have been identified in the EA study area for golden eagles and moose. Figure 5-7 shows game management zones and key wildlife areas

Issues concerning the study area have been presented in the "Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009." The main issue in the study area was managing critical moose habitat and wetlands along the Yukon River downstream from Carmacks to Minto. Unmanaged river traffic is the main disturbance to habitat, camps, and fishing nets. Moose numbers are thought to be low here, while both grizzly and black bear populations are thought to be high. Wolf management around communities is an ongoing issue.

The Fish and Wildlife Management Plan states that in the "old days," near the end of August, people would leave from Carmacks, travel with dogs and packs to the other side of Big Salmon Lake, build rafts, and float down the Yukon River to Carmacks with two or three moose dried. People have changed the way they hunt, from river hunting to travelling into the mountains to find moose.

5.4.1.2 Fish

Chinook and chum salmon runs in the Yukon River support important commercial and native food fisheries. Escapement and catch data for the commercial and First Nation fisheries on these species is presented in Appendix 4 of the IEE Volume 1, “Biophysical Assessment of the Williams Creek Mine Site” prepared by P.A. Harder and Associates in 1994. Adult Chinook salmon migrate up the Yukon River past the Williams Creek confluence between August and October. Salmon spawning does not occur in Williams Creek.

Members of the LSCFN harvest adult Chinook and chum salmon from the Yukon River during the late summer and fall months. Catch records are not maintained specifically for the Carmacks area. Interviews with First Nation members and village elders indicate that salmon fishing activities take place at many sites along the Yukon River between Carmacks and Fort Selkirk. Sites upstream of Carmacks are also used. Five seasonal fish camps were observed on the banks of the Yukon River between Carmacks and Williams Creek during the October 1991 survey. Three other fish campsites were identified downstream of the Williams Creek confluence. Locations of the fish camps change annually depending on flow conditions in the river (Chief Fairclough (1993), pers. comm.).

Other species of importance with respect to First Nation and sport fisheries include Arctic grayling, inconnu, round and broad whitefish, burbot and northern pike. Small numbers of these species may be found at the confluence of Williams Creek and the Yukon River at certain times of the year. It is suspected that some sport fishing may occur at the mouth of Williams Creek during the summer months as recreational canoeists pass the creek enroute to Dawson City. The extent of the First Nation fishery for these species in the Williams Creek area is not known. It is suspected that most fishing for these species would occur in the Yukon River. Historically, there have been reports of some fishing by First Nation members in the backwaters of the Williams Creek confluence (Chief Fairclough (1993), pers. comm.).

5.4.1.3 Recreation

The most significant recreation activity within the study area is summer canoeing on the Yukon River. Canoeists generally use the river between late May and September, with peak use in July and August. Dawson City is the usual destination, with people typically starting their journey in the Whitehorse area or Carmacks. Visitor records collected at Fort Selkirk on the Yukon River downstream of Carmacks and Williams Creek indicated that 693 canoeists used this section of the river during 1992. This figure represents a 11% increase over the 1991 visitor records. The usual time required to canoe from Carmacks to Dawson is 5 to 10 days, depending on flow conditions and other factors. There is a designated campsite at Carmacks, which is used by most canoeists as an overnight stop while restocking provisions. On average, canoeists travel 35 to 50 km per day. Using these estimates, and assuming the majority of canoeists have used Carmacks as the last stopping point, it can be projected that canoeists leaving Carmacks would camp between the Williams Creek area and Fort Selkirk. Although designated campsites along the Yukon River route are often associated with tributary confluences examination of the fan area at the Williams Creek confluence indicated low usage by campers. There was no evidence of regular campsites or fire pits.

The only other significant recreation activity in the area is the annual Yukon Quest Dog Sled race between Whitehorse and Dawson City. The Quest Trail parallels the west bank of the Yukon River and crosses lower Williams Creek approximately 150 m upstream of the Yukon River confluence.

The extent of other recreational activities such as hiking or skiing is not known. However, the Williams Creek area is not noted as a particularly popular or unique area for these activities. Access to the area is restricted by the seasonal road conditions.

5.4.1.4 Forestry and Native Plants

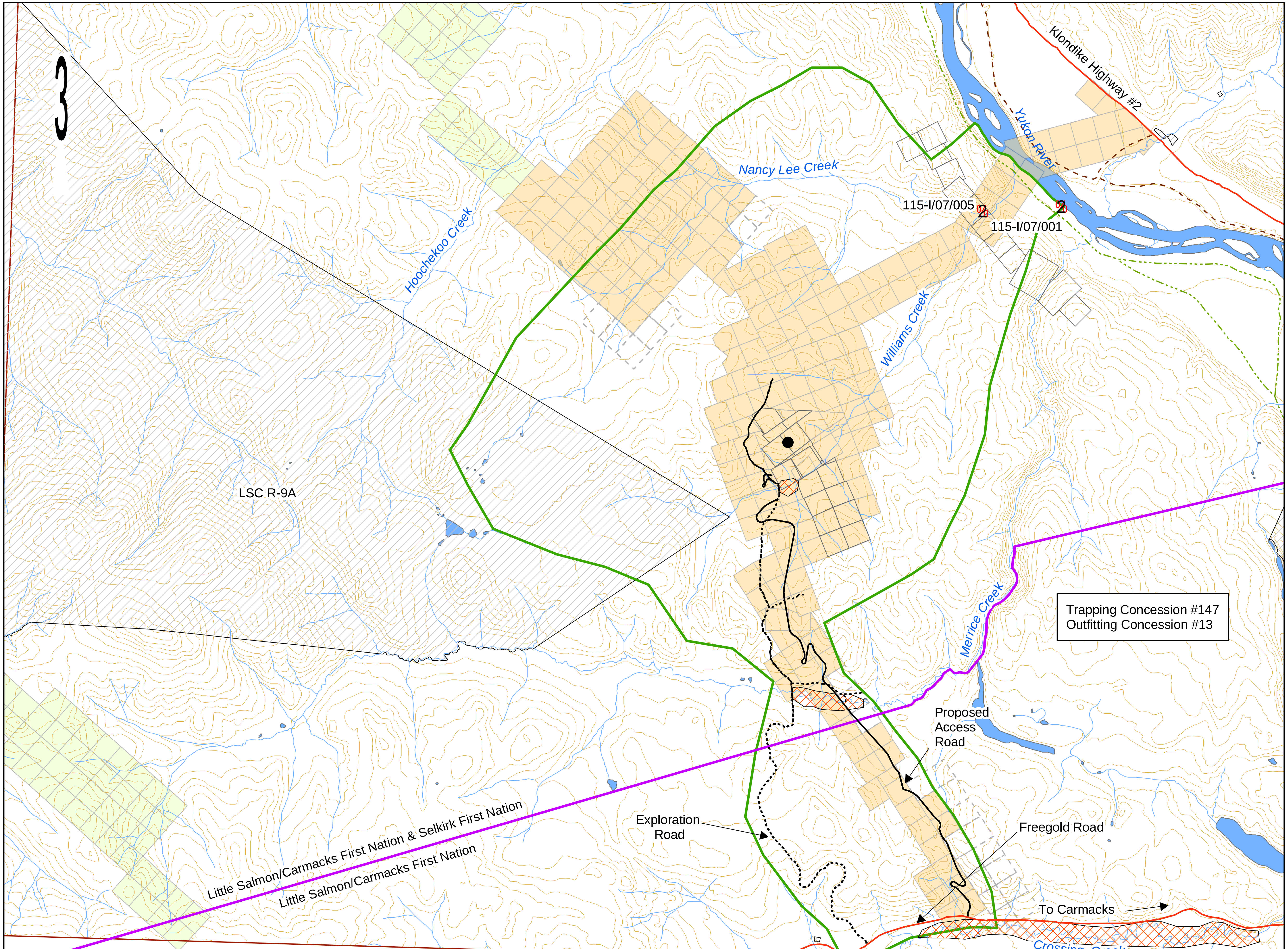
White and black spruce are the common conifer tree stands in the Williams Creek drainage, with some lodgepole pine occupying old burn areas. Commercial harvesting of these species in this region of the Yukon is not viable; therefore, commercial forestry values for the Williams Creek watershed are not significant.

Some of the indigenous plants of the region are used by members of the LSCFN for medicinal and traditional purposes. Specific areas of collection within the region and individual species of concern have not been identified at this time.

5.4.1.5 Access

The following text describing access to the BYG mine site has been included from the "Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009." Year-round access provided by the Mount Nansen road contributes to increased hunting of moose and caribou, as well as increased disturbance of wildlife. Access to the Carmacks Copper property could potentially have the same effects.

Specific mitigation measures are planned as part of the Carmacks Copper project to address potential concerns with increased access to the area for wildlife harvesting and will be discussed with the LSCFN.



Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

Legend:

- Ore Deposit
- Historic Archaeological Sites
- Contour
- Water Course
- Trail
- Limited-used Road
- Road
- Access Road
- Exploration Road
- First Nations Traditional Territory Border
- Little Salmon/Carmacks First Nation
- Mineral Parcel
- Western Copper Holdings Limited Claims
- Other Claims
- Expired License or Lease
- Environmental Assessment Study Area
- Water Body
- Medium Heritage Site Potential

UTM Zone 8 NAD83 Meters

Heritage Resources & Current Land Uses

Figure Number:

5-6

Scale:

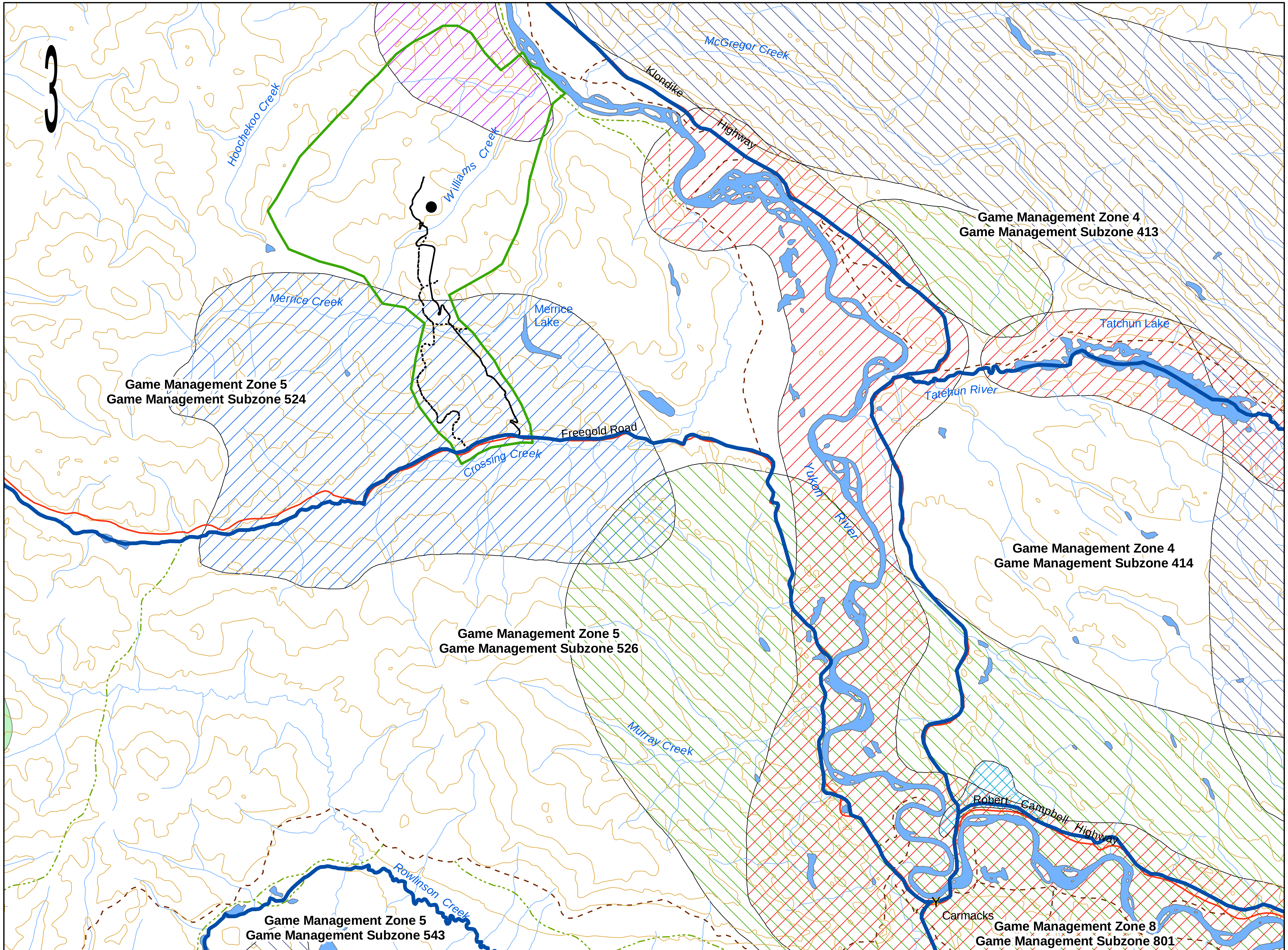
0 500 1,000 2,000 3,000 Meters

ACCESS CONSULTING GROUP

Drawn by: HD | Checked by: DC

Date: April, 2005

Our File: D:\Project\AllProjects\WCH-01\gis\mxd\Fig5_6_Land.mxd



Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

Legend:
- Town
- Ore Deposit
- Water Course
- Proposed Access Road
- Exploration Road
- Limited-used Road
- Road
- Trail
- Contour
- Water Body
- Environmental Assessment Study Area
- Game Management Zone

Wildlife Key Areas (Source: YG DoE)
- Bald Eagle
- Bison
- Golden Eagle
- Moose
- Mule Deer
- Woodland Caribou

UTM Zone 8 NAD83 Meters

Game Management Zones & Wildlife Key Areas

Figure Number:
5-7

Scale:
1:150,000

ACCESS CONSULTING GROUP

Drawn by: HD	Checked by: DC
Date: April, 2005	

Our File: D:\Project\AllProjects\WCH-01\gis\mxd\Fig5_7_Wild.mxd

5.5 SOCIOECONOMIC CONDITIONS

The proposed location of the Carmacks Copper Project is 38 km northwest of the Village of Carmacks, Yukon. The site is accessed from Carmacks by means of the Freegold Road and a 13 km seasonal access road at km 33 on the Freegold Road.

The following socioeconomic review for the Village of Carmacks was summarized from the IEE, Volume II, "Community Profiles and Socioeconomic Impact Assessment" (HKP, 1994) and the "Yukon Community Profiles" website, which was produced by Human Resources Development Canada in partnership with the Yukon Chamber of Commerce: Website address: http://www.yukoncommunities.yk.ca.

5.5.1 Population

In 2001, the Village of Carmacks had an average population of 411 – a decline from the mid-1990's when the average population was close to 470 for several years. The largest portion of the community is between the ages of 25 and 44 (30%). Carmacks has a young population in comparison to the Yukon average; 27% of residents are 14 years of age or younger, compared to the Yukon average of 20%. The remaining population consists of 14% in the 15 – 25 age group, 11% in the 45 – 65 range, and 7% 65 years and older. At the end of 2003, 50% of the residents in Carmacks were female, the same as the Yukon-wide percentage (Yukon Community Profiles, 2005). The majority of Carmacks residents are members of the LSCFN (70%).

5.5.2 Economy

Government services, including education and health, account for over half of the jobs in the Village, while tourism provides some summer jobs. Seasonal employment has also come from mining exploration, and providing services to exploration crews. (Yukon Community Profiles, 2005)

Approximately 75% of adults (>15 years) in Carmacks were involved in the labour market in 2001, which is lower than the overall Yukon percentage of 80%. Unemployment was reported at 24%, much higher than the Yukon average of 12% (in 2001). These figures reflect the few jobs, particularly long-term jobs, available in the Village. "Relatively little work in Carmacks is full-time and full year, reflecting the lack of long-term jobs and the seasonal nature of tourism, primary industry employment and mining exploration" (Yukon Community Profiles, 2005). Only 29% of all workers in Carmacks are working full-time, full year, much lower than the Yukon average of 46%. (Yukon Community Profiles, 2005)

5.5.3 Community Services

The Tantalus School in Carmacks offers kindergarten to grade 12 while the Carmacks Campus of Yukon College provides adult education programs. YG, LSCFN and the Village of Carmacks are presently planning the Tantalus school reconstruction. The Community Health Centre provides local health care. Policing is provided by an RCMP detachment with one sergeant and two constables. Additional community social services include a YG Health and Social Services social worker, a Yukon Housing Corporation part-time office, a safe house for women and children, and a daycare centre. Fire and ambulance services are provided by a volunteer service. The Village of

Carmacks operates a local recreational facility for the community. A small airstrip, located approximately 12 km north of the village, is capable of handling small fixed-wing and helicopter traffic. A branch of the Toronto Dominion Bank is open on Tuesdays and Thursdays.

Carmacks is serviced by two gas stations (one with automotive repair service), two general stores, a postal service, one hotel (with lounge), one motel, two restaurants, a year round helicopter charter and several small construction operators. Greyhound Buslines service the community on its route to Dawson City. The water supply is from private wells with some water delivery; however, the Village is pursuing funding for a community distribution system for potable water. Wastewater is treated and discharged into the Yukon River and replacement of this facility is currently in the works. It is expected that by December 2006 the new facility will be operational. The municipality operates a landfill that compacts and covers household solid wastes.

The following list of businesses, as presented on the Village of Carmacks website (www.carmacks.ca), have obtained their 2005 business licences.

Byers Automotive	Automotive service and sales
Carmacks Towing	Vehicle towing, services, storage and vehicle repair
Mukluk Manor	Bed and breakfast operations
Smokey n Pals	Construction and general maintenance
Berdoe Enterprises	Construction and general maintenance
Carmacks Chinese Restaurant	Restaurant
Coal Mine Campground	Tourist services, campground, restaurant, canoeing
Sunrise Service Centre	Auto service, fuel, RV park, retail sales, groceries
Carmacks Development Corp	Agency and general contracting
THWT Enterprises	Retail services and general contracting
Kando Enterprises Ltd	General contracting
Carmacks Hotel Ltd.	Hotel, RV park, and guest services
Tatchun Centre	General store and gas pumps
Gold Panner Restaurant	Licenced restaurant
Erik's Services	Auto service & repair, towing, general maintenance
Roydom Campgrounds Ltd.	Campground, restaurant, RV park and washhouse
Tom Kontogonis	General services, catering, janitorial
Fireweed Painting	Painting - residential, commercial, industrial
Dunena Zra Sanchi Ku	Daycare
Run-Away Yukon	Craft shop, RV park, wilderness tour, equip rental

5.5.4 LSCFN Community Services

The Carmacks municipal government and the LSCFN both provide municipal services for the community. Forestry and land use services are provided through YG and the LSCFN administration office.

The LSCFN offers social services to its members, including counseling, social assistance, adult care, and homecare.

Trucking and heavy equipment services are available through the First Nation economic development corporation as well as several private companies.

5.6 ENVIRONMENTAL STUDY PROGRAMS

It is expected that additional studies will be initiated during the course of the project to:

- build upon the existing environmental baseline data in preparation for mine construction, operation and closure;
- collect additional data in support of mine and infrastructure development;
- refine and optimize heap leaching and metal recovery processes; and
- develop and refine closure methods for eventual mine decommissioning, reclamation and closure.

A brief outline of the environmental study programs are presented below.

Environmental Effects Monitoring

A requirement of the Metal Mining Effluent Regulations is the development of an Environmental Effects Monitoring (EEM) program for the project. The objectives of the EEM program are to determine the potential effects of the project operations on the receiving water aquatic ecosystem in Williams Creek and assist in determining the effectiveness of various environmental protection measures at the mine site.

Prior to the initiation of mine construction an EEM study plan will be developed and submitted to regulatory agencies for review. It is expected that existing baseline environmental data will be augmented with current data to confirm the understanding of environmental conditions in the area. Monitoring stations in the study area will be reactivated and data collected for surface water quality and stream flow, groundwater quality and level, stream sediments, benthic invertebrates, algae and fisheries, including fish tissue analyses. These data will be used to monitor changes and trends in the aquatic ecosystem and develop supporting data to interpret biological monitoring results.

In addition, the EEM study program will also characterize effluents from the site including possible effluents from the contingency raffinate treatment plant and sediment control ponds. Acute toxicity testing will be conducted along with sublethal toxicity testing (fish, invertebrates, algae and plant).

All results will be reported to regulatory agencies as part of the licences and permits.

Archaeological Study

Previous archaeological investigations identified areas on the project access road that may have medium heritage site potential. Prior to access road construction these medium heritage potential sites located near Williams and Merrice Creek will be investigated to determine if heritage resources exist. The work will be conducted by qualified personnel in conjunction with the LSCFN.

Insitu Biological Oxidation Studies

Column test work has recently been completed to investigate the biological oxidation of elemental sulfur to produce sulfuric acid as part of the heap leaching process. This process option is currently under investigation with positive results. Large scale columns test work is being investigated. Leach test columns are also being used to further test heap detoxification methods.

Further test work would consist of a series of small reaction tanks and transportation of elemental sulfur. Agglomeration of elemental sulfur and bio-acid produced from bacteria would be required. Additional test work and economic evaluation is necessary to demonstrate scale-up and commercial application and the company continues to optimize the process.

Decommissioning and Closure Related Studies

It is expected that additional closure related studies would be undertaken once operations begin. These studies would include the following:

- revegetation test work and test plots to optimize revegetation seed mixtures, application rates, nutrient supplements and natural species recolonization success;
- characterization of overburden soils for revegetation
- reclamation test work to optimize heap cover design; and
- heap leach detoxification studies, including column studies to optimize heap rinsing, neutralization, and insitu biological treatment.

The results of the studies and test work would be used to optimize closure measures and designs for the final mine decommissioning and reclamation plan.

6.0 PUBLIC ENGAGEMENT / INPUT

Western Silver strives toward a close working relationship with the First Nation communities in the Carmacks Copper Project area, particularly the LSCFN, and is committed to working with the Village of Carmacks and all stakeholders as part of its ongoing project activities. Specifically, the company is committed to:

- Participating in local meetings and information sessions, and taking other appropriate steps to promote consultation and communication;
- Working directly with LSCFN regarding the EA process and their involvement and management of local environmental and socioeconomic issues;
- Consulting in an ongoing manner with communities, individuals, groups and stakeholders, so that local people are kept informed regarding plans and activities and employment opportunities;
- Providing local First Nation communities with notice of potential employment and contracting opportunities; and
- Maximizing opportunities for northern benefits from the Carmacks Copper project.

6.1 1991-1993 PUBLIC CONSULTATIONS

The opinions/concerns regarding the effects of the Carmacks Copper Oxide Project on the LSCFN have been documented in the IEE Volume II (January, 1994) prepared by HKP. A partial list of consultations that took place in 1991, 1992, 1993, and 1994 between individuals involved in the project and the LSCFN is presented in Appendix I.

A number of LSCFN members and several other residents of the Carmacks community were interviewed regarding their opinions/concerns about the Carmacks Copper Project. They were asked how they felt the proposed project would affect the LSCFN. Some of those opinions are given below.

The following individuals/agencies participated in the interview:

Paul Taylor (Yukon College)
Darlene Johnson (NNADAP)
Joseph O'Brien (NNADAP)
Tim Gooding (First Nation Staff)
Viola Mullet (First Nation Staff)
Jane Jack (Village Office)
Clyde Blackjack
Joyce Gage
Health & Welfare – Health Centre
R.C.M.P.

The Yukon College is interested in working with Western Silver in order to prepare further training programs such as the mill operator course which will provide specific training programs. It is hoped that the company will work with the college and pass on information which would assist in this regard.

Many individuals felt that there are both positive and negative aspects of the proposed Carmacks Copper Project. On the one hand, it could provide an opportunity for

Carmacks to grow. There are few opportunities for those currently without work. On the other hand, the influx of new people (miners & their families) could have a negative effect on the LSCFN people. They feel that the First Nation community is in the process of healing and that the influx of new people (miners) may disrupt the advances that have been made. There are many severe social problems already in the native community such as alcohol and drug abuse. In a mining community more alcohol and drugs may become available. Several people were also concerned about the influence of single males (working at mine and living in community) on young girls with low self esteem (unwanted pregnancies).

Several individuals expressed the desire for a more in-depth study completed on the social impacts of the mining project on the First Nation community.

One individual interviewed expressed concerns about the environment. He has worked previously in several mines and observed that the mine sites were left in poor condition after closure. He feels that abandoned mines should be cleaned up and that waste materials should be removed and that the site should be revegetated. He indicated that most elders are concerned about the effects of a mine on the environment and are often concerned about chemicals escaping into the environment. He also voiced some concern about animals affected by the mining operation (i.e. the animals would move out of the area).

Health and Welfare Canada were concerned about increased alcohol and drug abuse and increased violence (e.g. rape, unwanted pregnancies). They were apprehensive about additional health needs of new people in community as well as occupational health & safety (i.e. accidents, injuries at mine site) and felt that additional staff would be required.

The RCMP voiced concern about the increase in the law enforcement workload with influx of people to the community. They feel that they will probably require an increased staff as they are currently dealing with over 500 complaints per year.

Several individuals were enthused by the prospect of a local mining operation and were very interested in the opportunities for employment.

The following has been included from the "Environmental Assessment, Western Coppermine/Williams Creek, Yukon Region – Final Report" prepared by MDA Consulting Limited in March 2000.

> *"The Little Salmon/Carmacks First Nation has had a long standing concern about the development of the site, particularly with respect to the impact of the heap leach facility on the natural water resources, and habitat within. As well, they have a concern as to the impact of the development on the wildlife and the habitat within traditional areas. On the other hand, with the recent closing of another mine in the vicinity, which employed numerous band members, there is a strong interest in the development with appropriate environmental safeguards." (MDA, 2000)*

Throughout the development of the proposed Carmacks Copper Project, Western Silver has endeavoured to maintain cooperative and interactive association with the LSCFN.

6.2 RECENT PROJECT MEETINGS/DISCUSSIONS

Since reactivating the project Western Silver has undertaken a number of meetings with Yukon Government, LSCFN and the Village of Carmacks. A summary of these discussions is presented in the following sections.

6.2.1 Yukon Government

In August 2004, Western Silver approached YG regarding the environmental assessment process for major mines in Yukon. As the Carmacks Copper project had previously undergone an environmental assessment, the company was interested in YG's EA process changes relating to new mine development in the Yukon. A series of meetings were held with senior government officials within the Departments of Energy Mines and Resources, Environment, and Executive Council Office to refine the company's understanding of the EA review and permitting processes. A draft Project Agreement was developed between the company and YG following the outline provide by Yukon Government in their document entitled "Administrative Procedures for Major Mining Projects in the Yukon, September 2004".
(http://www.emr.gov.yk.ca/mining/info/procedures_ea_yukon.pdf)

The Project Agreement provides overall guidance for the conduct of the EA review process, including the roles and responsibilities for the parties, consultation requirements and the use of technical committees and consultants, the project performance standards and objectives for the project, EA transition and harmonization provisions, project tracking and a public registry requirements and timelines.

The Performance Standards and Objectives for the project as outlined in the Project Agreement are presented in Appendix C of this report. It is understood that the performance standards were reviewed by YG departments to provide the company with the minimum requirements for the project EA review. The company has used these performance standards as a basis for completing engineering designs for the project and assessing potential environmental and socioeconomic effects and determining their significance.

It is expected that further meeting will be convened with YG and the LSCFN as the EA review process continues and various stakeholders are consulted.

6.2.2 First Nations Communications

On February 7, 2005 a conversation took place between LSCFN Chief Eddie Skookum and Councilor Terry Billy, and Dan Cornett of Access Consulting Group. The purpose of the meeting was to reintroduce LSCFN to the project and the company's project plans. The main points addressed by the LSCFN during this project discussion include:

- LSCFN continued interest in the project and working with Western Silver to advance the project;
- Project effects on local ground and surface water resulting from the heap leach pad. LSCFN wants a design and project that does not effect local downstream resources including during future reclamation;
- Project effects to the local trapper's ability to harvest and use the area;
- Project effects to local wildlife;

- The LSCFN's interest in economic benefits from the project including employment opportunities; and
- LSCFN's interest in providing local infrastructure and housing support in Carmacks for the project.

On February 16, 2005, Western Silver representatives met with the LSCFN Chief and Council (Chief Eddie Skookum, Councilors Terry Billy, Darlene Johnson, George Skookum, Johnny Sam, Mary Tulk and administrative staff, Cathy Cochrane, Elizabeth Skookum, Violet Mullett, Susan Davis) to reintroduce them to the project and the company's plans to complete the EA and permitting process. At these meetings the company provided corporate background on Western Silver and their development plans. The subject matter covered was generally similar to that discussed during the February 7, 2005 conversation (above). In addition to the already mentioned concerns/points, the importance of social benefits was discussed. A draft socioeconomic agreement was previously developed between the company and LSCFN for the project and LSCFN is interested in renegotiating a benefits agreement with the company to address socioeconomic benefits for the project. The fact that more recent baseline data should be collected from the project area before project start-up was also discussed.

On March 7, 2005, Western Silver representatives met with the LSCFN Lands and Resources Branch personnel (Johnny Sam – elder, Susan Davis, Mark Nelson, and Robbie Cashin) to discuss the EA process, present an overview of the project development and review environmental and traditional use information for the project description documentation.

LSCFN wants to be an active participant in the EA process. Further meeting with YG should include LSCFN representatives. Methods to continue to brief LSCFN members and the community were discussed. Previous environmental, heritage and cultural data was reviewed and recent maps compiling data collected from past studies was provided to the Branch for review and input.

Additional community meetings are planned in Carmacks to provide project updates to LSCFN members.

6.2.3 Village of Carmacks

On February 16, 2005, Western Silver representatives met with the Village of Carmacks Council and administrative staff (Mayor Ed Larkin, Councilors Stuart Harris, Elaine Wyatt, Cory Belmore and Bob Jackman, Village CAO) to reintroduce them to the project and the company's plans to complete the EA and permitting process. At these meetings the company provided corporate background on Western Silver and their development plans. The Village continues to support the company's development plans. The importance of social benefits was discussed and the need to ensure employment equity hiring for all Village and LSCFN members. The Village is looking at a number of new developments within the community including a new school, wastewater treatment system and water distribution system. These developments bode well for the company's future plans. Continued communication with the community will be important as the project moves through the EA and permitting processes.

6.3 OPEN HOUSES

Western Silver's recent open house was advertised in local newspapers and held in the Village of Carmacks on February 16, 2005 to give the public an opportunity to present their comments or concerns directly with Western Silver and their consultants. Approximately 12 community members participated in the open house. Five large 3' x 5' posters were produced to present key project and environmental information. The focus for the posters was on visual material (diagrams, maps, photos). Key team members were on hand to discuss the posters and respond to and document questions arising. A newsletter was prepared and available as a hand out for the public (see Appendix J). A visitor's log recorded public participation. Additional open houses are planned for the LSCFN, Village of Carmacks, and Whitehorse.

6.3.1 Poster Displays

The following posters were prepared for the open houses:

Poster 1 – Project Overview – Text providing Western Silver's corporate information and commitments, as well as the scope of the Carmacks Copper project, with a photo of the project area.
Poster 2 – Project Components – Drawing showing the overall site plan for the project with text describing main components; simplified flowsheet of the Carmacks Copper project process; and photos of the project area.
Poster 3 – EA Study Area – Map, photos, and text illustrating the Carmacks Copper environmental assessment area and local geography.
Poster 4 – Project Studies – Maps, photos, and text showing assessment activities, heritage resources and current land use, game management zones, and key wildlife areas.
Poster 5 – Conceptual Reclamation/Closure Plan – Drawing, flowsheet, and text explaining reclamation measures to be undertaken upon mine closure.

Many of the questions raised by the public during the open houses focused on economic and employment benefits and opportunities. Community members were interested in the project plans and encouraged to see Western Silver reactivating the project EA.

Posters were used to explain the project location and environmental setting. Visitors were advised that an environmental assessment report was in preparation and this document would be available to the public for review and comment. Visitors were interested in the fisheries resources in Williams Creek and the measures to protect them. They were advised that national environmental quality guidelines would be used to ensure downstream resources are protected. Many questions surrounded the EA review process and opportunities to community input. Western Silver has acknowledged the community issues raised during this public process, incorporated where appropriate in the EA document, and will consider them in future planning. The company intends to continue to provide the community with information updates as the project proceeds.

6.4 NOTIFICATION

Notification to trappers, outfitters, and other resource users in the project area is being undertaken as a part of this environmental assessment. Initial contact has been made with the local trapping family regarding project activities. Formal notifications will be made to the following prior to commencement of project operations:

Individual Trapper

Trapping Concession #147
Kathleen Sam
Carmacks, YT

Outfitter Concession

Outfitting Concession #13
Mervyn's Yukon Outfitting
Tim & Jen Mervyn
Box 33036
Whitehorse, YT
Y1A 5Y5

7.0 POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

The IEE report for the Carmacks Copper Project dated October 1994 was prepared by HKP for Western Copper Holdings Ltd. Volume IV of the IEE, “Environmental Mitigation and Impact Assessment” contains the Environmental Impact Assessment, while the IEE Addendum submitted in June 1995 by HKP contains a revised environmental impact assessment. The following text and information has been included from the revised assessment, which supersedes the impact assessment presented in Volume IV of the IEE. However, the IEE and addendums should be referred to for further details and specific information where noted. The following section comprises the assessment of potential effects resulting from the development of the Carmacks Copper Project.

7.1 ENVIRONMENTAL ASSESSMENT APPROACH

The environmental assessment included the identification of Valued Ecosystem and Cultural Components (VECC’s), and an assessment to determine whether or not the project is predicted to cause significant adverse environmental effects on each identified VECC, after the implementation of appropriate mitigation measures. The following section consists of an assessment of potential adverse effects as a result of the Carmacks Copper project using the baseline environmental data for the EA study area with proposed mitigation measures.

To determine whether or not the potential adverse environmental effects were considered significant, seven criteria were taken into consideration. The first five descriptors follow those identified in The Responsible Authority’s Guide to the Canadian Environmental Assessment Act prepared by the Federal Environmental Assessment Review Office (FEARO) in 1994. The descriptors for economic and social context and risk characterization have been added to address potential socioeconomic effects from the project and to incorporate the risk assessment into the significance determination.

- **Magnitude** of the adverse environmental effect, where magnitude refers to severity. Minor or inconsequential effects may not be significant, but effects that are major or catastrophic will be significant;
- **Geographic** extent of the potential environmental effect. Localized effects may not be significant while widespread effects are more likely to be significant;
- **Duration** and frequency of the potential environmental effect. Long-term and/or frequent adverse effects may be significant, however, those of a short term and/or temporary nature could not be significant;
- **Reversibility:** Degree to which the adverse effect is reversible or irreversible. Reversible adverse environmental effects may be less significant than effects that are irreversible;
- **Ecological Context** of the potential environmental effect. The adverse effects of projects may be significant if they occur in areas or regions that have already been adversely affected by human activities and/or are ecologically fragile and have little resilience to imposed stresses;
- **Economic and Social Context**: The adverse effects of projects may be significant if they occur in areas or regions that have already been adversely

affected by human activities and/or are economically or socially fragile and have little resilience to imposed stresses or changes; and

- **Risk Characterization**: The potential consequences (adverse effects) of failure modes or hazards may be significant if potential failure and exposures are a high risk and likely to cause adverse effects.

The ratings system used to determine the significance of potential environmental effects is shown in Table 7-1. Table 7-2 provides a summary of the assessment of potential environmental effects, a listing of mitigation measures, and a determination of the significance of the potential effects using quantifiable measures. The ecosystem and cultural components that were evaluated for potential environmental effects include: soils; vegetation; groundwater quality and hydrology; surface water quality and hydrology; aquatic resources including fisheries resources and benthic invertebrates; wildlife and habitat; aesthetics, including air quality, visibility, and noise; land use capability; and, socio-economic effects including public health and safety.

Subsequent sections within Chapter 7 present the determination of VECC's, the details of the effect assessment and mitigation measure for various environmental and socio-economic conditions, a cumulative effects and risk assessment, closure planning, and capacity of renewable resources to meet present and future needs.

Table 7-1 Significance of Effects Descriptors

Descriptor	Duration	Geographic Extent	Magnitude	Reversibility*	Ecological Context	Economic & Social Context	Risk Characterization**
Very low (1)	<1 to 5 years (1)	<1 ha (1)	negligible effects to surrounding environment (1)	95-100% (1)	community with very good ecological fitness and a very high degree of resilience (1)	community with very good economic and social fitness and a very high degree of resilience (1)	negligible risk (1) : negligible to high hazard assessment; negligible to very low exposure assessment; and negligible consequence assessment
Low (2)	5 to 10 years (2)	1-75 ha (2)	low effects to surrounding environment (2)	75-95% (2)	community with good ecological fitness and a high degree of resilience (2)	community with good economic and social fitness and a high degree of resilience (2)	very low risk (2) : negligible to high hazard assessment; negligible to very low exposure assessment; and negligible consequence assessment
Moderate (3)	10 to 25 years (3)	75-200 ha (3)	moderate effects to surrounding environment (3)	60-75% (3)	community with moderate ecological fitness and a moderate degree of resilience (3)	community with moderate economic and social fitness and a moderate degree of resilience (3)	low risk (3): very low to high hazard assessment; low to medium exposure assessment; and very low to low consequence assessment
High (4)	25 to 100 years (4)	200-300 ha (4)	extreme effects to surrounding environment (4)	40-60% (4)	community with poor ecological fitness and a low degree of resilience (4)	community with a poor economic and social fitness and low degree of resilience (4)	medium risk (4) : low to high hazard assessment; medium to high exposure assessment; and low to medium consequence assessment
Very High (5)	100 years-permanent (5)	>300 ha (5)	catastrophic effects to surrounding environment (5)	<40% (5)	community with very poor ecological fitness and a low degree of resilience (5)	community with very poor economic and social fitness and a low degree of resilience (5)	high risk (5): low to high hazard assessment; medium to high exposure assessment; and medium to high consequence assessment

Notes:

Numbers in parenthesis ( ) equals numerical weighting value. * Descriptors for reversibility are opposite to the effects descriptors. ** Risk characterization adapted from Van Zyl, Koval and Li (1992).

Overall Significance Ranking Descriptor:

Very low	7-11
Low	12-17
Moderate	18-24
High	25-34
Very high	35

A Significant Impact is defined as an overall numerical ranking of great than 25 points

Table 7-2 Summary of the Assessment of Potential Environmental Effects Resulting from the Proposed Carmacks Copper Project

Parameters	Development	Occurrence	Consequence and Effect	Mitigation	Significance of Effects																Significant
					Duration	#	Geographic	#	Magnitude	#	Reversibility	#	Ecological	#	Economy & Social	#	Risk	#	Overall Rating	Overall Numerical Ranking	(Y/N)
Atmospheric	OP	O	fugitive dust	road watering	10 years - low	2	low	2	low	2	high	2	low	2	moderate	3	v. low	1	**LOW**	**14**	**N**
	MWRSA	C,O	fugitive dust	road watering	10 years - low	2	low	2	low	2	high	2	low	2	moderate	3	v. low	1	**LOW**	**14**	**N**
	HLP	C,O,C/P	fugitive dust, gaseous emissions	road watering/closed distribution system	10 years - low	2	low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**15**	**N**
	AR	C, O, (C/P)	fugitive dust	road watering	10 years - low	2	low	2	low	2	high	2	low	2	moderate	3	v. low	1	**LOW**	**14**	**N**
	AF		fugitive dust, gaseous emissions	baghouse dust collectors, ventilation system, scrubbers	10 years - low	2	low	2	moderate	2	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**15**	**N**
Topography	OP	O, C/P	permanent open pit	some recontour, and access barriers	permanent-v.high	5	29.5 ha - low	2	high	4	low	4	low	2	moderate	3	low	2	**MODERATE**	**22**	**N**
	MWRSA	O, C/P	single storage area	recontoured and revegetated	permanent-high	4	69.6 ha - low	2	moderate	3	moderate/high	3	low	2	moderate	3	low	2	**MODERATE**	**19**	**N**
	HLP	O, C/P	valley fill	recontoured, covered and revegetated	permanent-high	4	37.2 ha - low	2	moderate	3	moderate/high	3	low	2	moderate	3	low/moderate	3	**MODERATE**	**20**	**N**
	AR	C, O, C/P	road cuts	recontoured and revegetated	15 years - moderate	3	12.3 ha - low	2	low	2	high	2	low	2	moderate	3	v. low	1	**LOW**	**15**	**N**
	AF	C, O, C/P	facility area cuts	recontoured and revegetated	15 years - moderate	3	13.3 ha - low	2	low	2	high	2	low	2	moderate	3	v. low	1	**LOW**	**15**	**N**
Soils	OP	C,O,C/P	Stripping of soils	n/a	permanent-high	4	29.5 ha - low	2	high	4	low	4	low	2	moderate	3	low	2	**MODERATE**	**21**	**N**
(including permafrost)	MWRSA	C,O,C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	10 years-low/mod.	3	69.6 ha - low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**16**	**N**
	HLP	C,O,C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	10 years-low/mod.	3	37.2 ha - low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**16**	**N**
	AR	C,O,C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	10 years-low/mod.	3	12.3 ha - low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**16**	**N**
	AF	C, O, C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	15 years-moderate	3	13.3 ha - low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**16**	**N**
Surface Water Hydrology	HLP	C,O,C/P	discharge of effluent to Williams Creek	controlled discharge	15 yrs-moderate	3	moderate	3	moderate	3	v. high	1	low/mod.	3	moderate	3	low/moderate	3	**LOW TO MODERATE**	**19**	**N**
	MWRSA	C,O,C/P	discharge of effluent to North Williams Creek	controlled discharge	15 yrs-moderate	3	moderate	3	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW TO MODERATE**	**17**	**N**
	AR	C,O,C/P	stream crossings	bridge crossing on Merrice Creek	15 yrs-moderate	3	v. low	1	v. low	1	v. high	1	low/mod.	3	moderate	3	v. low	1	**LOW**	**13**	**N**
Surface Water Quality	AR	C, O	sediments	minimize instream construction, maintain vegetation buffer zones	15 yrs-moderate	3	low	2	low	2	v. high	1	low	2	moderate	3	low	2	**LOW**	**15**	**N**
	HLP	O,C/P	nitrogen compounds/metals/acid/sediments	no discharge, contingency treatment plant, sediment ponds, heap treatment, monitor	15 yrs-moderate	3	low/mod.	3	moderate	3	high	2	moderate	3	moderate	3	moderate	3	**MODERATE**	**20**	**N**
	MWRSA	O,C/P	nitrogen compounds/metals/sediments	maximize collection and water recycle. Settlement of runoff from disturbed areas.	15 yrs-moderate	3	low/mod.	3	low	2	high	2	moderate	3	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	OP	O	nitrogen compounds/metals/sediments	maintain vegetation buffer zones, no release of water from pit	10 yrs-low/mod.	2	low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**15**	**N**
Groundwater Hydrology	HLP	O,C/P	cone of depression in groundwater table	foundation drainage	permanent-high	4	low	2	moderate	3	moderate	3	low	2	moderate	3	low	2	**LOW TO MODERATE**	**19**	**N**
	MWRSA	O,C/P	groundwater mounding	foundation drainage	permanent-high	4	low	2	low	2	moderate	3	low	2	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	OP	O, (C/P)	cone of depression in groundwater table	n/a	25 to 100 yrs-high	4	low	2	moderate	3	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	AF	C,O, (C/P)	cone of depression in groundwater table - water source	multiple well locations, monitoring	10+ yrs-low/mod.	3	low	2	moderate	3	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**17**	**N**
Groundwater Quality	HLP	O,C/P	nitrogen compounds/metals/acid	LDRS, double composite liner	15 yrs-moderate	3	low	2	moderate	3	moderate	3	moderate	3	moderate	3	moderate	3	**MODERATE**	**20**	**N**
	MWRSA	O,C/P	nitrogen compounds/metals	waste chemically stable, sediment collection pond	12 yrs-moderate	3	low	2	low	2	moderate	3	moderate	3	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	OP	O	nitrogen compounds/metals	rock geochemically stable	25 to 100 yrs-high	4	low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**17**	**N**
Fisheries: Water Quality	AR	C, O	sediments	minimize instream construction, maintain vegetation buffer zones	15 yrs-moderate	3	low/mod.	3	low	2	v. high	1	low	2	moderate	3	low	2	**LOW**	**16**	**N**
	MWRSA	C, O, C/P	nitrogen compounds/metals/sediments	sediment control ponds, monitor discharge	15 yrs-moderate	3	low/mod.	3	low	2	high	2	moderate	3	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	HLP	C, O, C/P	nitrogen compounds/metals/acid/sediments	no discharge, treatment plant, heap treatment, collect and settle runoff from disturbed area	15 yrs-moderate	3	low/mod.	3	moderate	3	high	2	moderate	3	moderate	3	moderate	3	**MODERATE**	**20**	**N**
	OP	O	nitrogen compounds/metals/sediments	minimize instream construction, maintain vegetation buffer zones	10 yrs-low/mod.	2	low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**15**	**N**
Habitat loss	AF	C, O	decrease in surface flows	water recycling, ground water wells, monitor surface flows	15 yrs-moderate	3	low/mod.	3	low	2	v. high	1	moderate	3	moderate	3	low	2	**LOW**	**17**	**N**
Benthic Macro invertebrates	AR	C, O, (C/P)	sediments	minimize instream construction, maintain vegetation buffer zones	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW**	**16**	**N**
	MWRSA	O, (C/P)	nitrogen compounds/metals/sediments	sediment control ponds, monitor discharge	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW**	**16**	**N**
	AF	C, O	decrease in surface flows	water recycling, ground water wells, monitor surface flows	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW**	**16**	**N**
	HLP	C, O, C/P	nitrogen compounds/metals/acid/sediments	treatment plant, SCP, minimize instream construction, maintain vegetation buffer zones	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	moderate	3	**LOW TO MODERATE**	**17**	**N**
Periphyton	AR	C, O, (C/P)	sediments	minimize instream construction, maintain vegetation buffer zones	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW**	**16**	**N**
	MWRSA	O, (C/P)	nitrogen compounds/metals/sediments	sediment control ponds, monitor discharge	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW**	**16**	**N**
	AF	C, O	decrease in surface flows	water recycling, ground water wells, monitor surface flows	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	low	2	**LOW**	**16**	**N**
	HLP	C, O, (C/P)	nitrogen compounds/metals/acid/sediments	treatment plant, SCP, minimize instream construction, maintain vegetation buffer zones	15 yrs-moderate	3	low	2	low	2	v. high	1	low/mod.	3	moderate	3	moderate	3	**LOW TO MODERATE**	**17**	**N**
Wildlife	ALL	C, O	Direct habitat loss	revegetating (see reclamation program)	20-30 yrs-mod/high	4	170.5 ha - mod.	3	high	4	mod./high	3	low	2	moderate	3	low	2	**MODERATE**	**21**	**N**
	ALL	C, O	Indirect habitat loss, avoidance, habitat fragmentation	revegetating (see reclamation program)	15-20 yrs-moderate	3	170.5 ha - mod.	3	moderate	3	high	2	low	2	moderate	3	low	2	**MODERATE**	**18**	**N**
	ALL	C, O, C/P	Harassment	wildlife management plan	10 yrs-low/mod.	3	170.5 ha - mod.	3	low	2	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**17**	**N**
	AR	C, O, C/P	Hunting & poaching pressure	wildlife management plan, on-site no hunting policy	10 yrs-low/mod.	3	12.3 ha - low	2	low	2	high	2	low	2	moderate	3	low	2	**LOW**	**16**	**N**
	AR	C, O, (C/P)	Road kills	wildlife management plan, posted speed limits and wildlife crossings	10-15 yrs-moderate	3	12.3 ha - low	2	moderate	3	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**17**	**N**
Vegetation	HLP	C, O, C/P	Removal of vegetation	revegetating (see reclamation program)	15 yrs-moderate	3	37.2 ha - low	2	high	4	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	MWRSA	C, O	Removal of vegetation	revegetating (see reclamation program)	15 yrs-moderate	3	69.6 ha - low	2	high	4	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	OP	C, O, C/P	Removal of vegetation	n/a	permanent-high	4	29.5 ha - low	2	v. high	5	low	4	low	2	moderate	3	low	2	**MODERATE**	**22**	**N**
	AF	C, O	Removal of vegetation	revegetating (see reclamation program)	15 yrs-moderate	3	13.3 ha - low	2	high	4	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
	AR	C, O, (C/P)	Removal of vegetation	revegetating (see reclamation program)	15 yrs-moderate	3	12.3 ha - low	2	high	4	high	2	low	2	moderate	3	low	2	**LOW TO MODERATE**	**18**	**N**
Land Capability & Historic Use																					
Trapping	ALL	C, O, C/P	Decrease in wildlife populations, decrease trapping success	trapper will be compensated	15 yrs-moderate	3	170.5 ha - mod.	3	moderate	3	high	2	moderate	3	high	4	moderate	3	**MODERATE**	**21**	**N**
Traditional/Cultural Use & Trapping	ALL	C, O, C/P	Decrease in access to wildlife and cultural pursuits	provide access and revegetation and reclamation program	15 yrs-moderate	3	170.5 ha - mod.	3	moderate	3	high	2	moderate	3	moderate	3	moderate	3	**MODERATE**	**20**	**N**
Socioeconomic Effects																					
"Boom-bust " phenomenon	ALL	C, O, C/P	Erratic economic development, infrastructure requirements	construction of camp at mine site, widespread employment distribution	15 yrs-moderate	3	low	2	moderate	3	moderate	3	v. low	1	high	4	moderate	3	**MODERATE**	**19**	**N**
Local community	ALL	C, O, C/P	Increase population, positive and negative local social effects	community resource and infrastructure planning, social programs	15 yrs-moderate	3	low	2	moderate	3	moderate	3	v. low	1	high	4	moderate	3	**MODERATE**	**19**	**N**
Human Health & Safety (Accidents)	ALL	C, O, C/P	Effects of health/livelihood/community	Health & safety plans, EMS, Training, Monitoring	15 yrs-moderate	3	low	2	moderate	3	mod/low	4	v. low	1	high	4	low	2	**MODERATE**	**19**	**N**

C=construction, **O**=operations, **C/P**=closure/post-closure
OP=open pit, **HLP**=heap leach pad and associated ponds, **MWRSA**=mine waste rock storage area, **AF**=ancillary facilities, **AR**=access and haul roads, **ALL**=all mine activities
() = if occurrence is bracketed, it is occurring to a lesser degree
Those parameters that have not been impacted are not presented in this table

7.2 VALUED ECOSYSTEM AND CULTURAL COMPONENTS

The following information has been included from the “Administrative Procedures for Environmental Assessment of Major Mining Projects in the Yukon” prepare by Yukon Government in September 2004.

Valued Ecosystem and Cultural Components (VECC’s) are defined as elements of the environment, which are valued for environmental, scientific, social, aesthetic or cultural reasons. Selecting the project specific VECC’s or indicators are essential for focusing impact assessment and the determination of significance of effects.

The approach to selecting VECC’s and indicators has been based on the following:

- Identification of impacts to affected resources, rather than to specific VECC’s or indicator species;
- Stakeholder consultations and VECC importance ranking;
- Determining species vulnerability by reviewing the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists; and
- Determining which species or VECC’s that are likely to be affected based on issues identification.

The process for identifying the VECC’s varies with each project, however it usually begins with consultations with Responsible Authorities (RAs) and other stakeholders, particularly local First Nations. Baseline research, literature review, species vulnerability, community consultations and other initiatives are also used.

Examples of attributes that influence the selection of VECC’s include:

- Ecological importance;
- Socioeconomic importance (existing and potential);
- Cultural importance;
- Aesthetic value;
- Rare or endangered; and
- Responsiveness to impacts or stress.

The types of VECC’s selected for other Yukon mining projects has included, public and commercially important wildlife and fish species such as caribou, moose, or Chinook salmon, important cultural or heritage sites, designated protected or special management areas, and ground and surface water quality.

VECC selection should consider the likelihood of project effects on the VECC’s, whether or not proposed VECC’s effects mitigation can occur through existing regulator mechanisms and the potential for cumulative environmental effects.

With respect to cumulative environmental effects, even if the project on its own is unlikely to affect a VECC, the combined effects of the proposed project along with other projects and activities (e.g., harvesting) should be considered. Potential cumulative effects are discussed in Section 7.5 of this report.

The approximate spatial boundaries for identifying VECC's are the same as the boundaries proposed for the EA study area, which are primarily based on the potential geographic extent of effect. However, for certain VECC's a regional context is more appropriate for certain wildlife species, such as moose, which move into and out of the study area boundaries. The identification of socioeconomic/cultural VECC's is presented in a regional context, including the Village of Carmacks and the Yukon Territory as a whole. Input from the public (Section 6.0) including traditional knowledge has contributed to the identification of VECC's.

Table 7-3 provides a complete list of the VECC's within the EA study area and within a regional context that will be effected by the project and rational for their selection. Consultation with LSCFN, the Village of Carmacks and regulatory agencies, knowledge of local environmental conditions and best professional judgment lead to the selection of the project VECC's.

Table 7-3 Identification of Valued Ecosystem and Cultural Components

Component Type	Rationale For Selection
Environmental	
Air Quality	Fugitive dust and gaseous emissions.
Surface Water Quality	Williams Creek is receiving water for effluent discharge; support aquatic resources.
Groundwater Quality	Possible infiltration of metals/acid/nitrogen compounds with recharge to Williams Creek surface waters.
Permafrost	Disturbance of permafrost in WRSA and along road alignments.
Fisheries Resources – Lower Williams Creek and Yukon River	
Juvenile Chinook Salmon	Sensitive fish species; important commercial and native food fisheries; downstream indicator.
Arctic Grayling	Species of importance for First Nations and sport fisheries.
Wildlife Resources	
Moose	Important moose habitat along the Yukon River; increased harvest pressure, avoidance.
Furbearers	Direct/indirect habitat loss, avoidance, habitat fragmentation, increased harvest pressure, road kills.
Socioeconomic/Cultural	
Traditional Use – Trapping	Trapping concession provides employment benefits and sustenance lifestyle.
Traditional Use – Wildlife and Cultural	Wildlife, fish, berries, plant harvesting support sustenance lifestyle and cultural pursuits.
Heritage Resources	Known historic archaeological sites in EA study area; other sites along access road have medium heritage site potential.
Social	LSCFN and Village of Carmacks local community resources and infrastructure required to support the project. Possible social problems such as drug and alcohol abuse.
Economic	LSCFN and Village of Carmacks interested in economic and employment benefits and opportunities resulting from the project.
Human Health and Safety	Worker health and safety on the project and Freegold Road. Public health and safety.

7.3 SUMMARY OF POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

This section summarizes the key potential environmental effects for the project and proposed mitigation measures. The summary table in Appendix K presents a detailed significance assessment and associated mitigation plan for each potential environmental effect. Section 5 of the IEE Addendum prepared by HKP in June, 1995 presented an initial environmental effects assessment for the project. This information has been summarized and updated to reflect the current project and potential environmental effects and mitigation measures.

7.3.1 Atmospheric

Overall atmospheric emissions from mining operations at the Carmacks Copper project will be primarily limited to fugitive dust from open pit mining, hauling and crushing operations, and will be typical of most mine sites. As there will be no roasting or smelting operations, gaseous emissions will be limited to ventilation of the reagent area, the process plant (solvent extraction and electrowinning areas), acid plant, the fume hoods in the assay laboratory, equipment emissions, and diesel generators. An approved gas fired incinerator would be used to incinerate camp domestic waste. Therefore, no sources of significant chemical air emissions would require special treatment or control. The main sources of air emissions are primarily limited to:

- fugitive dust from mining;
- road dust;
- gaseous emissions from the SX/EW process and acid plant;
- gaseous emissions from diesel generators; and
- gaseous emissions from solid waste incinerator.

<u>Potential Effects</u>

- Release of SO_2 or volatile hydrocarbons could cause injury or mortality to living organisms by fire, explosion, toxicity, or asphyxiation;
- Settling of SO_2 produced by acid plant can cause high level ground level concentrations that could damage vegetation and soils and affect human and animal health;
- Burning of diesel, gasoline, and propane causes emissions of air polluting gases;
- Noise generated during operations may have a negative effect on the quality of life for residents and wildlife in the vicinity of operations; and
- Particulate matter during operations (fugitive dust) may have a negative effect on worker health and safety and the local environment (vegetation, wildlife, aquatic).

<u>Mitigation</u>

- Fugitive dust from blasting and hauling will be controlled to the maximum extent possible by employing normal dust control procedures such as watering main haul roads or calcium chloride addition;
- Mitigation for dust generated from crushing and screening will be baghouse type dry dust collectors. Ore transported from the crusher to the heap leach pile via conveyors is not expected to produce significant dust since the freshly crushed ore contains 1 to 2% moisture;

- Process controlled production of sulphuric acid to minimize gaseous emissions. Any gaseous emissions will meet national emission standards;
- Process plant and laboratory area equipped with gaseous scrubbers and ventilation systems to remove particulate matter and gaseous emissions;
- Gas monitoring meters, to measure L.E.L., SO_2, and O_2 level, and equipped with both audio and visual alarms, will be used at all times in process facilities. Safety procedures will be initiated in the event of L.E.L. > 10%, SO_2 450 mg/m^3, and O_2 < 19% or > 23% by volume in air;
- Sulfur dioxide monitors will be used. Ground level concentrations will not exceed 450 mg/m^3;
- Gas meters will be calibrated regularly to ensure accuracy;
- Personnel trained in the appropriate safety measures will be on site at all times during operations to manage emergency response plans;
- Wind direction will be monitored to ensure appropriate zone of safety established in the event of an uncontrolled release of gas;
- Emergency Response Plan will be followed as required;
- Acid plant emissions will be strictly regulated to ensure emissions standards are adhered to;
- Air contaminants will be monitored;
- Equipment installed with approved manufacturers devices for controlling air emissions;
- Proper maintenance of vehicles, pumps, compressors, generators, and other internal combustion engines will minimize emissions of polluting gases;
- Exhaust gases must be vented to outside of encloses spaces and adequate ventilation supplied;
- Worker Health and Safety program monitored so that sound levels will be maintained below worker safety requirements;
- No public vehicle access will be allowed to the site;
- Peak traffic operations occur during brief periods (project construction);
- Freegold Road bypass directs traffic away from Village of Carmacks residential areas;
- No known sensitive habitats in the project area; and
- Approved gas fired incinerator with high efficiency burner.

Potentially adverse effects to air quality are considered to be low to moderate as duration is low/moderate (approximately 10 years), geographic extent is limited, magnitude is low/moderate, reversibility is high, ecological sensitivity is moderate, economic and social context is moderate, and risk characterization is low/moderate (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.2 Topography

Mining operations will result in three permanent changes to local topographical features:

- An open pit covering an area of approximately 29.5 ha and a maximum depth of 230 m;
- A waste rock storage area covering an area of approximately 69.6 ha and a maximum height of 140 m; and
- A heap leach pad and events pond covering an area of approximately 37.2 ha.

Other minor changes to the local topography will result from the construction of diversion channels, drainage ditches and road ways, most of which will be restored to their original configuration on closure and reclamation.

The disturbance of soils due to mining activity will occur at a number of areas including:

- the open pit;
- waste rock storage area;
- the process plant and ancillary facilities;
- the heap leach pad (including events pond and sediment control pond);
- along road corridors; and
- borrow areas.

During construction, soils will be stripped from areas of development and stored for reclamation purposes on mine closure. Prior to construction, soil quality will be tested to confirm regional mapping and determine if the soils have sufficient nutrients and organic matter to support plant growth. Although soils and overburden material provide valuable growth medium, supplementation with fertilizer and other soil amendments may be required for successful revegetation.

Borrow areas will be developed with due consideration for drainage and runoff from the excavated surfaces so as not to cause erosion of the adjacent terrain. The borrow area will be excavated in near-horizontal layers and in such a matter that water will not collect and stand therein.

Areas of permafrost occur in the Williams Creek valley in the vicinity of the creek itself and in the north aspect tributaries. Permafrost areas are subject to mass wasting when vegetation is cleared and vehicle disturbance occurs. Ice layers begin to melt from increased heat absorption on bare ground resulting in mud sliding downhill and exposing more ice. As a result, roads in particular become unfit for travel and difficult to stabilize and reclaim.

Road alignments will be chosen carefully and constructed in a manner that avoids road cuts and therefore does not expose permafrost. Gravel roads will be engineered and constructed to maintain permafrost conditions (i.e., the -5^{o}C isotherm) under and surrounding the road. Typically, this involves construction of a gravel road base up to approximately 3 m thick directly on top of existing soils with no pre-construction stripping of organic material. If necessary, other design considerations (such as mixing insulating material with gravel and installation of thermal siphons to vent off heat) may be used to prevent permafrost degradation. The road will be maintained by installation of cross-drains and waterbars. Equipment movement over roads will be minimized and included in construction of diversion ditches, heap leach pad, waste rock area, and process and ancillary facilities to minimize the potential for permafrost degradation.

The heap leach pad and events area was cleared in 1997 and it is expected that any remaining permafrost within this area would have melted. Geotechnical conditions in the WRSA indicate the presence of permafrost. Mitigative measures have been incorporated into the design to minimize environmental effects associated with WRSA construction. This includes stripping and thawing of soils, drainage ditches and sediment control pond to capture melt water and a contingency perimeter berm to ensure the long term stability of the WRSA.

Potential Effects

- Loss or disturbance to topography or ground. Disturbance to the soil profile (i.e. soil loss, compaction, admixing, etc.);
- Disturbance to erosion prone banks and slopes;
- Disturbance of surface and subsurface drainage systems;
- Contamination of soil/potential for fuel and/or other substance spillage; and
- There is a potential for localized melting of permafrost in isolated portions of the heap leach pad, waste rock storage area, and roads.

Mitigation

- Stockpiling of soils for future reclamation;
- Existing trails and disturbed areas will be used where suitable to minimize environmental impact;
- No unnecessary disturbance to the organic mat and soils. EMS will be followed as required;
- Surface disturbance will be re-sloped and covered with soil or revegetated as appropriate;
- Vehicle movement will be restricted to access or haul roads to prevent permafrost and organic mat disturbance;
- No recreational off-road use of wheeled vehicles will be allowed;
- Permanent alteration to local topography (open pit, heap leach pad, waste rock storage area) – recontouring and revegetation will take place to enhance changes to topographic relief;
- Facilities and waste rock storage area located to minimize erosion prone banks and slopes, as well as reduce the possibility of inadvertent surface disturbance;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- Recontour and re-sloping of disturbed areas and progressive revegetation and reclamation;
- All activity will be conducted on constructed roadways;
- Facilities located in areas away from surface water drainage systems to minimize environmental impact;
- Hand cutting will be employed near access road stream crossings to reduce disturbance to riparian areas;
- Access road with clear span bridge structure across Merrice Creek to reduce disturbances;
- Ensure drainage channels are maintained and free of debris;
- Reclaim surface drainage to original condition (recontour, revegetation);
- Routine monitoring and maintenance in accordance with EMS to prevent disturbances;
- Heap leach pad and events pond constructed with double liner and LDRS system to prevent solution migration to soils and groundwater. Facilities located greater than 50 m from any watercourse;

- Heap leach pad and events pond LDRS will be monitored and sampled regularly. If leakage rates are exceeded in the LDRS then site-specific investigations will be undertaken to identify and mitigate the leakage;
- Liquid hydrocarbons, acids, and other chemicals will be stored in appropriate containers during transportation. No fuels or chemicals will be stored within 100 m of a watercourse;
- Main fuel, acid, and chemical storage facilities located at the plant site. Storage tanks with secondary containment. Segregation and controlled storage of plant chemicals. All hazardous materials located within controlled facility and routinely inspected and monitored as part of EMS;
- A spill contingency plan is in place, as part of the EMS;
- In the event of a spill, the Spill Contingency Plan will be implemented. Spills will be immediately reported to the Spill Report Line;
- Upon closure, assessment of soils for local contamination and completion of remediation activities;
- All hydrocarbons, chemicals, and waste materials resulting from the project will be removed from the area and cleaned up;
- The heap leach pad area has been previously cleared and stripped to enable local thaw. Additional geotechnical drilling should be conducted to confirm permafrost existence under leach pad area to minimize environmental effects;
- Stripping of the waste rock storage area to allow permafrost thawing and construction of drainage ditches and sediment ponds to control water. Staged waste rock storage area construction and monitoring with contingency berm;
- Road alignments chosen and constructed to maintain permafrost conditions. Gravel road base to be approximately 3 m thick directly on top of existing soils;
- Wheeled vehicles will be used only on access roads and mine areas. No recreational off-road use of wheeled vehicles will be allowed;
- Equipment operators will be instructed not to disturb ground unnecessarily;
- Physical stability of the heap leach pad and waste rock storage areas routinely monitored. EMS inspection and monitoring plans; and
- An evaporative transpiration cover will be applied over the heap to minimize water infiltration and provide for vegetation growth on closure of the mine.

Potentially adverse effects to topography are considered to be low to moderate as duration ranges from moderate to high (15 years – permanent: open pit), geographic extent is localized, magnitude ranges from low – high, reversibility ranges from low to moderate/high (open pit), ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2).

The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.3 Water Resources

7.3.3.1 Surface Hydrology

The proposed operations will result in a slight modification to the mean annual distribution in runoff. As all process streams are designed to operate at 100% recycle, limited adverse effects on the flow in Williams Creek are predicted.

Potential Effects

- Erosion of stream banks;
- Groundwater well use effects downstream surface flow in Williams Creek;
- Increased flows in Williams Creek from possible discharge; and
- Flood events associated with structure failure.

Mitigation

- Project components and operations will be located away from watercourses, except at Merrice and Williams Creek stream crossings;
- Bridge crossing (Merrice Creek) and culvert (Williams Creek) designed to protect watercourse and prevent erosion;
- Existing trails and disturbed areas will be used where suitable to minimize environmental impact;
- No recreational off-road use of wheeled vehicles will be allowed;
- Any material that accidentally falls into watercourses will be removed;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- Project footprint with buffer zone between riparian areas. Sediment ponds to control water releases;
- If the surface is disturbed in an area such as drainage channels where erosion is a possibility, control measures may include using earth breaks or cross ditches;
- Heap leach pad and events pond constructed with composite liner and LDRS system to prevent solution migration to surface and groundwater. Sediment pond located downstream from events pond. Facilities located greater than 50 m from any watercourse;
- Water for mining and processing will be collected from deep wells in the Williams Creek drainage basin and numerous sediment ponds. No direct surface water use;
- Recycling of water from ancillary facilities and sediment ponds to minimize groundwater well use;
- At closure, controlled release of heap leach pad solutions to prevent direct hydrological effects to local drainage;
- Environmental monitoring program with stations on Williams Creek to monitor stream hydrology and water quality. Perform required MMER EMM program;
- No direct discharge of process solutions or wastewater to surface waters during the operations. Recycling of process solutions and wastewater for other water uses;
- Contingency water treatment plant;
- Heap leach pad and events pond design to withstand combinations of critical events – operating solution volume, plus excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus, an allowance for heap draindown as follows:
  - During the first year of operation, 100% of the total potential heap draindown volume;
  - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m^3/hr this volume is 26, 000 m^3; and

  - o Redundant systems (i.e. pumps, power, spare parts) to prevent direct release of process solutions;
- At closure, covering, rinsing, and detoxification of the heap leach pad and treating solutions in a controlled manner to prevent effects to Williams Creek. Long term heap solutions directed to infiltration gallery to provide final solution polishing and prevent direct release to Williams Creek; and
- Progressive cleanup and remediation will be completed where possible.

Potentially adverse effects to surface water hydrology are considered to be low to moderate as duration is moderate (15 years), geographic extent is very low – low/moderate, magnitude is low to moderate, reversibility is very high, ecological sensitivity is low/moderate, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.3.2 Surface Water Quality

Since the proposed operations will operate with a water deficit and on the basis of 100% recycle of process streams, there will be no routine release of effluent to the receiving environment during operations. A contingency water treatment plant is planned, however, this plant should not be required until closure, based on average water balance conditions.

Any mine water encountered will be pumped out of the open pit and used as process water. Site drainage and wash water will be directed to the sediment control pond, recycled, or filtered back into Williams Creek below the ancillary facilities. A sediment pond located below the waste rock storage area will capture drainage from this area with water to be recycled for process use.

Results from acid-base accounting work on waste rock and ore, presented in Section 3.6.3.4, indicates that runoff from these sources would be neutral to basic in pH. Site runoff, on most occasions, is expected to carry a heavy suspended solids load during periods of high precipitation. These flows will be routed to the heap site sedimentation pond and waste rock dump sediment pond before release.

Flows calculated in the IEE Addendum (HKP, 1995) were used to project impacts on water quality at downstream stations using an arithmetic model that theoretically superimposes effluent quality on natural background concentrations to determine a resulting downstream concentration as follows:

$$Rc = \frac{[(Bc \times Bq) + (Ec \times Eq)]}{Rq}$$

Where: Bc = Background Concentration (mg/L)
Bq = Background Flow (m^3/s)
Ec = Effluent Concentration (mg/L)
Eq = Effluent Flow (m^3/s)
Rc = Resulting Concentration (mg/L)
Rq = Resulting Flow (Bq + Eq) (m^3/s)

Receiving water quality input to the model were based on mean, maximum and minimum background water quality data generated from baseline data collected between 1989 and 1999 (Appendix H). Projected effluent quality inputs to the model were based on effluent test work for the neutralized raffinate (Table 5.9, Appendix G) and SWEP tests for the waste rock (Table 5.6, Appendix G). The average concentration for copper was recalculated from the SWEP test results in Table 5.6, Appendix G for the waste rock, so that outlying data (sample considered as low grade ore) were not included in determining average conditions. The quantity of waste rock runoff used in the model was calculated on the basis that make-up water will be obtained from the waste rock runoff stilling pond. Resulting water quality in Williams Creek for a point immediately below North Williams Creek (W4) and at the mouth (W10) are compared to federal "CCME Canadian Water Quality Guidelines" for protection of aquatic life at ambient pH, hardness, alkalinity, and conductivity (Tables 7-4 to 7-7).

Four separate model predictions are presented in Tables 7-4 to 7-7. Tables 7-4 and 7-5 present the effects of waste rock seepage during operations on surface water quality in North Williams Creek (W4) and on lower Williams Creek (W10), respectively. These tables are provided to predict the effects of waste rock seepage on surface water if wastewater is not recycled during operations. Tables 7-6 and 7-7 present the effects of both waste rock and water treatment plant effluent during operations and closure on surface water quality in North Williams Creek (W4) and on lower Williams Creek (W10), respectively.

Water quality parameters that are predicted to exceed CCME Guidelines cannot exclusively be attributed to the proposed mine operations as the background water quality parameters for some metals (As, Cu, Pb, and Zn) have occasionally exceeded CCME Guidelines. For example, As concentrations are predicted to exceed CCME guidelines during all model runs due to naturally high mean concentrations for this parameter. In lower Williams Creek (W10) where fisheries resources are known to exist, CCME guidelines are met for Cu, Pb, and Ni. Zn marginally exceeds the CCME guideline. These predictions are considered worst-case modeling values, as waste rock runoff is not expected to be as predicted by the aggressive SWEP test results, and can be treated if required. Once operations commence, systems will be in place to recycle wastewater or to treat waste rock runoff if monitoring results require action.

Results from the fisheries sampling from 1991 to 1992 indicated that fish only utilize the lower reach of Williams Creek, downstream of the Nancy Lee Creek confluence. For the purposes of this assessment, the point of compliance for water quality criteria is to meet CCME guidelines for the protection of aquatic life in lower Williams Creek (W10).

Water quality monitoring will be routinely conducted at sediment control pond effluents to ensure that discharge criteria are being achieved. Downstream receiving water quality monitoring is also planned as part of the environmental surveillance network.

Based on the results of water quality monitoring, if the waste rock runoff or treatment plant effluent results in an increase in metals to lower Williams Creek such that metals levels exceed beyond natural background levels, then adaptive management and contingency measures could include one of the following:

- recirculation of waste rock runoff onto the dump to enhance evaporation;
- installation of an waste rock evaporation pond;

- treatment with lime at the sediment control pond to precipitate out heavy metals;
- decreasing the cutoff grade to reduce the quantity of mineralized rock in the dump; and
- other treatment alternatives including a biological treatment cell or infiltration gallery.

Potential Effects

- Erosion of stream banks causing siltation; and
- Degradation or contamination of watercourses or groundwater.

Mitigation

- Project components and operations will be located away from watercourses, except at Merrice and Williams Creek stream crossings;
- Bridge crossing (Merrice Creek) and culvert (Williams Creek) designed to protect watercourse and prevent erosion;
- Clear span bridge located at Merrice Creek to minimize disturbance to riparian zones;
- Existing trails and disturbed areas will be used where suitable to minimize environmental impact;
- No recreational off-road use of wheeled vehicles will be allowed;
- Any material that accidentally falls into watercourses will be removed;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- Project footprint with buffer zone between riparian area. Sediment ponds to control water releases;
- If the surface is disturbed in an area such as drainage channels where erosion is a possibility, control measures may include using earth breaks or cross ditches;
- Hazardous materials stored with secondary containment away from watercourse in controlled areas;
- Spill Contingency and Emergency Response Plans in place as part of EMS to prevent materials from accidentally entering watercourses;
- Heap leach pad and events pond constructed with composite liner and LDRS system to prevent solution migration to surface and groundwater. Sediment pond located downstream from events pond. Facilities located greater than 50 m from any watercourse;
- Water for mining and processing will be collected from deep wells in the Williams Creek drainage basin and numerous sediment ponds. No direct surface water use;
- Recycling of water from ancillary facilities and sediment ponds to minimize groundwater well use;
- At closure, controlled release of treated heap leach pad solutions to prevent degradation of local drainage water quality;
- No direct discharge of process solutions or wastewater to surface waters during the operations. Recycling of process solutions and wastewater for other water uses;
- Environmental monitoring program with stations on Williams Creek to monitor stream hydrology and water quality. Perform required MMER EMM program;

- Sediment pond located below heap leach pad, waste rock area, and ancillary facilities to prevent sediment release and treat surface water if necessary;
- Heap leach pad and events pond design to withstand combinations of critical events – operating solution volume, plus excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus, an allowance for heap draindown as follows:
  - During the first year of operation, 100% of the total potential heap draindown volume;
  - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m^3/hr this volume is 26, 000 m^3; and
  - Redundant systems (i.e. pumps, power, spare parts) to prevent direct release of process solutions;
- Heap leach pad and events pond LDRS will be monitored and sampled regularly;
- Contingency water treatment plant constructed using known technology on site to treat process solutions, if required;
- Sediment ponds will be monitored and sampled regularly to ensure wastewater quality;
- Liquid hydrocarbons, acids, and other chemicals will be stored in appropriate containers during transportation. No fuels or chemicals will be stored within 100 m of a watercourse;
- Main fuel, acid, and chemical storage facilities located at the plant site. Storage tanks with secondary containment. Segregation and controlled storage of plant chemicals. All hazardous materials located within controlled facility and routinely inspected and monitored as part of EMS;
- A spill contingency plan, as part of the Emergency Response Plan and EMS;
- In the event of a spill, the Spill Contingency Plan will be implemented. Spills will be immediately reported to the Spill Report Line;
- Any deleterious material that accidentally falls into a watercourse will be removed. A spill response plan will be implemented;
- Segregation of camp and ancillary facility wastewaters and treatment using in ground disposal and tile/absorption fields;
- At closure, covering, rinsing, neutralization, and detoxification of the heap leach pad and treating solutions in a controlled manner to prevent effects to Williams Creek. Long term heap solutions directed to infiltration gallery to provide final solution polishing and prevent direct release to Williams Creek;
- Progressive cleanup and remediation will be completed where possible;
- All waste materials containing fuels, chemicals and special waste will be properly stored and removed from the area; and
- A revegetation program using indigenous flora will be implemented for disturbed sites (access/haul roads, ancillary facilities, waste rock area, and heap leach pad) where native vegetation has been removed or destroyed, to prevent degradation of stream water quality.

Potentially adverse effects to surface water quality are considered to be very low to moderate as duration is low to moderate (10-15 years), geographic extent is low – moderate, magnitude is low/moderate, reversibility is very high, ecological sensitivity is low to moderate, economic and social context is moderate, and risk characterization is low to moderate (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

Table 7-4 Impact of Effluent (Waste Rock) During Operation on the Quality of Williams Creek at Station W4

Parameter	Bc			Bq	Ec[1]	Eq[1]	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m^3/s)	total (mg/L)	(m^3/s)	(m^3/s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	258	3	70.1	0.0558	15.00	0.0039	0.0597	242.1256	3.7839	66.5005	
Arsenic	0.12	0.0006	0.029	0.0558	0.03	0.0039	0.0597	0.1141	0.0025	**0.0291**	0.005
Copper	0.016	0.0005	0.006	0.0558	0.03	0.0039	0.0597	0.0169	0.0024	**0.0076**	0.002-0.004
Lead	0.01	0.00005	0.002	0.0558	0.04	0.0039	0.0597	0.0120	0.0027	0.0045	0.001-0.007
Nickel	0.014	0.001	0.004	0.0558	0.01	0.0039	0.0597	0.0137	0.0016	0.0044	0.025-0.15
Zinc	0.0578	0.001	0.014	0.0558	0.13	0.0039	0.0597	0.0625	0.0094	0.0216	0.03

Ambient Conditions: pH 7.4 to 8.1

Conductivity 98 to 465 umhos/cm

Hardness 85.6 to 216 mg/L $CaCO_3$

Alkalinity 28 to 169 mg/L

Shaded cells indicate concentrations below detection limits

[1] Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)

Bolded mean Rc values exceed federal CCME guidelines

Table 7-5 Impact of Effluent (Waste Rock) During Operation on the Quality of Williams Creek at Station W10

Parameter	Bc			Bq	Ec[1]	Eq[1]	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m^3/s)	total (mg/L)	(m^3/s)	(m^3/s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	25	5	11	0.1575	15.00	0.0039	0.1614	24.7584	5.2416	11.0967	
Arsenic	0.08	0.04	0.0317	0.1575	0.03	0.0039	0.1614	0.0788	0.0398	**0.0317**	0.005
Copper	0.005	0.001	0.0023	0.1575	0.03	0.0039	0.1614	0.0056	0.0017	0.0030	0.002-0.004
Lead	0.03	0.004	0.0043	0.1575	0.04	0.0039	0.1614	0.0302	0.0049	0.0052	0.001-0.007
Nickel	0.01	0.001	0.0041	0.1575	0.01	0.0039	0.1614	0.0100	0.0012	0.0042	0.025-0.15
Zinc	0.195	0.003	0.038	0.1575	0.13	0.0039	0.1614	0.1934	0.0061	**0.0402**	0.03

Ambient Conditions: pH 7.4 to 8.1
Conductivity 98 to 465 umhos/cm
Hardness 85.6 to 216 mg/L $CaCO_3$
Alkalinity 28 to 169 mg/L
Shaded cells indicate concentrations below detection limits
[1] Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)
Bolded mean Rc values exceed federal CCME guidelines

Table 7-6 Impact of Effluent (Waste Rock & WTP) During Operation and Closure on the Quality of Williams Creek at Station W4

Parameter	Bc			Bq	Ec[1]	Eq[1]	Ec[2]	Eq[2]	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m^3/s)	total (mg/L)	(m^3/s)	total (mg/L)	(m^3/s)	(m^3/s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	258	3	70.1	0.0558	15.00	0.0039	15.00	0.011	0.0707	206.7878	5.5290	58.4877	
Arsenic	0.12	0.0006	0.029	0.0558	0.03	0.0039	0.02	0.011	0.0707	0.0995	0.0052	**0.0277**	0.005
Copper	0.016	0.0005	0.006	0.0558	0.03	0.0039	0.04	0.011	0.0707	0.0205	0.0083	**0.0126**	0.002-0.004
Lead	0.01	0.00005	0.002	0.0558	0.04	0.0039	0.02	0.011	0.0707	0.0132	0.0054	0.0069	0.001-0.007
Nickel	0.014	0.001	0.004	0.0558	0.01	0.0039	0.02	0.011	0.0707	0.0147	0.0045	0.0068	0.025-0.15
Zinc	0.0578	0.001	0.014	0.0558	0.13	0.0039	0.13	0.011	0.0707	0.0730	0.0282	**0.0384**	0.03

Ambient Conditions: pH 7.4 to 8.1
Conductivity 98 to 465 umhos/cm
Hardness 85.6 to 216 mg/L $CaCO_3$
Alkalinity 28 to 169 mg/L
[1] Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)
[2] Effluent from Water Treatment Plant - concentration (mg/L) from neutralized raffinate test results (Table 5.9, Appendix G)
Shaded cells indicate concentrations below detection limits
Bolded mean Rc values exceed federal CCME guidelines

Table 7-7 Impact of Effluent (Waste Rock & WTP) During Operation and Closure on the Quality of Williams Creek at Station W10

Parameter	Bc			Bq	Ec[1]	Eq[1]	Ec[2]	Eq[2]	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m^3/s)	total (mg/L)	(m^3/s)	total (mg/L)	(m^3/s)	(m^3/s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	25	5	11	0.1575	15.00	0.0039	15.00	0.011	0.2364	17.6015	4.2766	8.2741	
Arsenic	0.08	0.04	0.0317	0.1575	0.03	0.0039	0.02	0.011	0.2364	0.0547	0.0281	**0.0225**	0.005
Copper	0.005	0.001	0.0023	0.1575	0.03	0.0039	0.04	0.011	0.1724	0.0078	0.0041	**0.0053**	0.002-0.004
Lead	0.03	0.004	0.0043	0.1575	0.04	0.0039	0.02	0.011	0.1724	0.0296	0.0058	0.0061	0.001-0.007
Nickel	0.01	0.001	0.0041	0.1575	0.01	0.0039	0.02	0.011	0.1724	0.0106	0.0024	0.0052	0.025-0.15
Zinc	0.195	0.003	0.038	0.1575	0.13	0.0039	0.13	0.011	0.1724	0.1894	0.0140	**0.0460**	0.03

Ambient Conditions: pH 7.4 to 8.1
Conductivity 98 to 465 umhos/cm
Hardness 85.6 to 216 mg/L $CaCO_3$
Alkalinity 28 to 169 mg/L
[1] Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)
[2] Effluent from Water Treatment Plant - concentration (mg/L) from neutralized raffinate test results (Table 5.9, Appendix G)
Shaded cells indicate concentrations below detection limits
Bolded mean Rc values exceed federal CCME guidelines

7.3.3.3 Hydrogeology

The distribution of groundwater at the site is limited to the active layer, small perched water tables above the discontinuous permafrost and at considerable depths along the main drainage courses as subpermafrost groundwater. Investigations at the site have intersected groundwater in the active layer during test pit excavations. Groundwater was encountered in only two drillholes (DH-C and RC-92-01). The depth to groundwater in DH-C, in the proposed leach pad area, was 6.8 m as a shallow perched water table above the permafrost. The depth of groundwater in RC-92-01, south of the events pond adjacent to Williams Creek, has been monitored since 1992 at 15.5 m (HKP, 1995).

<u>Open Pit</u>

Development of the open pit will result in a cone of depression in the groundwater table radiating from the floor of the pit outwards. This water, which normally migrates to North Williams and Williams Creeks as groundwater, will be collected in the pit and pumped to the process plant as make-up water.

On mine closure the pit will be allowed to accumulate water; however, the currently available data indicates that the groundwater table may not be intercepted in the vicinity of the open pit. Although the exact pre-production conditions will be altered by the loss of water to the open pit, the resulting flow conditions in Williams Creek will not be significantly altered.

Based on modeling results it is expected that the pit will take a significant period of time to fill (>300 years).

<u>Waste Rock Storage Area</u>

The hydrogeological effect at the WRSA is not expected to be significant. Most of the precipitation onto the waste rock will runoff and be collected in drainage ditches along the toe of the pile. The amount of runoff which enters the pile will be minimal and will flow in the near surface groundwater at the base of the pile for collection in the toe drains and ultimately into the sediment control pond for use as make-up water for leaching operations and for dust control on the roads.

The organic layer covering the WRSA will be removed during the initial development thereby initiating thawing of the permafrost. This will result in an increase in the hydraulic conductivity of the thawed soil and the generation of near surface groundwater, which will flow downslope and be intercepted by drains along the toe of the dump. The water quality effect model presented in the IEE indicates that if 50% of the total effluent from the waste dump is collected and recycled then the effect on receiving waters is not significant. The seepage losses into the groundwater will be an insignificant fraction of this amount and therefore seepage losses to North Williams Creek are not a concern.

<u>Heap Leach Pad</u>

During construction, the entire leach pad area will be lined in order to prevent leakage to groundwater. Consequently, surface recharge to the groundwater table in the area of the heap leach pad will not occur over an area of approximately 37 ha (~ 0.4% of the 88 km^2 watershed). There is the potential for the permafrost levels to lower under the heap leach pad due to heat losses from leach solutions into the ground possibly melting the permafrost. This could partially divert near-surface groundwater flows within this area. However, this effect is not expected to be significant, as the leach pad area has been cleared to allow the permafrost to thaw.

Well Water Supply System

To provide domestic and process water for the project, 8 wells located in the bedrock confined aquifer underlying Williams Creek drainage will be drilled. Each well is estimated to provide ~ 150 m^3/day.

Potentially adverse effects to ground water hydrology are considered to be low to moderate as duration is low/moderate to high (10+ years / permanent), geographic extent is low, magnitude ranges from low to moderate, reversibility is low to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2).

The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.3.4 Groundwater Quality

Extensive control measures have been included in the design of the Carmacks Copper project to ensure that the effects to groundwater are minimized. The measures include maximizing recycle of process streams, inclusion of primary and secondary liner systems, LDRS, containment berms, seepage detection systems and groundwater monitoring systems.

Groundwater was not encountered by the exploration geologists or the geotechnical engineers in any of the exploration drill holes or geotechnical evaluations except in two isolated locations, which consisted of perched water tables over permafrost. Groundwater flow is restricted to minor seasonal flows within the active swampy zones just below the ground surface.

Western Silver intends to proceed with the installation of a double synthetic geomembrane liner system for the entire heap leach pad overlying by a low permeability soil liner. The primary and secondary liners will be separated by a HDPE geonet LDRS. A high level of QA/QC will be employed during liner placement ensuring liner integrity.

Any seepage collected by this system will be pumped back to heap storage. In addition to the geonet leak detection and recovery system, the entire heap leach pad below the secondary soil liner will be equipped with foundation drains, which are located in natural draws within the heap leach pad area. This secondary drainage system, which is designed to provide drainage and pore pressure relief for groundwater generated by thawing permafrost, terminates in the events ponds and acts as a secondary leak detection and recovery system. Consequently, minimal contamination to the groundwater is expected since any seepage though the primary leak detection system and any seepage picked-up by the foundation drains will be directed to heap storage.

The events pond is also equipped with a double synthetic geomembrane liner separated by its own geonet leak detection and recovery system, independently equipped with a pump-back recovery system.

Any seepage which escapes the leak detection and recovery system and the foundation drainage system, if any, is expected to be extremely minor and will be restricted to the active layer above the underlying permafrost. If this water layer is active, or activated at a later date, it will migrate down gradient toward the events pond, the mine site sediment control pond and then to Williams Creek.

Knight Piésold Ltd. (amended design report, 1995) estimate that seepage rates through the outer liner from the heap leach pad will be in the order of 0.1 m^3/day when applying a contact coefficient of 0.21 for the liner moulding and 0.5 m^3/day when using an extremely conservative coefficient of 1.15. Even if these seepage rates could not be intercepted by the fountain drains, they would have little or no effect on regional groundwater quality and were found to be too small to project effects on Williams Creek water quality. Seepage through the liner and seepage collection systems would be minor, given that the active layer is relatively restricted and shallow. If localized groundwater was adversely affected, measures could be implemented to intercept this water within the draw down-gradient of the heap leach pad for pump-back or treatment, as required.

Waste rock storage facilities will not be lined, but analyses of the waste (acid-base accounting) indicates that waste rock is overwhelmingly acid consuming. The waste rock storage area will be equipped with a sediment pond and a foundation drainage system to collect waste rock dump seepage, both lined with 8 oz. non-woven geotextile. The waste rock dump will also be equipped with perimeter drainage ditches to intercept and collect surface runoff. The sediment pond will allow for the removal of suspended solids in the runoff before it enters the water storage pond.

Although effects to groundwater quality are projected to be negligible, a comprehensive groundwater monitoring program has been initiated and will be ongoing through construction and operation. Twelve groundwater piezometers have been installed in the vicinity of the heap leach pad and downslope of all facilities will be sampled to ensure a monitoring system that could detect potential losses from the site during operations.

Potentially adverse effects to ground water quality are considered to be low to moderate as duration is moderate (12-15 years), geographic extent is low to moderate, magnitude is low to moderate, reversibility is moderate to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low to moderate (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.4 Aquatic Resources

7.3.4.1 Fisheries

Williams Creek drains the Carmacks Copper project area and combines with flows from Nancy Lee Creek before flowing into the Yukon River. The Yukon River then flows north and west before discharging to Norton Sound on the west coast of Alaska. Fisheries studies including biophysical inventory, electrofishing, minnow traps, and spawning surveys were completed for three periods between August 1991 and August 1992.

Fisheries results indicate that fish inhabit the lower section of Williams Creek to the confluence with Nancy Lee Creek. Species in lower Williams Creek include juvenile Chinook salmon (*Oncorhynchus tshawytscha*), arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), longnose sucker (*Catostomus catostomus*), burbot (*Lota lota*), and northern pike (*Esox lucius*).

No fish were observed or captured in Williams Creek above the Nancy Lee Creek confluence. Spawning was not observed in the Yukon River near the Williams Creek confluence during the October 1991 survey and no spawning in Williams Creek has been observed by local residents.

Based on modelling, fisheries could potentially be affected by changes to metal concentrations, however baseline water quality data collected in lower Williams Creek naturally exceeds CCME guidelines for total aluminum, arsenic, copper, iron, and zinc. These metals may be slightly elevated during operations. Maximum recycle of waste rock runoff will take place during operations to avoid high metal loadings in the receiving environment. If heap discharge were required, wastewater would be treated prior to discharge to reduce metals. Downstream water quality will be monitored to determine if the projected metal levels occur and whether treatment or further mitigation measures are required.

Increased sediment loads caused by construction and erosion of fine particles disturbed by mine operations result in scouring attached algae from the stream substrate and a reduction in habitat for benthic macroinvertebrates, both resulting in a reduction in the fisheries food source. Increased sediment loads in the water column can also cause abrasion of fish gills. Fine particles abrade the gill surface reducing the capacity for gas exchange potentially resulting in suffocation and rendering the fish more susceptible to infection and gill parasites.

In order to minimize and mitigate this potential effect, strict construction guidelines will be adhered to and monitored. Construction guidelines will include the following items:

- ditch construction along roadways will incorporate settling ponds and baffles to reduce erosion and to settle out sediments;
- diversion ditches and settling ponds will be constructed around waste piles and leach pads;
- creek disturbance will be minimized by building engineered bridges or properly installing culverts and prohibition on fording;
- construction during heavy rainfall or snowfall events will be minimized; and
- construction will be minimized around streams during critical spawning periods in August and September for salmon and for May and June for grayling.

7.3.4.2 Benthic Macroinvertebrates

Benthic macroinvertebrates are an important component of the ecological network and are useful in assessing environmental effects from mining activity. They are efficient indicators of water and habitat quality in streams because the majority of their life cycle is intimately linked to the aquatic environment. Therefore, they reflect any disturbance to surrounding vegetation or changes in water quality. Juvenile and adult stages of important fisheries species, particularly salmon and other insectivorous species, depend on the availability of benthic macroinvertebrates as a food source.

Benthic macroinvertebrates may typically be adversely affected by in-stream construction, removal of overstorey cover, increased heavy metals, sediment and nutrient loadings, acid rock drainage or reduction or loss of flows. Increased sediment loads abrade the gill membranes of macroinvertebrates, scour algal growth from rock surfaces, which reduces the food source, and fill interstitial pore spaces of substrate, which reduces habitat availability. These have a direct effect on benthic organisms, their food resources and their habitat, respectively. Under extreme conditions, increased nutrients such as nitrates and phosphates (from blasting) may have a direct toxic effect or may result in excessive eutrophication, which reduces available habitat and oxygen. Moderate increases in nutrient levels causes community stress and increased algal growth which may, for example, result in a shift to a community dominated by herbivorous species. High concentrations of chemicals and heavy metals have the potential to be acutely toxic to benthic macroinvertebrates, or chronically toxic if they are bioaccumulated and interfere with normal physiology.

Effects to benthic communities in the Carmacks Copper Project area will be minimized by:

- maximizing the recycle of process water;
- maximizing the collection and settlement of runoff from disturbed areas to the greatest extent possible;
- minimizing instream construction;
- maintaining buffer zones of vegetation adjacent to streams;
- monitoring seepages from the waste rock dump, open pit and leach pad; and
- taking precautions during blasting to reduce nutrient losses to receiving waters.

Potential Effects

- Erosion of stream banks;
- Physical damage to fish habitat and spawning sites;
- Contamination of watercourses or groundwater; and
- Other aquatic issues – hydrogeological effects.

Mitigation

- Project components and operations will be located away from watercourses, except at Merrice and Williams Creek stream crossings;
- Construction minimized around streams during critical spawning periods (May-June for grayling);
- Bridge crossing (Merrice Creek) and culvert (Williams Creek) designed to protect watercourse and prevent erosion;
- Ditch construction along roadways will incorporate settling ponds and baffles to reduce erosion and settle out sediments;
- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- No recreational off-road use of wheeled vehicles will be allowed;

- Any material that accidentally falls into watercourses will be removed;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- Project footprint with buffer zone around riparian areas. Sediment ponds to control water releases;
- If the surface is disturbed in an area such as drainage channels where erosion is a possibility, control measures may include using earth breaks or cross ditches;
- Upper Williams Creek does not support fish. Project mine components and operations will be located at least 50 m away from watercourses;
- Clear span bridge located at Merrice Creek to minimize disturbance to riparian zones;
- Hazardous materials stored with secondary containment away from watercourse in controlled areas;
- Spill Contingency and Emergency Response Plan in place to prevent materials from accidentally entering watercourses;
- Heap leach pad and events pond constructed with composite liner and LDRS system to prevent solution migration to surface and groundwater. Sediment pond located downstream from events pond. Facilities located greater than 50 m from any watercourse;
- Water for mining and processing will be collected from deep wells in the Williams Creek drainage basin and numerous sediment ponds. No direct surface water use;
- Recycling of water from ancillary facilities and sediment ponds to minimize groundwater well use;
- At closure, controlled release of heap leach pad solutions to prevent direct hydrological effects to local drainage;
- Environmental monitoring program with stations on Williams Creek to monitor stream hydrology and water quality. Perform required MMER EMM program;
- No direct discharge of process solutions or wastewater to surface waters during operations. Recycling of process solutions and wastewater for other water uses;
- Sediment pond located below heap leach pad, waste rock area, and ancillary facilities to prevent sediment release and treat surface water if necessary;
- Heap leach pad and events pond design to withstand combinations of critical events – operating solution volume, plus excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus, an allowance for heap draindown as follows:
    - During the first year of operation, 100% of the total potential heap draindown volume;
    - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m^3/hr this volume is 26, 000 m^3; and
    - Redundant systems (i.e. pumps, power, spare parts) to prevent direct release of process solutions;
- Heap leach pad and events pond LDRS will be monitored and sampled regularly;
- Contingency water treatment plant constructed on site using known technology to treat process solutions, if required;
- Sediment ponds will be monitored and sampled regularly to ensure wastewater quality;

- Liquid hydrocarbons, acids, and other chemicals will be stored in appropriate containers during transportation. No fuels or chemicals will be stored within 100 m of a watercourse;
- Main fuel, acid, and chemical storage facilities located at the plant site. Storage tanks with secondary containment. Segregation and controlled storage of plant chemicals. All hazardous materials located within controlled facility and routinely inspected and monitored as part of EMS;
- A Spill Contingency Plan, as part of the EMS;
- In the event of a spill, the Spill Contingency Plan will be implemented. Spills will be immediately reported to the Spill Report Line;
- Any deleterious material that accidentally falls into a watercourse will be removed. A spill response plan will be implemented;
- Segregation of camp and ancillary facility wastewaters and treatment using in ground disposal and tile/absorption fields;
- At closure, covering, rinsing, and detoxification of the heap leach pad and treating solutions in a controlled manner to prevent effects to Williams Creek. Long-term heap solutions directed to infiltration gallery to provide final solution polishing and prevent direct release to Williams Creek;
- Progressive cleanup and remediation will be completed where possible;
- Construction during heavy rainfall or snowfall events will be minimized;
- All waste materials containing fuels, chemicals, and special waste will be properly stored and removed from the area;
- A revegetation program using indigenous flora will be implemented for disturbed sites (access/haul roads, ancillary facilities, waste rock area, and heap leach pad) where native vegetation has been removed or destroyed, to prevent degradation of stream water quality;
- Water will be collected in the pit and pumped to the process plant as make-up water. Resulting flow conditions in Williams Creek will not be significantly altered. Expected that the pit will take >300 years to fill;
- Runoff that enters the WRSA will be minimal and will flow in the near surface groundwater at the base of the pile for collection in the toe drains and ultimately into the sediment control pond for use as make-up water;
- Near-surface groundwater flows could be partially diverted in the heap leach pad area; however, the effect is not expected to be significant, as the leach pad area has been cleared to allow permafrost to thaw; and
- Water recycling and use of events and sediment ponds for make-up water.

Potentially adverse effects to fisheries are considered to be low as duration ranges from low to moderate (10 – 15 years), geographic extent is low/moderate, magnitude ranges from very low to low, reversibility is very high, ecological sensitivity is moderate, economic and social context is low, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

Potentially adverse effects to benthic invertebrates and periphyton are considered to be low to moderate significance as duration is low (5 – 10 years), geographic extent is low, magnitude is low, reversibility is high, ecological sensitivity is moderate, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.5 Wildlife

7.3.5.1 Species Concerns

No significant effects to wildlife are foreseen. This interpretation is based on information obtained in the wildlife surveys to date, whereby a basic knowledge of the broad patterns of distribution and seasonal movement of key species is presented. From 1991 and 1992 surveys and wildlife logs, very little ungulate, furbearer, or other mammal activity was noted. Historically, caribou herd migration extended into this area, however, this does not presently occur and no ungulates appear to have filled this abandoned niche (Little Salmon Carmacks First Nation, Carmacks Renewable Resources Council, 2004). A field survey conducted in July 1994 indicated that the steep sloping south scarps may provide habitat for mule deer, but this area will not be affected. Waterfowl were not observed, likely due to the absence of productive wetland habitat. Although raptor nests were observed on cliffs near the Yukon River, only the American kestrel was sighted. Key summer nesting habitat is recognized to occur northeast of the project in the Nancy Lee and Hoochekoo creeks watersheds. However, these creeks will not be affected, as the project site is located nearly 9 km away.

One possible explanation for the apparent limited wildlife use of the area is a cyclic low in the different species cycles, analogous to the lynx and hare 10-year population low, which occurred in 1991 according to territorial government information.

Effects to wildlife habitat are discussed in the following generalized categories which are typically recognized for similar construction projects in remote and undeveloped regions.

7.3.5.2 Direct Habitat Effects

Open pit development will result in permanent loss of approximately 29.5 ha of low capability conifer dominant upland habitat. The heap leach pad, process plant and camp facilities will result in a temporary loss of around 41 ha of moderate habitat capability land, which is aspen dominant uplands. Waste rock storage will cover approximately 69.6 ha of moderate capability conifer dominant wetlands. Aspen dominant uplands have moderate potential for moose, snowshoe hare, black bears, and ruffed grouse. Conifer dominant uplands have high potential for red squirrel and spruce grouse, low to moderate potential for hare and its predators, and very low moose habitat potential.

Access roads (12.3 ha) will transect similar habitat to the mine facilities including low capability conifer dominant uplands and moderate capability conifer dominant wetlands.

7.3.5.3 Indirect Habitat Effects

Habitat loss also occurs where some form of disturbance prevents a species from using an area or reduces the frequency of use, even though no physical loss of habitat occurs. This may involve avoidance by animals to normal feeding activities in the vicinity of a road or through blocking access to traditional habitats used seasonally. This also includes avoidance by species due to machine noise and operational activity.

It is difficult to predict or estimate the actual area of wildlife habitat lost by avoidance behaviour. McLellan and Shackleton (1988) provide the best comparative data for grizzly bears, in which a seven year study in southeastern B.C. showed most bears used habitats within 100 m of roads less frequently than expected. Avoidance of roads was independent of traffic volume, which suggested that even limited vehicle use can displace bears.

It is expected that there will be some effect on wildlife from mine construction and operation. Some degree of habituation is expected with ungulates as noted at many mining projects. Since the project does not cut through any major migration routes and from field surveys does not lie in critical habitat, the project is expected to cause minimal indirect habitat loss for caribou.

Some disturbance to wolf, black bear and grizzly bear is expected due to mine operations, however, due to the relatively low abundance of these species in the mine site area, little indirect effect is expected.

To prevent injury to wildlife the company proposes to encompass the heap leach pad, events pond, and process area with fencing to prevent entrance into these areas.

Despite what appears to be an area of good wildlife habitat the project area is currently underutilized (HKP, 1994).

Bears

The following text has been included from the "Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009." Talks in the community about bear species and their behaviour may help to minimize conflicts between bears and people. The company will have an employee bear awareness program. A YG Conservation Officer will work with the Carmacks Renewable Resources Council and LSCFN to identify appropriate times and places to hold these talks.

The "Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009" identified a need to protect the Yukon River from Tatchun Creek to Minto as important habitat for moose, salmon, and other wildlife. The proposed solution to this concern is to pursue designating this area along the Yukon River as a Habitat Protection Area under the Wildlife Act. The Fish and Wildlife Management Plan states that the community and governments need to get together to decide what kind of activities should happen in this important wildlife habitat.

Potential Effects

- Disturbance to wildlife from direct habitat loss;
- Disturbance of wildlife migration or blockage of wildlife movement corridors;
- Project components may create fragmentation and alter wildlife movements;
- Attraction of nuisance animals;
- Encroachment on endangered species or important wildlife habitats; and
- Roads could allow for increased access for wildlife harvesting or direct mortalities.

Mitigation

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- All project activities will be maintained to the project area;
- No hunting, trapping or fishing will be allowed on the project. A "no firearms" policy will be enforced (banned except as authorized for protection of employee's safety while in the field). Employees will be instructed regarding the project's "no wildlife harassment" policy, which will encompass, no wildlife feeding, employee wildlife education, and wildlife avoidance;
- Environmental personnel on site to monitor project activities and modify operations to address wildlife concerns;
- Wildlife surveys of the area indicated no sensitive habitats or unique wildlife habitat features. Avoidance of sensitive habitats, such as denning or nesting sites, if encountered during operations;
- Routine garbage patrols will be undertaken to remove materials, (e.g., metals, plastics, grease) which may be potentially harmful to wildlife;
- No recreational off-road use of wheeled vehicles will be allowed;
- All encounters with wildlife, and/or mortalities, will be reported to a YG Conservation Officer;
- Avoidance and buffer zones between stream riparian areas and facilities to minimize wildlife disturbances and protect wildlife corridors;
- Personnel movement will be restricted to the project area and access routes;
- Project footprint localized and buffer zone between riparian area and corridors. Wildlife movements will not be restricted;
- No unnecessary disturbance to local surroundings;
- Surface disturbance will be re-sloped, covered with soil or revegetated as appropriate;
- Natural revegetation will be encouraged as part of the revegetation plan;
- Snow banks on access roads will be plowed back, with breaks in the bank to ensure adequate road wildlife sighting and escape;
- Garbage and debris will be collected routinely for disposal, or stored in wildlife proof containers for disposal at approved facilities;
- Use of incinerator for camp facilities;
- Project avoids key habitat areas (raptors, moose) along Yukon River;
- Very few waterbodies exist within the project area. However, no disturbance within 50 m of a watercourse will occur;
- Restrict direct access to mine site and project area by using a gate during operations to prevent opportunities for increased hunter access;
- Provide and encourage project bussing and transportation to mine site to minimize hunting opportunities and direct road mortalities;
- Post speed limits and signage at wildlife crossings to minimize direct road mortalities; and
- Fencing of heap leach pad area to minimize direct mortalities.

Potentially adverse effects to wildlife are considered to be low to moderate significance as duration ranges from low to moderate (10 – 20 years), geographic extent is localized, magnitude ranges from low to moderate, reversibility is moderate to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.6 Vegetation

The amount of existing and proposed clearing will total approximately 152.17 ha as follows:

- the ultimate open pit mine configuration will encompass approximately 29.5 ha on an area presently dominated by lodgepole pine, white and black spruce, and aspen;
- waste rock storage to the north of the open pit adjacent to North Williams Creek will require that approximately 69.6 ha of land be cleared of predominantly lodgepole pine, aspen and black spruce;
- construction and operation camp facilities, maintenance shop, warehouse, process plant, and ore conveyors are dominated by lodgepole pine, aspen and black spruce. Approximately 3.57 ha of land will need to be cleared for these facilities;
- the leach pad facilities, sediment control pond and events pond will encompass approximately 37.2 ha of land dominated by aspen, lodgepole pine and grasses; and
- main access road will encompass approximately 12.3 ha;

Removal of vegetation will result in the loss of wildlife habitat and, if acceptable procedures are not employed, may also result in spread of forest infestation, increased fire hazard, increased runoff and increased erosion.

No unique or endangered vegetation is known to occur in the mine site area. Most of the leach pad area was cleared in 1997; however, a certain amount of regrowth will have taken place. The amount of merchantable timber removed for site preparation at the time was extremely low, as climate and elevation near the mine site limit forest productivity. Clearing and recovering merchantable timber from approximately 152.17 ha was contracted out, and if further clearing is required during construction this also will be contracted out. Efforts will be made to stockpile suitable logs for various requirements such as temporary bridges, retaining walls and guard rails. Slash will be burned or buried as necessary, or stockpiled for used as cord wood for the local community.

Effects will be minimized by incorporating engineered standards of construction where clearing and earthworks are required; the size of such areas will be kept to a minimum and vegetated buffer strips will remain adjacent to streams. Reclamation and revegetation of existing disturbed areas such as the exploration camp, old drill pads, and road side margins will be initiated immediately after construction, wherever feasible, and monitored to determine if additional seeding and fertilizing are required.

<u>Potential Effects</u>

- Loss of vegetation communities;
- Loss of timber;
- Fire hazards; and

- Potential disturbance to rare, sensitive or unique plant species or vegetation communities.

Mitigation

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- No unnecessary disturbance to ground (EMS);
- No recreational off-road use of wheeled vehicles will be allowed;
- Access road width will be restricted to 8 m. Clearing for new access and facilities will be kept to the minimal amount required;
- Hand cutting will be employed near access road stream crossings to reduce disturbance to riparian areas;
- Windrows will not be created so that wildlife movements are not restricted, and fire hazards are minimized;
- Recontour and re-sloping of disturbed areas and progressive reclamation;
- Surface disturbance will be re-sloped, covered with soil or revegetated as appropriate;
- Routine monitoring and maintenance in accordance with EMS to prevent disturbances;
- In areas with denser woodlands (access/haul roads, ancillary facilities, heap leach pad), clearing will be kept to the minimal amount required;
- Surface disturbance will be re-sloped, covered with soil or revegetated as appropriate to promote natural revegetation;
- Fire safety measures and responses, as provided in the EMS will be adhered to;
- Fire protection and distribution systems and equipment will be located at the project area;
- Trained personnel for fire response as part of EMS;
- Redundant systems for key operations (heap leach pad, ancillary facilities) as part of fire contingency plans;
- If fire hazards exist in the area during operations, procedures will be implemented to avoid fire hazard areas and prevent inadvertent fires;
- Vegetation survey indicates that no rare or sensitive plant species are located in the project area; however, surface disturbances will be kept to a minimum; and
- A revegetation program using indigenous flora will be implemented for disturbed sites where native vegetation has been removed or destroyed. Natural revegetation of disturbed areas will be promoted as part of revegetation plans.

Potentially adverse effects to vegetation are considered to be low to moderate as duration ranges from moderate to high (20 – 30 years / permanent), geographic extent is localized, magnitude is low to moderate, reversibility is low (open pit) to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.7 Heritage Resources

Two sites were identified by Antiquus Archaeological Consultants in August 1992 in the EA study area. One site consists of an old mine adit on upper Williams Creek and is associated with a log cabin and remains from mining activity from the 1930s or 1940s which is located approximately 400 m away. An old horse trail leads from this cabin to a cabin on the banks of the Yukon River which was probably used as an ore transfer station for river transport. More details on these sites and study may be found in the report entitled “An Archaeological Impact Assessment for the Proposed Carmacks Copper Project, Williams Creek Valley, Near Carmacks, Yukon Territory” prepared by Antiquus Archaeological Consultants in 1992 (IEE, Volume 3).

It was determined that no archaeological effects are expected from development of the open pit, heap leach pad, or waste rock facility. Additionally, if access roads into these areas are required they will avoid land-altering activity at these sites. If it is necessary to disturb these sites then a systematic data recovery program will be carried out by a qualified archaeologist (Antiquus Archaeological Consultants, 1992).

As the project footprint is not expected to affect the lower Williams Creek, Yukon River Valley, these sites will not be disturbed.

There are three locations near the proposed mine access road considered to have medium heritage site potential. One large medium heritage site potential area is located on both sides of Crossing Creek between the bridge over the creek on the existing Freegold Road and the turnoff to the mine access road. The remains of prehistoric or historic camps may be located in this area. The other two medium heritage site potential areas are located where the mine access road crosses Merrice and Williams Creeks.

Antiquus Archaeological Consultants recommends that areas identified as having medium heritage site potential be subjected to further study prior to the initiation of any land-altering activities.

<u>Potential Effects</u>

- Loss, damage, or alteration of heritage sites or sites of archaeological/historical interest or cultural artifacts.

<u>Mitigation</u>

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- A heritage site survey was completed. Known sites located off the project area (Yukon River) will be avoided. Medium potential sites will be investigated prior to construction;
- Should any archaeological or palaeontological sites be discovered during construction or operations, work will be suspended at that location until permission is sought and granted to continue operations; and
- In the event previously unknown heritage resources are discovered during mining operations, staff of the YG Heritage Branch and LSCFN will be notified and consulted for advice on mitigation.

Potentially adverse effects to heritage resources are considered to be low as duration is moderate, geographic extent is localized, magnitude is low, reversibility is high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.8 Current and Cultural Land Uses

Current land use in the project area has been documented and consultations undertaken with the LSCFN to document cultural land use in the area.

Potential Effects

- Loss or damage or alienation of traditional uses or pursuits by First Nations;
- Loss or damage to existing cabins/structures along the roads;
- Conflicts with wildlife harvesting;
- Conflicts with trap line operations; and
- Impairment of visual aesthetics by mining operations.

Mitigation

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- Previous vegetation, wildlife, fisheries, and traditional uses surveys and studies were conducted to identify local areas of interest. The area is generally used for traditional hunting and gathering, however, no known unique areas identified;
- Local trapper uses area for trapping and traditional life style. Identification of trapping trails and relocation, re-establishment of trapper trails if required. Compensation for loss of income during active mining operations, if required;
- No specific cabin/structures have been identified. Appropriate site-specific mitigation measures will be discussed with any identified cabin/structure owners in the project area;
- Public consultation with all local communities has been undertaken to notify communities of operations and timing;
- Posting of warning signs on roads and mine site areas;
- Identification of trapping trails and relocation, re-establishment of trapper trails if required;
- Notification will alert trappers and land users to operations and timing;
- Work with local trappers to ensure effects to trapline are minimized;
- Identify work or hazardous areas with signage;
- Project area will not be visible from public roads;
- Equipment and infrastructure will be removed at end of program. Garbage will be regularly collected and removed from site;
- A reclamation and revegetation plan will be finalized for the project. Revegetation using indigenous flora for access and haul roads, ancillary facilities, heap leach pad, and waste rock area where native vegetation has been removed or destroyed. Natural revegetation of the roads, leach pad, waste rock area will be promoted; and
- All equipment and refuse will be removed or buried by the end of the project.

Potentially adverse effects to current and cultural land uses are considered to be moderate as duration is moderate (15 years), geographic extent is moderate, magnitude is moderate, reversibility is high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.9 Socioeconomic Effects

The following sections include the socioeconomic impact assessment, which has been included from the IEE Volume II (January, 1994) prepared by HKP. Please refer to this document for further details and information.

As a relatively large, well established community, and a contemporary regional centre for the Yukon, Whitehorse, located approximately 250 km to the southeast of the Carmacks Copper area, has sufficient infrastructure to absorb any effects that are expected to arise from the proposed mining development. Carmacks, located approximately 38 km southwest of the project area is significantly smaller, and consequently the effects would be proportionally greater.

Previously, the mining industry provided a major economic base for the communities of Whitehorse, Faro and Watson Lake. With recent industry closures the remaining mining operation in Yukon are limited to placer mining, which seasonally employs approximately 700 people and provides the Yukon Territory with $25 million annually (Yukon Chamber of Mines, 1993). Comparably, hardrock mining produced $214 million of revenue in 1990. The mining industry provides a significant contribution to both the regional economy and the well-being of these communities. The economic benefits of the Carmacks Copper Project would include export earnings, direct and indirect/induced employment, contracting opportunities and revenue to municipal, territorial and federal governments.

7.3.9.1 Employment and Labour Force

During the first year of mining, operations are expected to require approximately 90 people. An average of 109 individuals would be employed at the mine each year, with 130 the maximum.

Indirect jobs will result from expenditures on goods and services such as transportation, explosives, drilling and camp services. Induced jobs (those created by a demand for goods and services by direct and indirect employment of the mine) will encompass a broad spectrum of modern economic necessities, ranging from government services to consumer goods. The B.C Mining Association (Annual Report, 1991) estimates that each direct job in mining results in one additional job within the territory (or province) and another job within Canada. Based on this assessment, 136 mining jobs associated with the Carmacks Copper Project will produce an additional 272 indirect/induced jobs within the country, 136 of those in the Yukon. This figure does not include employment created as a result of exploration and construction. The total potential direct, indirect and induced employment created by the Carmacks Copper Project will be approximately 408 jobs.

Current unemployment rates for Whitehorse and Carmacks indicate that there is a surplus of people seeking employment. Due to the recent mining industry closures in the Yukon and northern B.C., approximately 800 people with some mining related training and experience are available for employment. In addition, several transport companies involved with the transport of ore and mining supplies have reduced their employment roles. Combined, as many as 1,000 people associated with the mining industry are currently unemployed. Thus, the required compliment of staff for the Carmacks Copper Project could be filled entirely from within the Yukon labour force.

Whitehorse and Carmacks are expected to be the primary sources of skilled workers for the Carmacks Copper Project. Some of these individuals, notably contractors, are expected to relocate in or near Whitehorse and find employment in other industry sectors. When the Carmacks Copper Project begins construction and, subsequent mine production, it is probable that some individuals will wish to leave their jobs in other industries to seek employment at the mine. At that time an equivalent number of replacement employees will have to be recruited from current unemployment roles or elsewhere from within the Yukon to fill the vacancies created. Many of these individuals may be recruited from current unemployment roles, with skill upgrading. Training and capacity building will be required if local individuals wish to seek active employment in a skilled setting.

<u>Predicted Effects</u>

- Economic effects;
- Lack of skilled labour force; and
- Training and capacity building.

<u>Mitigation</u>

- Public consultations will allow people to voice economic concerns about the program;
- Economic concerns have been discussed during public consultations;
- Benefits Agreement will be negotiated with LSCFN;
- When possible, local individuals and companies will be preferentially hired for the project;
- Identification of workforce training requirement and training implementation; and
- Local capacity building as part of Benefits Agreement.

7.3.9.2 Population

Assuming that 48% (133) of the direct and indirect jobs created by the Carmacks Copper Project will be filled by residents of Whitehorse and Carmacks, 52% (139 jobs) are expected to be filled by workers recruited from other Yukon communities. Since it is expected that the entire workforce cannot be filled by residents of the Yukon, the effect of the Carmacks Copper Project on the total population of the Yukon is expected to be minor. However, it is expected that because a vast majority of the work force required for the project will reside in Whitehorse, Carmacks or other local communities, effects to these communities, particularly Carmacks, will be greater.

<u>Carmacks</u>

Of the 136 direct jobs created by the Carmacks Copper Project approximately 60% (82 jobs) of those are expected to be filled by people residing in or moving to Carmacks. Based on current data it is assumed for this analysis that 100% of the unemployed residents (18) and approximately 40% of those individuals receiving social assistance (20) could be employed by this project. The remaining 44 jobs would be filled by people moving into Carmacks in response to job opportunities.

For the purposes of this analysis it is assumed that of the 44 people moving into Carmacks in response to direct jobs opportunities created by the Carmacks Copper Project, 20% of the jobs (9) will be filled by singles and the remaining 80% of the jobs (35) will be filled by people with families. It is assumed that a family comprises on average 3.7 persons and that approximately 80% of the families will have one-wage earner and the remainder will have two-wage earners. On this basis, the number of people moving to Carmacks in response to the Carmacks Copper Project will be: 9 singles, 27 single-income families and 4 double-income families, resulting in a population growth of 124 people. Of the total estimated population increase 53 will be children; 15 of pre-school age and 38 from grades one to twelve.

<u>Whitehorse</u>

It is expected that the remaining 54 direct jobs and all 136 indirect jobs created within the territory would be filled by Whitehorse residents as the city is the main industrial service centre for the area. For this analysis, it is assumed that 50% of the direct/indirect jobs (95) taken by people living in Whitehorse will be filled by individuals currently residing in the city and the remainder (95) will be filled by people moving into the city.

For the purposes of this analysis it is assumed that of the people moving into Whitehorse in response to job opportunities created by the Carmacks Copper Project (both direct and indirect), 20% of the jobs (19) will be filled by singles and the remaining 80% of the jobs (76) will be filled by people with families. On the basis of normal distribution approximately 30% of the families will have one wage earner and the remainder will have two wage earners. On this basis, the number of people moving to Whitehorse in response to the Carmacks Copper Project would be: 19 singles, 22 one-income families and 27 two-income families, resulting in a population growth of 200 people distributed throughout the municipality. Of the total estimated population increase 83 will be children; 23 pre-school age and 60 from grades one to twelve.

7.3.9.3 Housing and Real Estate

It is anticipated that after production begins the existing 100 person construction camp at the Carmacks Copper Project will be reduced to a small camp (20 persons) for key operational positions or rotating shift workers. Individuals employed by the mine will likely reside in Whitehorse or Carmacks and will be transported by bus from Carmacks to the mine site.

<u>Carmacks</u>

Based on current data there is presently a zero vacancy rate in Carmacks. Based on the calculated increase in population of a maximum of 124 people; 9 singles, 27 one-income families and 4 two-income families, up to 40 dwellings would be required to house the influx of people into Carmacks. The population growth within Carmacks will be gradual and will increase in response to the labour requirements at the mine. Thus, the construction of the required houses can occur over several years. Although the establishment of a trailer park in the vicinity would allow for the immediate provision of needed housing, pressures on housing and real estate prices is expected to be pronounced if not acute during the initial years of operation.

Impacts on housing in Whitehorse is expected to be minimal (HKP, 1994).

7.3.9.4 Community Infrastructure and Services

Apart from the impact on housing and associated services such as public works (i.e. sewage treatment, water supply, solid waste disposal) the main impacts on the municipality of Carmacks due to an increase in the population will be social services.

<u>Carmacks</u>

A projected increase of 124 people in the Village of Carmacks will result in a population increase of 21.6%. Accordingly, fire protection, school facilities, health and welfare services will require adjustments to accommodate this increase.

An influx of 38 students into the Tantalus School would result in a 28.8% increase in school enrolment. If the existing student teacher ratio of 8.5:1 is to be maintained, a further five teachers must be employed. If no additional teaching staff is hired the student/teacher ratio would become 12:1.

Similarly, the increase in population will result in the need for further law enforcement. Carmacks residents and LSCFN members are concerned that an increase in alcohol consumption in the community and a misuse of wages on both alcohol and drugs may occur. Many individuals have expressed a concern that the crime rate would increase when workers leave camp and return to Carmacks for leisure activities. More cash, more young in-migrants and increase use of drugs and alcohol may all lead to an increase in crime. The enlargement of the existing RCMP station to accommodate 20 personnel is opportune.

The existing health services in the Village of Carmacks would require enlargement. The health centre would accommodate the increased population by hiring an on-site doctor and a full-time receptionist.

Replacement of the existing wastewater treatment plant and disposal facility is currently in the works. It is expected that by December 2006 the new facility will be operational.

<u>Whitehorse</u>

The project influx of 200 people into Whitehorse will result in a 0.9% increase in the city's total population. Police and fire protection, school facilities, municipal, health and welfare services will likely not be affected by this increase. Whitehorse is a well established, planned community, and as such, will have an adequate degree of infrastructure to absorb the potential impacts associated with this small increase in population.

7.3.9.5 Social Effects

The Carmacks Copper Project will undoubtedly have an impact upon the LSCFN way of life. Some of the changes will include the acquisition of new skills, establishing new careers and achieving personal success through opportunities associated with the mine. From the acquisition of new skills and experience will come access to career opportunities at other mines and industries in the Yukon Territory and throughout Canada. In order to ensure that the benefits of the Carmacks Copper Project are experienced by the community of Carmacks and the LSCFN, Western Silver is committed to the following course of action:

- provide opportunities for employment and capacity building at the mine to members of the First Nation and Village of Carmacks;
- provide members of the First Nation with opportunities for supplying services to the project on contract, both during construction and during operations;
- work closely with the First Nation community to help individuals prepare themselves by training, including apprenticeships, to qualify for employment at the mine;
- continue to build a strong business relationship with the LSCFN throughout the life of the Carmacks Copper project; and
- develop a benefits agreement with the LSCFN.

Certain other changes will be difficult to document but should be recognised as potential stress on the community. Several social problems such as chemical dependency and violent crimes exist in the community and the proposed development may aggravate them. The Village of Carmacks and the LSCFN members acknowledge that these problems exist in their community. The young people, particularly males, seem to be at the highest risk. In recent years there has been an increasing demand for counselling through the National Native Alcohol and Drug Addictions Program. This trend is expected to continue which will result in the need for additional counselling personnel.

Also, there may be a disruption of family life, as one or both parents will be away from home for at least twelve hours a day, four days a week. This will result in a need for daycare services in the community. Some of the approaches which might be taken to deal with the afore mention social problems are to:

- Facilitate the appropriate daycare services;
- Organize financial management workshops;
- Review and amend all chemical dependency programs to reflect the changing demands of the community;
- Promote community development through such resources as a youth drop-in centre, crisis lines and family life improvement programs;
- Support parenting classes and workshops for single parents; and
- Support community athletic programs.

Other possible mitigative measures include: encouragement of seminars in time, money and stress management, cultural awareness workshops, and the promotion of scholarship programs to serve as incentives for students interested in pursuing post-secondary education."

Refer to the IEE, Volume II "Community Profiles and Socioeconomic Impact Assessment" prepared by HKP in 1994 for information on revenue and expenses, direct and indirect income, procurement of goods and services, and tax revenues.

Predicted Effects

- Social effects;
- Increased demand for local housing;
- Increased pressure on local community infrastructure;
- Increased requirement for social services and assistance programs; and
- Increased requirement for training and skills upgrading.

Mitigation

- Public consultations will allow people to voice social concerns about the project.
- Economic Benefits Agreement will be negotiated with LSCFN;
- When possible, local individuals and companies will be preferentially hired for the project;
- Consumption of alcohol and ‘recreational’ drugs will not be allowed on site. Employees will be required to undergo drug testing;
- Occupational health and safety standards will be enforced for all personnel on the site;
- Traditional land use activities (excluding hunting) will be permitted when they do not compromise site safety;
- Employee transport from workplace to mine site;
- Western Silver will work with YG, Village of Carmacks, and LSCFN to ensure that measures are undertaken to ensure that local infrastructure and accommodations are planned, and social programs (health, education) are augmented;
- Western Silver will work with YG to ensure that the Freegold road is maintained and community bypass constructed to coincide with project development;
- Western Silver will participate in local meetings and information sessions, and take other appropriate steps to promote consultation and communication with the community. The company will actively consult in an ongoing manner with communities, individuals, groups, and stakeholders, so that local people are kept informed regarding project activities; and
- Western Silver will ensure that subcontractors agree to the company’s commitments and policies for employment of northern residents.

Potentially adverse socioeconomic effects are considered to be moderate as duration is moderate (10+ years), geographic extent is low, magnitude is moderate, reversibility is moderate, economic and social context is moderate, and risk characterization is low to moderate (Table 7-2). The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.3.10 Effects of the Environment on the Project

Potential Effects

- Extreme climatic conditions can cause process upsets;
- Unusually cold weather; and
- Reduced visibility due to winter storms and blowing snow can restrict access to or from the site.

Mitigation

- Heap leach pad, events pond, and facilities designed to retain and store excess precipitation events and 100 year snow melts. Redundant systems in place to ensure solution pumping and power systems operational during extreme events;
- Onsite fuel storage and back up power generators to ensure pumping and process systems operational;
- Spare parts and equipment to ensure equipment failures are replaced and repaired and ensure continued solution processing;
- Sediment ponds and other water management structures designed for extreme events (10 yr return period 24 hr duration storm);
- Trained personnel onsite to maintain redundant systems during emergency situations;
- Monitoring of heap leach pad solutions inventory and climatic conditions to forecast solution storage requirements;
- Contingency water treatment system in place if controlled release necessary;
- Heap leaching proven technology in winter conditions. Sulphuric acid heap leach an exothermic reaction and produces heat. Redundant systems in place as contingency measures;
- Facilities and equipment design has been previously proven and personnel are trained to work under Arctic conditions;
- Government of Yukon is expected to maintain the Freegold Road year-round;
- Snow clearing equipment will be available on site to maintain mine access road;
- Radio telephone or satellite phones will be on site to ensure communication links;
- Trained first aid staff will be on site at all times during operations; and
- Scheduled changes and alternative delivery methods (aircraft) will be implemented in case environmental changes affect usability of the winter access.

Potentially adverse effects of the environment on the project are considered to be low to moderate based on implementation of mitigation measures. The summary table in Appendix K presents a significance assessment and associated mitigation measures for each potential environmental effect.

7.4 ENVIRONMENTAL HEALTH AND SAFETY AND ACCIDENTS AND MALFUNCTIONS

A Spill Contingencies and Emergency Response Plan provided in Appendix L outlines response protocols for spills of potentially hazardous substances that may be used during the construction and operation of the Carmacks Copper Mine. The purpose of this plan is to minimize effects of environmental disturbances and the resultant hazard to people, aquatic systems, and wildlife. The plan is consistent with Western Silver Policy on Health and Safety and Environment (Appendix B).

The area covered by this plan includes not only the mine site operations area but also the operation of the access road. Special mitigative measures for the mine site area including containment structures, response equipment, and the presence of trained spills-response personnel will be instituted to minimize the possibility of contamination of watersheds adjacent to these facilities.

The potential for accidents and malfunctions was also considered in detail as part of the risk assessment for the project. The details of the risk assessment are presented in

Section 7.6 and consider the effects of various failure modes by project component. The potential for accidents or equipment failures or malfunctions was assessed and mitigation measures identified to address these potential failure mechanisms.

Once construction details and personnel are determined, a comprehensive Spill Response Contingency Plan will be updated for submission to regulatory agencies.

Potential Effects

- Accidents and malfunctions;
- See risk assessment for various failure modes, hazards, exposure pathways and consequences.

Mitigation

- Training will be provided to all staff on general safety and safe vehicle operations;
- Supervisors and emergency personnel on site at all times to address accidents/malfunctions;
- Safety meetings will be held for all staff at the beginning of each work assignment period;
- Medical equipment and trained personnel will be on site 24 hours a day during operations;
- Occupational health and safety standards will be enforced for all personnel on the site;
- Consumption of alcohol and 'recreational' drugs will not be allowed on site. Employees will be required to undergo drug testing;
- Emergency Response Plan will be implemented as necessary;
- Employees will be eligible for Workers Compensation;
- Transportation crews will be instructed on traffic safety. Traffic will be controlled on mine access road. Communication and notification of hazardous materials transport to the site;
- Vehicles will be equipped for winter travel and will carry emergency first aid kits;
- Posting of warning signs on the highways and access road;
- Freegold Road bypass directs traffic away from Village of Carmacks residential areas to minimize traffic accidents;
- Project engineering designs with appropriate factors of safety, containment systems, and redundant systems to minimize accidents and malfunctions; and
- Monitoring and maintenance programs to ensure facility and worker safety and equipment integrity.

Refer to the Risk Assessment in Section 7.6 for further discussion of the possible malfunctions or accidents associated with the project activities.

7.5 CUMULATIVE ENVIRONMENTAL EFFECTS

Cumulative effects refer to those effects on the environment that result from effects of a project when combined with those of other past, existing, and imminent projects and activities. To address cumulative effects, a project's activities must be considered in context to actual or potential impacts on the environment from other sources.

The approximate spatial boundaries for assessing cumulative effects are the same as the boundaries proposed for the EA study area, which are based on the potential geographic extent of effect. The geographic boundary for the project site has been identified as the Williams Creek watershed and the area encompassing all mine infrastructure including the access road and waterways in the downstream flow path from the mine (Figure 2-2, Section 2.3). The assessment of cumulative socioeconomic and economic effects is presented in a regional context, including the Village of Carmacks and the Yukon Territory as a whole.

With the area for the cumulative effects study defined, the next stages of the assessment were to conduct the following:

- To revisit the identified VECC's and identify environmental effects from the project's activities on these components;
- Identify other likely projects or activities that would occur in the study area during the operation of the Carmacks Copper project, and assess linkages and cumulative effects from other potential projects or activities with project related effects;
- Consider mitigation measures and evaluate significance of cumulative effects; and
- Summarize finding of cumulative effects assessment.

Table 7-3 in Section 7.2 provides a listing of VECC's and rationale for their selection. To summarize, the VECC's for the project include:

- air quality;
- surface water quality;
- groundwater quality;
- permafrost;
- fisheries resources – lower Williams Creek and Yukon River: juvenile chinook salmon, arctic grayling;
- wildlife resources: moose, furbearers;
- traditional use – trapping;
- heritage resources;
- social;
- economic; and
- human health and safety.

7.5.1 VECC Project Interactions

With the VECC's identified, the potential interactions between the project disturbances or activities and the VECC were then assessed. Interactions within the spatial boundaries of the study area as well as regionally were also considered. Table 7-8 provides a summary of the possible types of project environmental effects, the VECC's effected, and an assessment of mitigative measures designed to address potential effects. As noted in Table 7-8, all project effects are mitigable.

Table 7-8 Identification of Local Effects on VECC's and their Mitigation

Possible Types of Project Effects	VECCs Affected	Effects Mitigable ?		Mitigation Description
		Y	N	
Environmental				
Altered air quality	air quality, wildlife, human health and safety	X		dust control procedures, air emissions control devices (baghouse dust collectors, ventilation system, scrubbers), monitoring and maintenance
Altered surface water quality	surface water quality, fish, wildlife, traditional use	X		no release of effluent to the receiving environment during operations, contingency treatment plant, minimize instream construction, buffer zones, sediment control ponds, monitoring (EPP) and maintenance
Altered groundwater quality	groundwater quality, fish, wildlife, traditional use	X		maximizing recycle of process streams, double composite liner, LDRS, sediment control ponds, containment berms, seepage detection systems, and groundwater monitoring systems
Disturbance of permafrost	permafrost, groundwater quality?	X		road alignments chosen and constructed to avoid exposing permafrost
Altered fish habitat	fish	X		water recycling, ground water wells, monitoring and maintenance
Sensory disturbance/habitat alienation	wildlife	X		wildlife management plan
Habitat fragmentation	wildlife	X		revegetation
Direct wildlife mortality	wildlife	X		wildlife management plan, on-site no hunting policy, posted speed limits and wildlife crossings
Cultural				
Reduced wildlife resource use/harvest	traditional use	X		trapper to be compensated
Loss of cultural value	heritage resources	X		known heritage resources not to be disturbed, further investigations to be completed prior to project construction, discovery of new sites will be reported to appropriate persons
Increased community pressure	social	X		community resource and infrastructure planning, social programs
Erratic economic development	economic	X		widespread employment distribution
Altered human health	human health and safety	X		

Note: Table modified after DIAND, 1997

7.5.2 Other Projects and Activities

With an understanding of the potential effects to VECC's resulting from the project, interactions with any likely projects or activities that would occur during the operation of the Carmacks Copper project have been considered. The Carmacks Copper project is located in a relatively remote area and other regional activities are limited. The current activities in the region include:

Current Land Uses:

- traditional use;
- subsistence and recreational harvesting of wildlife and fisheries; and
- trapping (1 trapline).

Other: In addition to considering the current land uses, which may cumulatively interact with the project, consideration was also given to interactions, based on future land use activities. Upon review of the current land use activities, the potential future land use activity was identified as follows:

- upgrading of the Freegold Road and installation of Nordenskiold bridge.

7.5.3 Interactions and Significance Assessment

Once all of the potential effects to VECC's, as a result of project related activities, were assessed, an interaction assessment was completed and a significance ranking assigned to determine potential cumulative effects. Significant rankings were based on DIAND, 1997 guidelines (Hegmann, et al, 1997) and defined in Table 7-9. Table 7-10 summarizes the results of assessment. The interaction assessment of the VECC's with the project related effects were based on three types of interactions: duration, magnitude, and geographic extent. Refer to Table 7-1 (Section 7.1) for the significance and ranking of effects descriptors. Overall significance rankings of low, moderate or high could be assigned to each VECC based on duration, magnitude and extent of interaction of effects associated with the project.

Table 7-9 Significance Ranking Definitions

Questions for each VECC Type	Significance Rankings			Significance Conclusion
	Low (L)	Moderate	High (H)	
Biological Species VECC's				
1. How much of the population may have their reproductive capacity and/or survival of individuals affected? Or, for habitat, how much of the productive capacity of their habitat may be affected?	<1%	1-10%	>10%	L if Low. If M or H, go to question 2.
2. How much recovery of the population or habitat could occur, even with mitigation?	Complete	Partial	None	L if Low. If M or H, go to question 3.
3. How soon could restoration occur to acceptable conditions?	< 1 year or 1 generation	1-10 yrs or 1 generation	>10 yrs or > 1 generation	L, M or H
Physical-chemical VECC's				
1. How much could changes in the VECC exceed that associated with natural variability in the region?	<1%	1-10%	>10%	L if Low. If M or H, go to question 2.
2. How much recovery of the VECC could occur, even with mitigation?	Complete	Partial	None	L if Low. If M or H, go to question 3.
3. How soon could restoration occur to acceptable conditions?	< 1 year	1-10 yrs	>10 yrs	L, M or H
Socio-economic VECC's				
1. Could the effect be of concern to local residents or administrative authorities, or directly impact on commercial operations or subsistence livelihood, or alter quality of life of residents or recreational enjoyment by visitors?	Little or no concern or change	Some concern or change	Substantial concern or change	L if Low. If M or H, go to question 2.
2. Could the effect be unacceptable to users even after the application of compensation measures, mitigation or the ready availability of reasonable alternatives?	Acceptable to most people	Somewhat acceptable	Unacceptable to most people	L if Low. If M or H, go to question 3.
3. How soon could restoration occur to acceptable conditions?	< 1 year	1-10 yrs	>10 yrs	L, M or H

Table 7-10 VECC Project Interaction and Significance Ranking for Potential Cumulative Effects

VECC	Duration of Effect	Magnitude of Interaction	Geographic Extent of Interaction	Significance Ranking
Air Quality	Low	Low	Low	Low
Surface Water Quality	Low	Low	Low	Low
Groundwater Quality	Low	Low	Low	Low
Permafrost	Low	Low	Low	Low
Fisheries Resources – Lower Williams Creek and Yukon River (juvenile Chinook salmon, arctic grayling)	Low	Low	Low	Low
Wildlife Resources (moose, furbearers)	Moderate	Moderate	Low	Low - Moderate
Traditional Use – Trapping	Moderate	Moderate	Low	Low - Moderate
Heritage Resources	Moderate	Low	Low	Low
Social	Moderate	Moderate	Low	Low - Moderate
Economic	Moderate	Moderate	Low	Low - Moderate
Human and Health Effects	Moderate	Moderate	Low	Low

Legend: Level of interaction or significance ranking defined as low, moderate, or high and considers mitigation success. Where duration of interaction = short term (1-3 years); medium term (4-10 years); long term (>10 years); Magnitude of interaction defines magnitude of effects on VECC; Extent of interaction = low (local); medium (regional); high (territorial or national).

After the interaction assessment and significance rankings were completed for project related environmental effects, effects were considered in combination with other project activities in the study area.

Table 7-11 presents a summary of the VECC interactions with other project activities and the significance of these effects were ranked. The types of other project activities' environmental effects were noted and summarized in the table. An evaluation was undertaken to determine the interaction of VECC's with other project activities and significance evaluated. The potential for cumulative interactions was then identified.

Table 7-11 VECC and Other Activities Effects Significance Rankings

VECC	Significance Ranking	Other Activities Environmental Effects	Significance Ranking for Other Activities	Interaction for Cumulative Effects
Air Quality	Low	Low	Low	Low
Surface Water Quality	Low	Low	Low	Low
Groundwater Quality	Low	Low	Low	Low
Permafrost	Low	Low	Low	Low
Fisheries Resources – Lower Williams Creek and Yukon River (juvenile Chinook salmon, arctic grayling)	Low	Low	Low	Low
Wildlife Resources (moose, furbearers)	Low - Moderate	Moderate	Low - Moderate	Low - Moderate
Traditional Use – Trapping	Low - Moderate	Low	Low	Low
Heritage Resources	Low	Low	Low	Low
Social	Low - Moderate	Low	Low	Low
Economic	Low - Moderate	Low	Low	Low
Human and Health Effects	Low	Low	Low	Low

Based on this evaluation, wildlife resources have a low to moderate potential for significant cumulative interactions, while all other VECC's have a low potential for significant cumulative interactions. However, activities associated with increased use of the Freegold Road can be mitigated through controlling access to the road, posting speed limits signs, and upgrading the road to decrease effects to wildlife. With the appropriate mitigation measures applied, the cumulative effects to wildlife resources are not significant.

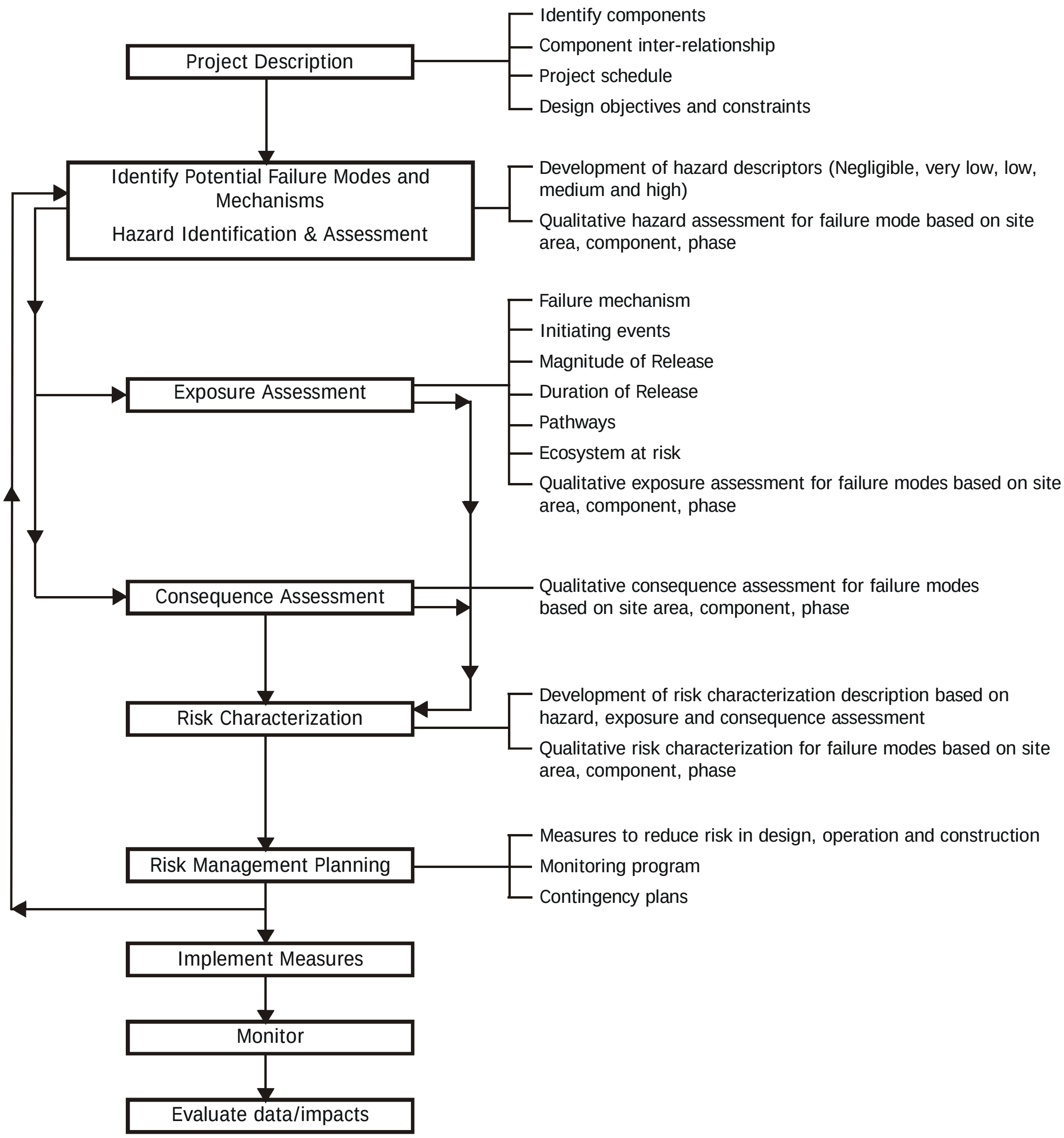
7.6 RISK ASSESSMENT

A qualitative risk assessment was completed for the project based on procedures presented by Van Zyl, Koval and Li (1992). Project team members were involved in the selection of potential failure modes and the preparation of selected failure analyses. The qualitative risk assessment was used to:

- address the hazards;
- determine the probability of occurrence or exposure assessment;
- perform consequence assessments of various failure modes and hazards; and
- conduct risk characterization.

A simplified flowsheet for identifying the steps in the qualitative risk assessment are presented in Figure 7-1.

Figure 7-1 Qualitative Environmental Risk Assessment



Adapted from Van Zyl, Koval and Li, 1992, Broughton, 1997

The primary objectives for the project development are the protection of human health and safety, and the protection of the environment. At this stage in the project development, engineering plans; technical designs and data were collected to identify the issues that may pose a risk to either the public or the environment. The potential concerns or consequences (adverse effects) associated with these issues were then evaluated, and assessed for overall risk associated with the project development plan. This evaluation or risk assessment is used to assess potential hazards, the potential for “failure” of a facility or structure, the pathways and exposures mechanisms and the likelihood and level of concern that would result from the failure.

Risk can be defined as the chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to human health, property, the environment, or other things of value (CSA, 1997). A risk assessment consists of answering the following three questions:

- What can happen - that is, what can go wrong?;
- How likely is it to happen?; and
- If it does happen, what are the consequences?

A risk assessment is a systematic evaluation process used to assess the potential failure modes under investigation and determining the likelihood and consequences as a result of each failure.

A qualitative risk assessment was used to systematically assess the project components and design features, and determine if the mitigation measures and environmental management plans are adequate to protect socio-economic values and the environment during project construction, operations and at closure. The risk assessment was used to help assess the significance and likelihood of potential adverse effects from the project as part of the environmental and socio-economic assessment process.

The risk assessment was undertaken in the following manner. First, the project team members reviewed the project to describe and identify what can happen, that is, what are the "hazards". Table 7-12 identifies the project areas or components, potential failure mechanisms, the likelihood of the failure mechanism occurring, potential hazards or contaminants resulting from the component or area, potential release mechanisms (vectors), proposed mitigation, and the overall risk characterization. This approach allows for a preliminary identification of potential failure modes and component areas that require further evaluation. These component areas are considered in detail using a detailed worksheet. Appendix M provides detailed qualitative risk assessment worksheets for these key/critical areas or components and failure mechanisms.

The areas/components and failure mechanisms in Table 7-12 are labeled (e.g. A1.1 represents seepage through faults in the open pit). These labels are used in Figure 7-2 to illustrate the likelihood and risk of the failure mechanism occurring. Figure 7-2 identifies key/critical areas or components and failure mechanisms that have a moderate to high likelihood and risk of occurrence and therefore require further assessment. Details of these components are presented in Appendix M.

Risk characterization includes an overall assessment of hazard, failure modes, exposure pathways, and hazard consequence. Table 7-12 provides principal failure mechanisms; combinations of failure modes have not been considered further as the principle mechanism identification enabled completion of the risk assessment.

Table 7-12 Component Hazard Identification and Potential Release Mechanisms

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Mine (A)						
Open pit **A1**	1. Seepage through faults. 2. Spillage from haul trucks. 3. Failure of pit wall.	1. Moderate 2. Moderate 3. Low	Sediment, metals (copper and others), nitrates from explosives, physical.	1. Groundwater. 2. Surface runoff. 3. Slope stability.	1. Low 2. Low 3. Low	1. None required. 2. Maintenance of drainage collection ditches. 3. Monitoring of pit wall stability.
Waste rock storage area **A2** *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment failure, including permafrost degradation. 2. Blocked drainage ditch. 3. Seepage through waste rock.	1. Low 2. Moderate 3. High	Sediment, metals (copper and others), nitrates from explosives, physical.	1. Surface runoff, slope stability. 2. Surface runoff, slope stability. 3. Groundwater seepage.	1. Low 2. Low 3. Moderate	1. Pre-construction geotechnical ground study and construction plan; embankment monitoring during operations. 2. Maintenance of drainage collection ditches. 3. Geochemical assessment of waste rock; seepage collection; progressive reclamation of WRSA.
Mine plant, crushing, and explosive storage **A3**	Equipment failure leading to discharge of contaminant (water or air).	Moderate	Sediment, fuel, oil, nutrients (nitrates from explosives).	Surface runoff, air.	Low	O&M manual procedures; emergency response training; monitoring; maintenance of emission equipment.
Overburden dump **A4**	Embankment failure, including permafrost degradation.	Low	Physical, sediment.	Surface runoff, slope stability.	Low	Pre-construction geotechnical ground study and construction plan; embankment monitoring during operations.

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Water management (ditches, sediment ponds, and pipelines) **A5** *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment failure. 2. Blocked drainage ditch or pipe or spillway. 3. Overflow (extreme event). 4. Equipment or pipe failure, accidents. 5. Seepage through ground.	1. Low 2. Moderate 3. Low 4. Moderate 5. Low	Physical, sediment, metals from pit and waste rock, nitrates from explosives.	1. Surface runoff, slope stability. 2. Surface runoff, slope stability. 3. Surface runoff, slope stability. 4. Surface runoff, slope stability, spills. 5. Groundwater.	1. Low 2. Low 3. Low 4. Low 5. Low	1. Pre-construction geotechnical ground study and construction plan; embankment monitoring during operations. 2. Maintenance of drainage collection ditches; decant pipes; emergency spillways. 3. Design incorporates extreme hydrologic events and monitoring. 4. O&M manual procedures; emergency response training; monitoring. 5. Monitoring and maintenance.
Heap Leach Pad, Events Pond and SX/EW Plant (B)						
SX/EW plant and chemical storage **B1**	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills). 3. Blocked pipe or containment failure.	1. Low 2. Moderate 3. Moderate	H_2SO_4, kerosene, sulfur oxide, various other chemicals.	1. Surface runoff, seepage, air. 2. Surface runoff, seepage, air. 3. Surface runoff, seepage, air.	1. Low 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring. 3. O&M manual procedures, emergency response training, monitoring, maintenance of equipment, redundant systems.

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Power plant and fuel storage **B2**	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills). 3. Blocked pipe or containment failure.	1. Low 2. Moderate 3. Moderate	Nitrogen and sulfur oxide, fuel.	1. Surface runoff, seepage, air. 2. Surface runoff, seepage, air. 3. Surface runoff, seepage, air.	1. Low 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring. 3. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant systems.
Service/haul roads **B3**	1. Embankment or road failure. 2. Blocked drainage ditch or culvert.	1. Low 2. High	Sediment	1. Surface runoff, slope stability. 2. Surface runoff, slope stability.	1. Low 2. Low	1. Pre-construction geotechnical ground study and construction plan. Embankment monitoring during operations. 2. Design incorporates extreme hydrologic events; monitoring and maintenance of drainage collection ditches.
Low grade ore, stock pile **B4**	Seepage through rock.	High	Sediment, metals (copper and others), nitrates from explosives.	Surface runoff.	Moderate	Geochemical assessment of rock; seepage collection; processing of low grade ore

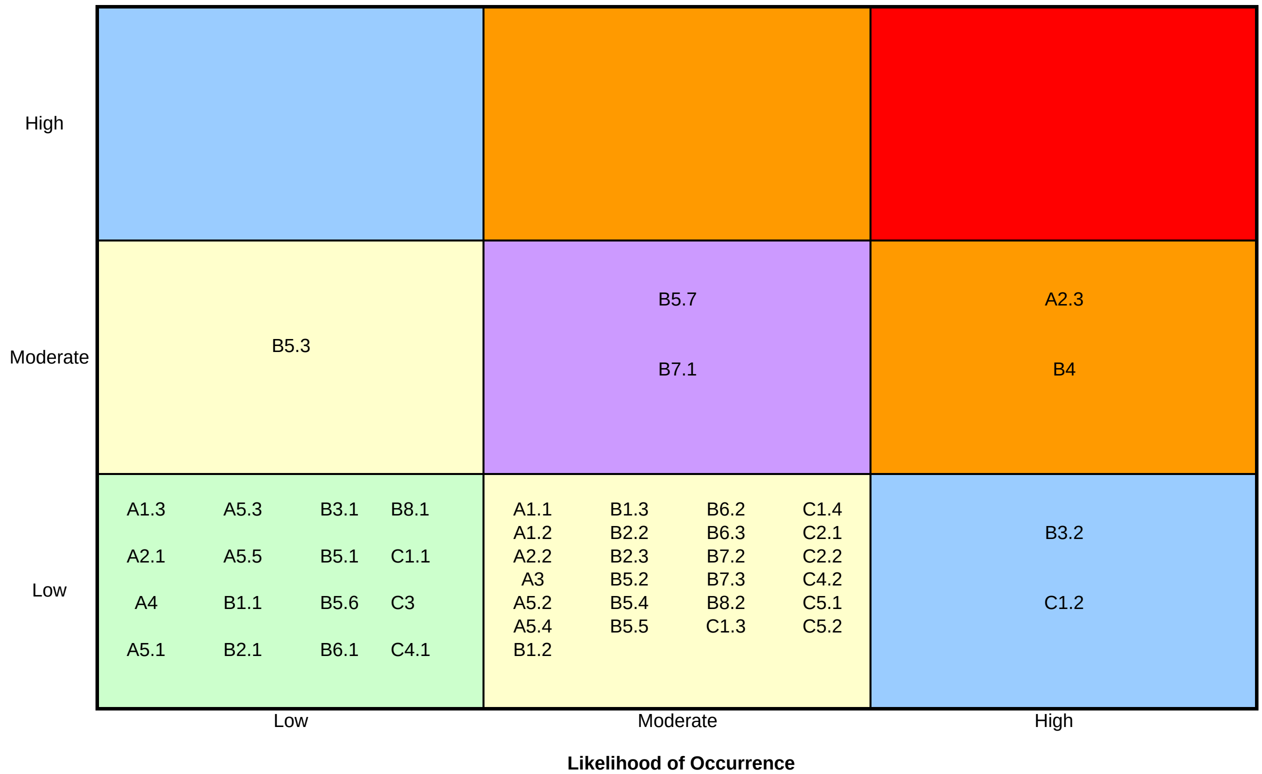
AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Heap leach impoundments (solids, fluids), events pond & solution management **B5** *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment failure.	1. Low	Physical, H_2SO_4, copper and other metals, pH, sediments.	1. Surface runoff, slope stability.	1. Low	1. Pre-construction geotechnical ground study; construction QA/QC plan; embankment monitoring during operations.
	2. Blocked drainage ditch or pipe or spillway.	2. Moderate		2. Surface runoff, slope stability, groundwater.	2. Low	2. Maintenance of drainage collection ditches; decant pipes; emergency spillways; redundant systems.
	3. Overflow (extreme event).	3. Low		3. Surface runoff, slope stability, groundwater.	3. Moderate	3. Design incorporates extreme hydrologic events with events pond storage; operational water balance; redundant systems; water treatment plant; monitoring.
	4. Equipment, liner or pipe failure leading to discharge of contaminant (water or ground).	4. Moderate		4. Surface runoff, slope stability, groundwater.	4. Low	4. O&M manual procedures; emergency response training and plans; redundant systems; LDRS; monitoring.
	5. Accidents (spills).	5. Moderate		5. Surface runoff, groundwater.	5. Low	5. O&M manual procedures; emergency response training and plans; redundant systems; monitoring and maintenance.
	6. Seepage through liner to LDRS or ground.	6. Low		6. Groundwater.	6. Low	6. Pre-construction geotechnical ground study; construction QA/QC plan; operational water balance; redundant systems; monitoring.
	7. Power failure during winter.	7. Moderate		7. Surface runoff, slope stability, groundwater.	7. Moderate	7. O&M manual procedures; emergency response training and plans; emergency spillways; redundant systems; monitoring; LDRS.

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Acid Plant **B6**	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills). 3. Blocked pipe or containment failure.	1. Low 2. Moderate 3. Moderate	Sulfur, SO_2, H_2SO_4.	Surface runoff, spills, air.	1. Low 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring. 3. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant systems.
Water Treatment Facility **B7** *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Equipment failure leading to discharge of contaminant (water). 2. Blocked pipe or containment failure. 3. Blocked drainage ditch.	1. Moderate 2. Moderate 3. Moderate	Metals from acid heap, pit and waste rock, pH, nitrates.	1. Surface discharge. 2. Surface runoff. 3. Surface runoff, groundwater, slope stability.	1. Moderate 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system. 2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system. 3. Maintenance of drainage collection ditches.
Pipeline and Wells **B8**	1. Equipment failure leading to discharge of water. 2. Blocked pipe or containment failure.	1. Low 2. Moderate	Sediment, physical.	1. Surface runoff. 2. Surface runoff.	1. Low 2. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system. 2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system.

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Transportation, Storage and Handling Facilities and Camp (C)						
Access roads, haul roads, lay down area, storage facilities **C1** *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment or road failure. 2. Blocked drainage ditch or culvert. 3. Equipment failure leading to discharge of contaminant (water, air, or ground). 4. Accidents (spills).	1. Low 2. High 3. Moderate 4. Moderate	Sediments, chemicals, fuels, acids.	1. Surface runoff, slope stability. 2. Surface runoff, slope stability. 3. Surface runoff, groundwater. 4. Surface runoff, groundwater.	1. Low 2. Low 3. Low 4. Low	1. Pre-construction geotechnical ground study; construction plan; embankment monitoring during operations. 2. Design incorporates extreme hydrologic events; monitoring and maintenance of drainage collection ditches. 3. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; secondary containment systems. 4. O&M manual procedures; emergency response training; monitoring.
Chemical storage **C2**	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills).	1. Moderate 2. Moderate	Cobalt, kerosene, processed chemicals.	1. Surface runoff, groundwater. 2. Surface runoff, groundwater.	1. Low 2. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; secondary containment systems. 2. O&M manual procedures; emergency response training; monitoring.
Borrow/gravel pits **C3**	Embankment failure.	Low	Physical, sediment.	Surface runoff, slope stability.	Low	Pre-construction geotechnical ground study; construction plan; embankment monitoring during operations; interceptor ditch; progressive reclamation.

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Sewage treatment **C4**	1. Equipment failure leading to discharge of contaminant (water). 2. Blocked pipe or containment failure.	1. Low 2. Moderate	Bacteria, nitrates	Surface runoff, groundwater seepage.	1. Low 2. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment.
Camp **C5**	1. Equipment failure leading to discharge of contaminant (surface water and groundwater). 2. Accidents (spills).	1. Moderate 2. Moderate	Bacteria, nitrates	Surface run off, spills.	1. Low 2. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment.

Figure 7-2 Likelihood and Risk of Failure Mechanisms Occurring



Legend: Table depicts relative ranking of the likelihood of project component failure and subsequent risk characterization based on hazard failure, exposure, and consequence assessment.

- Low likelihood of occurrence, low risk.
- Moderate likelihood of occurrence, low risk; **or** moderate risk, low likelihood of occurrence.
- High likelihood of occurrence, low risk; **or** high risk, low likelihood of occurrence.
- Moderate likelihood of occurrence, moderate risk.
- High likelihood of occurrence, moderate risk; **or** high risk, moderate likelihood of occurrence.
- High likelihood of occurrence, high risk.

	AREA/COMPONENT
A	**Mine Area**
A1	Open pit
A2	WRSA
A3	Mine plant, crushing, & explosives storage
A4	Overburden dump
A5	Water management (ditches, sediment ponds, pipelines)
B	**Heap Leach Pad, Events Pond and SW/EW Plant**
B1	SW/EW plant and chemical storage
B2	Power plant and fuel storage
B3	Service/haul roads
B4	Low grade ore, stock pile
B5	Heap leach impoundments, events pond & solution management
B6	Acid plant
B7	Water treatment facility
B8	Pipeline and wells
C	**Transportation, Storage and Handling Facilities and Camp**
C1	Access roads, haul roads, lay down area, storage facilities
C2	Chemical storage
C3	Borrow/gravel pits
C4	Sewage treatment
C5	Camp

*See Table 7-12 for specific failure mechanism.

Project Description:

Generally the project area was divided into three large areas (Table 7-12) including:

- Mine area (open pit, WRSA, mine plant and crushing area, explosive area, and associated water management structures such as sediment ponds and ditches;
- Heap Leach Pad, events pond and SX/EX Plant area (heap, events ponds, sediments ponds, pipelines, emergency overflow structures, SX/EW plant, power plant and acid plant); and
- Transportation and Storage/Handling and Camp areas.

Section 3 provides a detailed description of the various project components and their operations, while Appendix F provides a conceptual closure and reclamation plan for the project. These areas were used to help identify individual component failure modes resulting from the three project phases (construction, operations, and decommissioning, reclamation and closure). From this, the types of hazards and effects that may arise are determined.

Hazard Assessment:

As noted in Table 7-12, the potential hazard or contaminant and release mechanism have been identified for each component or area. This systematic approach was further evaluated to select hazards that were then further assessed. (See Appendix M). Other hazards that were identified in Table 7-12 were not analyzed further due to lower concentrations or volumes. The hazard assessment descriptors for key hazards of concern are presented in Table 7-13. Table 7-13 presents the concentrations of contaminants and their relative toxicity or detrimental affect to the receiving biota. For example, copper concentrations of 0.002 mg/L would have a “negligible” risk to, or effect on, biota; however, greater than 10 mg/L would be very toxic or have a “high” risk to, or effect on, biota. Similarly for pH, a pH with a range from >6.5 to <9.0 would have a “negligible” effect, while a pH of 2.0 would be very toxic to the environment and a “high” risk assigned to this value. Table 7-13 adapted from Van Zyl, Koval and Li (1992) reflects contaminants of concern if released due to a failure from the heap leach pad and events pond system, the water treatment plant or other component area.

Table 7-13 Hazard Assessment Descriptors

Raffinate Leach Solution and Treated Solution	
Metals	
Basis	copper (mg/L)
negligible	<0.002
very low	0.002-0.05
low	0.05-1
medium	1-10
high	>10
pH (acidity)	
Basis	pH (unit)
negligible	>6.5<9.0
very low	>6.0<9.5
low	5.0-6.0
medium	2.0-4.0
high	>2.0
Physical	
Material	
Basis	slope failure (tonnes)
negligible	<50
very low	50-1,000
low	1,000-10,000
medium	10,000-100,000
high	>100,000
Other Contaminants	
Sediments	
Basis	concentration (mg/L)
negligible	<5
very low	5-100
low	100-1,000
medium	1,000-50,000
high	>50,000
Fuels/Lubricants	
Basis	concentration (liters)
negligible	<50
very low	50-500
low	500-5,000
medium	5,000-50,000
high	>50,000

Source: Adapted from Van Zyl, Koval and Li (1992)

Exposure Assessment:

The exposure assessment must take into account the failure mechanism from each failure mode, the potential for that event, magnitude and duration of a release, pathways or vectors for release and the ecosystem at risk. The exposure assessment considers how the contaminant would be modified or reacts in the ecosystem (diluted, attenuated, degraded, precipitated) from the point of release and a result of a failure; determine the exposure mechanism to receptors in the environment. Both the aquatic and terrestrial ecosystems can be exposed to the release of hazards as well as to humans.

For most failures, losses of process solutions or wastewaters were predicted to enter surface water or groundwater regimes as the exposure pathway. Surface water releases from the leach pad and events pond area will enter upper Williams Creek and travel downstream to lower Williams Creek and eventually to the Yukon River located some 11 kilometres downstream. Groundwater in the heap leach and events pond area, open pit and WRSA is expected to be relatively deep, however losses to groundwater were assumed to eventually contribute to surface recharge in the upper Williams Creek drainages.

Key receptors in the receiving environment are generally limited to the aquatic environment and include surface water and groundwater quality, algae, benthic macroinvertebrates and fish. Fisheries resources have not been documented in the upper reaches of Williams or North William Creek near the project area. Fish have been documented in lower Williams Creek near the confluence with the Yukon River (juvenile Chinook salmon, arctic grayling and slimy sculpin). The Yukon River supports an important fisheries resource; terrestrial habitat and wildlife resource and is critically important for cultural and traditional pursuits and other resource users. In the upper reaches of Williams Creek, it is expected that surface and groundwater water quality, periphyton and invertebrate communities would be the most effected receptors. Wildlife are at risk through ingestion, diet and direct contact. Human use in the area includes hunting and trapping near the project area and First Nation subsistence food fisheries located downstream in the Yukon River. A full description of the environmental conditions located in the project area is described in Section 5.

Contaminants such as excessive sediment, heavy metals such as copper, and acidity have the potential to be acutely toxic or chronically toxic to aquatic resources. Acutely toxic levels of contaminants result in physiological changes that are lethal to fish and other aquatic biota. Chronically toxic levels are sublethal concentrations of contaminants that result in physiological changes that affect the reproductively, birth rate, and life span. Chronic toxicity is many times less apparent than acute toxicity, but is reflected by changes in the species composition of a population, population size, the appearance of another, more tolerant species, or species distribution. These aspects of various receptors (receiving ecosystem) were considered as part of the exposure assessment, so that potential ecosystem sensitivities are defined and used as a basis for evaluating the consequences. Consequences can then be compared, and evaluated for various failure modes based on project components and used to develop an overall risk characterization.

Consequence Assessment:

Potential consequences of a failure first require the identification of the contaminant pathway and identification of the receiving biota and particular sensitive ecosystem components that might be affected by a potential contaminant release. Relative descriptors are provided for hazard and consequence assessments and the relative magnitude of risks associated with failures events and consequences are characterized. An assessment of consequence addresses how the biotic populations respond to the contaminant. For example, is the contaminant lethal, sublethal, or what percent change in the population might be expected? Table 7-14 indicates the descriptor that is used for different scenarios of effects.

Risk Characterization:

Once the hazard, exposure and consequences have been identified, assessed and rated, a risk characterization descriptor can be obtained according to Table 7-15. The resulting risk characterization descriptor is more dependent on the exposure and consequence rating than the hazard rating. In addition, there is an interpretive factor that gives the range of each of the hazard, exposure and consequence ratings. Best professional judgment, and the various experience of the various team members involved in the assessment provide the basis for selecting the risk characterization descriptor.

Risk Management Planning:

The risk characterization identifies key project components that require measures to reduce risk in the design, construction, operation and closure of the facility. Specific preventative engineering measures can be incorporated into the project design to reduce the potential for failure. Monitoring programs, operational plans and contingency and response plans can reduce the likelihood of an event occurring and thus minimize the potential for failure and effects.

Appendix M provides the individual qualitative risk assessments that were completed for individual key components with failure modes that required further assessment for the project. These includes failure modes associated with:

- Sediment release from various construction and operation activities associated with project components;
- Metals and low pH released from the heap leach pad, events ponds;
- Metals and low pH released from the water treatment plant;
- Metals and low pH released from the mine waste rock storage area; and
- Fuels/acids released from transportation of products and process reagents to the site.

Table 7-14 Consequence Assessment Descriptors

Descriptor	Terrestrial Ecosystem	Aquatic Ecosystem or Biota	Fish Populations
Negligible	no effect	no effect	no effect
Very low	productivity or biomass (<5%)	slight loss in aquatic biota or species diversity (<5%)	slight effects on growth or mobility (5%)
Low	loss in species or productivity (5-10%)	reduction in species or productivity 50-60	loss in growth or mobility, reproduction (5-10%)
Medium	large or long-term loss in species or productivity (>10%)	2.0-4.0 large reduction in species diversity or productivity (>10%)	sublethal effects on large fish population or fish mortality and loss of reproduction (>10%)
High	total destruction of terrestrial ecosystem in a large area (>100 ha)	total or long-term degradation of a long reach of stream (>15 km) or a large body of water (>75 ha)	large and permanent fish kill (>5,000 or one cohort) or destruction of spawning habitat in total stream

Source: Adapted from Van Zyl, Koval and Li (1992)

Table 7-15 Qualitative Risk Characterization

Hazard Assessment	Exposure Assessment	Consequence Assessment	Risk Characterization
Negligible to High	Negligible to Very Low	Negligible	Negligible
Negligible to High	Very Low to Low	Negligible to Very Low	Very Low
Very Low to High	Low to Medium	Very Low to Low	Low
Low to High	Medium to High	Low to Medium	Medium
Low to High	Medium to High	Medium to High	High

Source: Adapted from Van Zyl, Koval and Li (1992)

Summary/Conclusion:

Table 7-12 presents a summary of the qualitative risk assessment results for the project assessment. In addition, risk characterization was also considered in the significance assessment for various VECC's and this is presented in detail in Appendix K.

The risk characterization was then used in the risk management planning for the project. Component areas with the potential for significant exposure and consequence assessments supported the requirement for robust engineering design and facility operation. As such, the heap leach pad has been designed to minimize the potential failure mode hazards and lower the risk characterization for this component.

7.7 CONCEPTUAL CLOSURE PLAN

Western Silver has prepared a conceptual closure and reclamation plan for the project. Details of the "Conceptual Closure and Reclamation Plan" are provided in Appendix F. This plan presents further information and details respecting closure issues, conceptual closure measures, remaining closure issues and investigations, and closure scheduling. A brief summary is presented in the following sections.

Figures showing closure plans are presented in Appendix F. Appendix A, Drawing ACG-01 provides a schematic of the conceptual heap leach facility closure.

7.7.1 Closure Objectives

There are three overall closures objectives for mine closure:

- protection of public health and safety;
- minimize or prevent adverse environmental impacts; and,
- ensure land use commensurate with the surrounding land.

For the Carmacks Copper mine these objectives have become part of the design process to ensure both physical stability and chemical stability of the site in the long term. Mine design, development and progressive reclamation will be undertaken in such a manner to ensure that the amount of work required at the end of mine life to achieve the above objectives is minimized.

The ideal scenario at closure is to be able to achieve the above three objectives in a "walk-away" scenario, that is, one in which there will be no further requirements for monitoring and maintenance. Clearly, for some mines, some level of human activity may be required for a period after closure resulting in either an "active care" or "passive care" closure scenario.

The Conceptual Closure and Reclamation Plan presented in Appendix F describes the concepts that have been developed for closure of the Carmacks Copper Project, and addresses both temporary shutdown and final closure scenarios.

The long-term objective is to achieve a passive "walk-away" closure condition, however it is realised that some active care will be required for a period of time to demonstrate that passive "walk-away" closure is achievable, especially for the heap leach pad. A plan is presented that provides "walk away" closure for all aspects of the project, with the exception of the heap leach pad. The heap leach pad will be rinsed and process solution circulated until no longer economical. Excess solutions will be released from the heap and treated for discharge to the environment. The heap will be covered with an evaporative/transpiration soil cover to reduce infiltration. Heap solutions will then be further neutralized and treated to raise the pH and stabilize metals. An infiltration gallery is proposed for capturing long term solution release from the heap.

7.7.2 Closure Issues

Closure issues can be considered in terms of three major areas:

- issues associated with (geo)chemical stability;
- issues associated with physical stability; and,
- issues associated with land use, aesthetics and public health and safety.

For this project, issues of chemical stability and water quality are typically the major issues to be addressed at closure. These issues, which are particularly associated with the heap, are therefore the focus of the conceptual closure plan.

At mine closure, there are no major water retaining structures, diversions or impoundments for which physical stability must be ensured in the long term. The remaining structures for which physical stability must be addressed are the spent ore heap and associated water management facilities, and the mine rock waste dump.

For most of the site, reclamation of the disturbed areas of the mine site and rock waste dumps would raise no issues that are particular to a heap leach project. The primary issue is the control of erosion and public safety.

Closure and reclamation of the spent heap does require special consideration in that the spent ore has been chemically changed from the in-situ condition. Closure of the spent heap is discussed herein primarily in terms of the issues associated with water chemistry. The requirements for control of water quality (i.e. rinsing, solution draindown and active treatment using known lime treatment technology, chemical addition for neutralization and metals stability, soil evaporative/transpiration covering, heap effluent biological treatment cell and infiltration gallery) will dictate the conditions under which further reclamation would be done.

The Conceptual Closure and Reclamation Plan in Appendix F presents further information and details respecting closure issues, conceptual closure measures, remaining issues and investigations, and closure scheduling.

7.8 RECLAMATION SECURITY AND COSTS

Preliminary reclamation cost estimates were provided in HKP, 1995. Western Silver intends to update and revise the reclamation and security cost estimates for the conceptual closure and reclamation plan and present this information to government agencies and the public for review as part of the licensing process.

The company's philosophy for closure and reclamation security is to:

- Undertake progressive closure and reclamation during operations to offset post closure costs;
- Develop and prepare a final mine closure and reclamation plan that meets closure objectives;
- Post security for project closure in accordance with applicable Yukon regulations (Yukon Waters Act and Regulations and Yukon Quartz Mining Act), including Yukon Government's mine reclamation policy; and
- Ensure that security provisions are adequate and available to fund closure activities at any time during the operation.

7.9 CAPACITY OF RENEWABLE RESOURCES

7.9.1 Introduction

Section 12 (2) (d) of YEAA requires that the EA consider whether the project effects the capacity of the renewable resources to meet present and future needs. This report assesses the effects from the Carmacks Copper project and determined the significance of those effects to the local environmental (renewable resources) and socioeconomic conditions in the project area, after the implementation of appropriate mitigation measures.

Extensive baseline environmental data for the project is presented to enable a prediction of project effects to those resources. The project incorporates detailed engineering designs and preventative engineering measures to address potential project effects. Specific mitigation measures, plans and monitoring programs have been developed to address project environmental and socioeconomic effects and a determination of the significance of residual effects made.

The following steps were used in determining the capacity of renewable resources to meet present and future needs based on guidelines prepared by the CEAA Agency:

- Identification of the renewable resources;
- Determining if they are to be significantly affected by the project; and

- If a renewable resource is likely to be significantly affected by the project: define how the capacity is measured; determining time scales; assessing the capacity of the resource to meet present and future needs; providing mitigation measures; determining the significance of residual effects; and identifying risk or uncertainty which must be addressed.

7.9.2 Renewable Resources Identification

Environmental and socioeconomic baseline data was gathered for the Carmacks Copper Project and summarized in Section 5. Valued ecosystem and cultural components (VECC's) were identified and used to complete the associated environmental effects assessment for the project (Section 7). These VECC's are essential to the renewable resources components for the project and considered in this assessment

In summary the following valued renewable resources were described and environmental effects determined: terrain (including soils); air quality; hydrology (including surface and sub-surface waters); water quality (including surface and groundwater); aquatic resources (including fisheries, with Arctic grayling and juvenile Chinook salmon identified as valued components, benthic invertebrates and periphyton); vegetation (including forestry resources); and wildlife (including moose as VECC's). Other noteworthy socioeconomic components include LSCFN traditional resources use including, hunting, fishing, gathering and trapping.

7.9.3 Significance of Effects

To determine whether or not the adverse environmental effects to renewable resources were considered significant seven criteria were taken into consideration when determining the significance of effects:

- **Magnitude** of the adverse environmental effect, where magnitude refers to severity;
- **Geographic** extent of the adverse environmental effect;
- **Duration** and frequency of the adverse environmental effect;
- Degree to which the adverse effect is **reversible** or irreversible;
- **Ecological Context** of the adverse environmental effect;
- **Socio and Economic Context** of the project effects; and
- **Risk Characterization** and likelihood of the adverse environmental effect**.**

A criteria ranking was assigned to each of the above descriptors ranging from very low to very high. The overall rating for the significance of effects was determined using a numerical scoring system and calculating an overall average. The descriptors were quantified, as shown on Table 7-1. A discussion of the environmental and socioeconomic effects and the significance of those effects was presented in detail in Section 7 and summarized in Table 7-2.

7.9.4 Summary

Valued ecosystem and cultural components were identified for the project and predictions made of the environmental effects on those VECC's. A determination of the significance of those effects on the noted resource components was completed considering the mitigation measures, a cumulative effects assessment, and a risk assessment. Table 7-2 presents a summary of the projects effects, their occurrence, proposed mitigation measures and significance of effects for the various renewable resource components.

The overall significance of project effects ranged from low to moderate with none of the environmental or socioeconomic effects considered significant after implementation of mitigation measures. This assessment is based upon the detailed significance determination presented in Section 7.3 and best professional judgment of the project team. Western Silver considers that the capacity of renewable resources to meet present and future needs would not be significantly affected by the project.

8.0 FOLLOW-UP PROGRAMS

8.1 PROJECT PERFORMANCE STANDARDS AND OBJECTIVES

8.1.1 General Approach

This section describes the project performance standards and objectives and design criteria that will be used to ensure that project components are designed, constructed, operated and closed in a manner that ensures environmental and socio-economic protection. These standards and objectives are consistent with the company's Environmental Policy (Appendix B). The standards and objectives will ensure that:

- Measurable performance standards and design criteria are set to ensure that various mine and infrastructure components are constructed and operated;
- Mine and project component performance is monitored and performance tracked;
- Maintenance measures or contingency plans can be implemented if project component performance is not achieved;
- The company, regulatory agencies, First Nations and the public will know the performance standards and objectives that are required for the project to ensure environmental and socio-economic protection;
- Closure measures for various project components are designed, implemented and monitored in the long term; and
- The company, regulatory agencies, First Nations and the public will know when the project's closure and reclamation liability obligations have been met.

Measurable performance standards and objectives have been developed to guide the environmental assessment for the project and implementation of project development. It is expected that these measurable performance standards and objectives will be established in key project authorizations (Water Use Licence and Quartz Mining Licence) to ensure that the project is constructed, operated, and closed as intended.

Table 8-1 presents a summary of the performance standards and objectives, along with monitoring or follow up programs for the various mine components for the project. The performance standards are presented in three categories: water/chemical stability, physical stability and revegetation. Monitoring and potential follow-up programs are also outlined where required.

Appendix C presents a detailed report outlining the performance standards and design criteria parameters for the project.

Table 8-1 – Carmacks Copper Project Summary Performance Standards and Objectives

Mine Component	Water / Chemical Stability	Physical Stability	Revegetation	Monitoring
Open Pit	• Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER); • Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek.	• Inter-ramp angles of 55^o with overall angles of 41^o in the NW & SE sectors and 45^o & 55^o in the NE & SW sectors respectively; • Double benching to be used with bench height and catchment berm width 12 m and 8 m respectively; • Bench face angles will be blasted to 70^o; • Terrestrial Reclamation Standards for terrain stability and erosion control.	• Terrestrial reclamation standards for revegetation.	• Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER and CCME guidelines; • MMER environmental effects monitoring; • Routine physical and revegetation monitoring and geotechnical inspection; • Annual reporting.
Waste Rock Storage Area (WRSA)	• Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER); • Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek.	• WRSA slopes 2½ h: 1v; • 100 m wide stripped buffer below the toe of the waste rock pile until final configuration achieved; • Terrestrial Reclamation Standards for terrain stability and erosion control.	• Terrestrial reclamation standards for revegetation.	• Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER and CCME guidelines; • MMER environmental effects monitoring; • Routine physical and revegetation monitoring and geotechnical inspection; • Annual reporting.
Diversion Channels & Stream Crossings	• Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER); • Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek.	• Convey peak flows from a 100-year return period storm event with 250 mm freeboard; • Culverts at stream crossing sized to convey peak flows from a 25-year return period event; extreme peak flows with return periods of up to 100-years may be considered for critical road sections; • Stilling basins will be excavated at the intake of all culverts to prevent sedimentation and blockage; • Terrestrial Reclamation Standards for terrain stability and erosion control. • Clear span bridge – Merrice Creek	• Terrestrial reclamation standards for revegetation.	• Routine physical and revegetation monitoring and geotechnical inspection; • Annual reporting.
Heap Leach Pad	• Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER); • Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek; • Contaminated Site Regulations for Industrial Groundwater.	• Heap will be designed to store ~13.3 million tonnes of ore at a dry density of 1.9 tonnes/m^3; • Ore will be placed for 8 yrs at about 9,872 tonnes/day for up to 300 days/yr; • The 31.5 ha leach pad will be constructed in 3 stages ahead of ore placement; • Ore will be placed in 8-m lifts at an overall slope of 2½h: 1v; • Raffinate will be applied at a rate of 0.204 litres/min/m^2 and total raffinate flow to the heap will be 540 m^3/hr for a cycle of 120 days; • Leach pad design exceeds YG criteria with a double composite liner system with a LDRS; • The pad will be surrounded by a 2-m high perimeter berm on the north and west sides and a perimeter bench on the east side; • A confining embankment will form the lower limit to the leach pad to support the heap (CDSG, high consequence); • With a crest elevation of 780 m, it will be ~22 m high and 350 m long; • Terrestrial Reclamation Standards for terrain stability and erosion control.	• Terrestrial reclamation standards for revegetation.	• Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER and CCME guidelines; • MMER environmental effects monitoring; • Routine physical and revegetation monitoring and geotechnical inspection; • Annual reporting.
Events Pond	• Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER); • Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek; • Contaminated Site Regulations for Industrial Groundwater.	• Capacity of approximately 160,000 m^3 and will have a lined area of about 62,000 m^2; • Storage to be created by a dam across the valley at the lower end of the pond about 30 m high, 380 m long with a crest elevation of about 754 m (CDSG, high consequence); • Allowable leakage rate into the events pond LDRS is 200 L/day averaged over a 12-month period, and 600 L/day averaged over a 3-month period.	• Terrestrial reclamation standards for revegetation.	• Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER and CCME guidelines; • MMER environmental effects monitoring; • Routine physical and revegetation monitoring and geotechnical inspection; • Annual reporting.
Infrastructure and Buildings	• Infrastructure and buildings removed.	• Terrestrial Reclamation Standards for terrain stability and erosion control.	• Terrestrial reclamation standards for revegetation.	• Terrestrial reclamation standards for buildings and infrastructure; • Physical Inspection; • Annual reporting.
Haul Road and Trails	• See Stream Crossings.	• Haul roads will have an overall width of 26 m including an allowance for ditches and safety berms; • Maximum grade will be 10 % on all main roads and 12 % on bench access roads; • Bridge will be sized to convey peak flows from a 100-year return period event; • Terrestrial Reclamation Standards for terrain stability and erosion control.	• Terrestrial reclamation standards for revegetation.	• Routine physical and revegetation monitoring; • Annual reporting.
Main Access Road	• See Stream Crossings.	• Options for closure to be determined with community; • Physical inspection.	• Options for closure to be determined with community; • Physical inspection.	• Routine physical and revegetation monitoring.

8.2 MONITORING PROGRAMS

8.2.1 Introduction

The following Monitoring Program describes the proposed environmental, geotechnical, and operational monitoring requirements for the project. Environmental and physical monitoring programs are required at all stages of the mine development including construction, commissioning, operations, closure and post-closure. These programs are designed to monitor:

- the effectiveness of component design;
- mitigation success; and
- potential impacts to the receiving environment.

The program is intended to act as an Operational Monitoring Manual for site personnel, once operations commence. Detailed reclamation program plans and monitoring requirements are presented in the "Conceptual Reclamation and Closure Plan" (Appendix F).

8.2.2 Construction Monitoring

During construction, a Construction Supervisor, or Owners Representative (employed by Western Silver), who is a Professional Engineer (P.Eng.), will be responsible for supervising all construction activities. An Environmental Monitor will establish monitoring programs and monitor construction activities. The construction supervisor and environmental monitor will be charged with ensuring that environmental protection and mitigation facilities are incorporated as designed and that environmental safeguards are implemented by the various contractors. The supervisors will also have the responsibility of ensuring that the requirements of the applicable acts and regulations are complied with. A third party independent geotechnical engineer will monitor key construction activities such as the heap leach pad and events ponds construction.

These personnel will oversee all phases of the construction within the operations area (mine, heap leach pad, and process plant). A Construction Quality Assurance/Quality Control (CQA) manual will be prepared and outline personnel responsibilities. The CQA program will be implemented by a resident engineer, a geotechnical engineer, and several inspectors, all suitably qualified in the specialized requirements of each job.

8.2.2.1 Physical and Geotechnical Monitoring

The CQA Manual will be prepared for the project and guide construction. A third party, responsible to the Owner, provides CQA. CQA is a planned system of activities that provides assurance that the facility complies with the design, specifications and drawings, including inspections, verifications and evaluations of materials, and workmanship.

Component facilities to be covered by the specific CQA plans are:

- heap leach pad, embankment, piping, and diversions;
- events ponds and sediment control ponds;

- solution piping;
- fuel and acid storage secondary containment facility;
- SX/EW plant excavation and concrete floor; and
- waste rock storage area berms, drains, lifts, sediment ponds and spillways.

The CQA Manual will be developed for these facilities and submitted prior to construction once the detailed designs are completed.

8.2.2.2 Environmental Monitoring

The Construction Supervisor and Environmental Monitor will be responsible for ensuring environmental protection by ensuring mitigation measures are implemented and facilities are constructed as designed. Monitoring programs will be established. Monitoring will include:

- proper installation of spill containment devices, instrumentation, monitoring facilities, bridge and culverts;
- protection of all water courses from siltation, spills, and blockages during site development; and
- proper clean up and disposal of construction debris and the proper incineration and/or disposal of refuse.

These personnel will ensure compliance with regulatory authorizations including the Water Licence and Production Licence.

To guide environmental monitoring procedures an Environmental Procedures Manual will be developed. The Manual will outline monitoring procedures and protocols, environmental specifications, and regulatory requirements to be followed by engineering staff, construction workers, and environmental technicians.

8.2.3 Operational Monitoring

An operational monitoring program will be developed and maintained for the project. The program is to ensure that all process and water and waste management facilities are operating properly, that the EMS is implemented, and that facilities are geotechnically stable.

It is intended that many components of the mine will be equipped with automated monitoring devices for continuous surveillance. Automated monitoring systems equipped with alarm systems will be used to monitor remote equipment. Regular inspections of the entire system will be undertaken on a routine basis to physically inspect monitoring equipment, facilities, and structures. A program of geotechnical, physical and environmental monitoring will be maintained during operations as shown in Table 8-2.

8.2.3.1 Geotechnical Monitoring Plans

<u>Heap Leach Pad and Events Pond</u>

The leach facility will be monitored on an on-going basis to evaluate overall performance of the facility and ensure all design objectives are satisfied during operation of the facility. Instrumentation comprising vibratory wire piezometers, survey monuments, water level monitors and flow meters will be installed at various locations within the facility to monitor the performance of the constructed components. Specific detailed design of the monitoring components will be provided during the detailed design stage of the project. General descriptions of the monitoring requirements are outlined below.

Vibrating wire piezometers will be installed in the following locations:

- Within the embankment foundations to monitor pore pressures;
- Within the geonet leakage collection drain to monitor the head on the outer liner; and
- Within the foundation drains, overliner, leachate collection headers and near the 3 leachate sumps in order to measure water levels and pore pressures.

Survey monuments along the embankment crest, downstream slope, and downstream toe of the embankments will be installed to measure settlements and monitor slope stability.

Water level monitors for the heap leachate collection sumps and in the events pond leachate removal system, which will be connected to the control, room of the process plant will be installed to measure water levels for the various components.

A flow meter in the foundation drain/leak detection system within an insulated manhole will be installed to measure flow out of the leak detection system prior to entering the events pond.

<u>Waste Rock Dump</u>

The waste rock storage area will be monitored on an on-going basis to evaluate overall performance of the facility and to confirm design assumptions and parameters used in the stability assessment. The monitoring program will be implemented during initial stages of production and revised as necessary to ensure design objectives are satisfied during construction and throughout the operation of the facility.

Requirements for monitoring and instrumentation are as follows:

- Installation of vibrating wire piezometers to monitor pore pressure conditions within the thawed foundation layer beneath the waste dump toe;
- Survey monuments along intermediate benches to monitor slope stability and settlement;
- Flow weirs along foundation drains to monitor discharge flow rates;
- Visual inspection during operations to evaluate methods of construction and performance of the facility; and
- Annual review and inspection.

8.2.3.2 Mine and Plant Operations

A monitoring program will be instituted which will ensure the safe and economic operation of the Carmacks Copper mine. Operations monitoring will be focused on ore production, the leach pile and the solvent extraction-electrowinning plant. Note that these represent the minimum standards under which the mine will operate. Education programs will focus on employees being aware of the hazards of the operation and the necessity for early detection and prompt action. There is some overlap with the environmental and geotechnical monitoring program plans outlined in the previous sections.

Ore Production

- Tonnes of ore and waste mined will be monitored daily;
- A running inventory of crushed and uncrushed stockpiled ore will be maintained;
- Inspection twice per shift of acid supply lines for preconditioning; and
- Regular clean up of preconditioned ore, which has fallen off the conveyor belts.

Leach Pad

- Hourly recording of solution temperatures onto and reclaimed from the leach pile;
- Hourly average solution volumes pumped onto and reclaimed from leach pile;
- Daily recording of solution levels in the bottom of the leach pile;
- Daily inspection of water levels in leak detection system;
- Hourly recording of ore temperatures at the drip emitter level in grids scheduled for starting irrigation in January, February or March;
- Hourly recording of temperature gradients in the sides of the leach pile at strategic locations;
- Hourly recording of temperature gradients below and on margins of leach pile at strategic locations;
- Daily inspection for development of surface ice at drip emitters;
- Continuous inspection for ice lenses uncovered during preparation of leach pile surface for placement of new lift;
- Weekly inspection of retention berm crest for over topping by ice or solutions;
- Monthly recording of accumulated snow on top of the leach pile;
- Seasonal shovel tests for ice development in the sides of the leach pile;
- Weekly recording of frost depth;
- Logging of periods of flow into the events ponds from the heap;
- Regular updating of the leach pad area operating water balance and forward projections of expected storage requirements; and
- Periodic inspections of diversion facilities, removal of blockages and stabilization of areas of local erosion as required, and removal of accumulated snow in the channels prior to the annual snowmelt.

SX/EW PLANT

- Twice per shift sampling of pregnant leach solutions grades;
- Continuous monitoring of power consumption;
- Continuous monitoring of propane consumption;
- Weekly inspection of acid, solvent and propane piping and storage facilities;
- Continuous recording of leach solution pumping pressures;
- Daily inspection of acid, pregnant and leach solution pipeline in plant and to and from the leach pile;
- Weekly inspection of piping and storage facilities,
- Recording of solution recycle rates and solution flows to the ADR plant,
- Recording of make-up water inflows;

- Recording of times of water treatment plant operation and treatment rates if required;
- Recording of sediment pond water levels, release rates and times of release;
- Treatment plant process control monitoring (temperature and pH) and internal laboratory testing for specific water quality parameters;
- Periodic inspections of all standby pumping and power facilities;
- Periodic inspection of sediment control dams, and all piping and spillways with clearing of pipe and spillway inlet obstructions as necessary and controlled removal of accumulated sediment as required to maintain design storage capacity;
  Sampling of sediment pond effluent quality; and
- Daily recording of ambient air temperatures and precipitation (See Meteorology monitoring below).

8.2.4 Environmental Monitoring Plans

8.2.4.1 Meteorology

Ongoing meteorological data is required to verify design assumptions. The information will be used to monitor site temperatures, solar radiation, frost and wind speed to assist in scheduling ore loading and heap leach operations near freezing conditions, and snow pack and precipitation data for regulating the water management systems and updating the heap water balance.

The Water Resources Branch of YG Environment established an automatic weather station at the Williams Creek site in September 1994. The station records the following information every half hour and provides a daily average:

- Net radiation (W/m^2);
- Short-wave Incoming Radiation (W/M^2);
- Short-wave Outgoing Radiation (W/M^2);
- REBS Soil Heat Flux (W/m^2);
- Soil Temperature @ 6 cm depth ^oC);
- HMP 35CF Upper Temperature (^oC);
- HMP 25C Upper Relative Humidity (%);
- Lower Wind Speed (m/s);
- Upper Wind Speed (m/s);
- Precipitation (Tipping Bucket) (mm); and
- Battery Voltage.

Three snow course sites in the Williams Creek watershed were previously operated during the winters of 1994/1995. Each site consisted of 5 sub samples located 20 m apart and measurements of snow depth and water equivalent were taken in accordance with government protocol. A snow course station will be reinstated at the Williams Creek site once operations commence and will be monitored monthly during the period of snow accumulation (November to June).

8.2.4.2 Hydrology

The hydrology of the Williams Creek watershed will be required to monitor stream flow for available dilution and downstream water quality impacts. A Stevens water level recorder was installed in Williams Creek near Station W2 upstream of North Williams Creek in 1993 and staff gauges are located in the upper portion of Williams Creek. Once operations commence it will be necessary to monitor daily flows in the receiving environment at several locations as follows:

- Williams Creek and North Williams Creek above operations (W7 and W9);
- Williams Creek and North Williams Creek below operations (W2 and W3);
- Williams Creek outflow from the Water Storage Reservoir (W4); and
- Williams Creek below Nancy Lee Creek (WI0).

Other operational flows on site, which will be monitored on a daily basis for environmental purposes, include:

- Open pit water;
- Heap leach leak detection system;
- Heap leach underdrains;
- Elevation of water in the events pond;
- Outflow from the WRSA sediment pond;
- Make-up water recovered from the WRSA sediment pond; and
- Outflow from the plant site and events pond sediment control ponds.

8.2.4.3 Surface and Ground Water Quality Monitoring

An operational water quality monitoring program will be required to ensure that effluent and receiving water quality criteria are being achieved on a consistent basis. The effluent characterization program will follow the program outlined in the MMER EEM. Recommended water quality monitoring locations are listed below, together with recommended analyses and shown in Table 8-2.

<u>Receiving Water Quality Sample Sites (Monthly)</u>

- Williams Creek and North Williams Creek above operations (Control Stations W7 and W9);
- Williams Creek and North Williams Creek below operations (W2 and W3);
- Williams Creek outflow from the Water Storage Reservoir (W4);
- Williams Creek below Nancy Lee (W10); and
- Yukon River above and below Williams Creek.

<u>Effluent Quality Sample Sites (Weekly)</u>

- WRSA sediment pond;
- Open pit sump water;
- Events pond water;
- Plant Site sediment pond; and
- Contingency Water Treatment Plant if required (daily).

In addition, the EEM study program will also characterize effluents from the site including possible effluents from the contingency raffinate treatment plant and sediment control ponds. Acute toxicity testing will be conducted along with sublethal toxicity testing (fish, invertebrates, algae, and plant).

Ground Water Quality Sample Sites (Quarterly)

- Heap leach leak detection system;
- Heap leach underdrains;
- Groundwater wells downstream of the heap leach pad, events pond and plant site sediment control pond (to be located); and
- Groundwater wells downstream of the waste rock storage area (to be located).

Water Quality Analyses

Analyses to include physical parameters (pH, conductivity, alkalinity, total and suspended solids, hardness), anions (nitrate-N, nitrite-N, ammonia-N, total sulphate, total, dissolved and orthophosphate) and total and dissolved metals (ICP scan). Protocols will follow those specified by the MMER EEM program.

8.2.4.4 Annual Receiving Water Biological Assessment

An EEM program will be established in accordance with the MMER. The biological assessment of the receiving environment be conducted at the following water sample stations W2, W3, W4, and control stations W9 and WI0, to compare with baseline data. The annual biological assessment would include the following three main components:

- Stream Sediments (Six replicates at each site for CIP metals, TOC and LOI for the -65 u size fraction;
- Benthic & Macroinvertebrates (Three replicates at each site for species composition and total numbers); and
- Fish Resources Characterization and Tissue Analysis (10 replicates of one species, arctic grayling, for muscle and hepatic Cu, Pb, Hg and Zn and a sub sample submitted for MIMS analyses).

8.2.4.5 Waste Rock

Although results from static testing indicate that both ore and waste, which have long been oxidized, contain very little remaining oxidizable sulphur and are non-acid generating, representative samples of waste rock will be collected from drill hole cuttings from representative blast holes and submitted for acid-base accounting. Any waste material detected as having a propensity of generating acid will be identified by the geological staff and the material will be selectively placed in the internal areas of the waste rock stockpile or blended to ensure that the material is mixed with neutralizing material.

8.2.4.6 Reclamation Research Monitoring

An important component of the Reclamation Plan is an ongoing reclamation research program with the objective of establishing the necessary methods and materials required to implement a successful abandonment plan that will meet with the stated objectives of returning all disturbed lands to pre-mining use and capability, when the operations are closed. The Reclamation Research Program will initially consist of six primary elements:

- On-site detoxification tests of spent heap leach material to determine the optimum method of neutralizing the spent ore and removing heavy metals in the leachate;
- On-site tests to determine the optimum method of capping the spent heap leach pad and to minimize the amount of infiltration;
- On-site tests to characterize the physical and chemical composition and stability of precipitates derived from the heap neutralization process for purposes of determining the optimum method of final precipitate disposal;
- Detailed characterization of soils and soil chemistry in the mine site area for purposes of determining occurrences of growth inhibitor sand soil amendment requirements;
- Establishing a series of test plots on various disturbed materials to determine the optimum depth of materials, soil amendment sand moisture requirements to sustain growth;
- Documenting natural recolonization successes for purposes of determining the optimum species for revegetating various reclamation units (overburden, road sides, riparian areas); and
- Species for revegetating various reclamation units (overburden, road sides, riparian areas).

Each of these research initiatives will be implemented at the end of the first year of operations and monitoring will be ongoing. Each of the programs will have to be sufficiently flexible such that monitoring results can be used to direct each phase of testing.

8.2.4.7 Environmental Surveillance Monitoring

In addition to the operational environmental monitoring program plan outlined in the foregoing, site personnel will be responsible for regular environmental surveillance to ensure that all waste management facilities, such as dump pads, settling ponds, solution pumps, and septic tanks are operating efficiently and to ensure that environmental protection systems such as fuel storage berms, liner aprons, diversion ditches and the fire water tank are maintained and that water treatment facilities are functioning as required.

8.2.5 Wildlife Population and Habitat Monitoring

A wildlife monitoring program will be established during construction and maintained throughout all phases of the mine including post-closure. The program will determine trends or changes in wildlife populations and will include:

- a wildlife observation log;
- wildlife mortality reporting;
- routine monitoring of netting over ponds; and
- working with the LSCFN Lands Branch to track moose utilization in the project area.

8.2.6 Closure and Post Closure Monitoring

The regular monitoring of all operations will continue for approximately three to five years following the termination of mining activities while the heap leach pad is being rinsed and neutralized. It is expected that closure monitoring will consist of the same level of requirements set out in the operational monitoring program. Routine inspections of facilities and closure activities and reclamation programs will continue. The operational monitoring program will then convert to a post-closure monitoring program once the leachate quality from the heap leach pad has been certified as suitable for direct release to the environment. A detailed post closure monitoring program will be included with a final closure and reclamation plan for the site.

<u>Closure Monitoring</u>

A conceptual closure and reclamation plan is presented in Appendix F. The following activities will require monitoring by an Environmental Coordinator and a Professional Engineer:

- salvage and removal of all ancillary facilities;
- assessment and removal of any hazardous substances;
- rinsing, neutralizing and insitu metals stabilization in the heap;
- treatment and release of excess solutions from the heap;
- Treatment of solutions or water in the events ponds and sediment ponds and the excavation and disposal of sediments;
- removal of the geomembranes and geonets, and their disposal in one of the events ponds;
- recontouring, grading and placement of overburden and revegetating the WRSA;
- Replacement of the overburden on the disturbed areas;
- removal of the WRSA sediment control dams;
- removal of all piping from the surface and perimeter of the heap and events ponds; and
- trenching through the top of the containment dike in two places near the abutments, and filling these trenches with coarse rock.

Table 8-2 - Operational Monitoring Program Plan

Area	Location	Materials	Analysis	Frequency
Meteorology	Automatic meteorological station at camp site	Ambient air conditions	Net Radiation (W/w^2)	Daily average based on recordings every half hour
			Short-wave incoming Radiation (W/w^2)	
			Short-wave outgoing Radiation (W/w^2)	
			REBS soil temperature at 6cm depth (^oC)	
			Soil temperature at 6 cm depth (^oC)	
			HMP 35CF upper temperature (^oC)	
			HMP 25C upper relative humidity (%)	
			Lower wind speed (m/s)	
			Upper wind speed (m/s)	
		Tipping bucket rain gauge	Precipitation (mm)	
		Snow pack	Snow depth and water equivalents	Monthly November to June
Hydrology	Water quality sites W2, W3, W3, W4, W7, W9 and W10	Williams Creek North Williams Creek	Flow	Daily Automatic water level recorder to be relocated below water storage reservoir
	Open pit inflow	Open pit inflow	Flow	Daily
	Heap leach pad	Leak detection system	Flow	Daily
	Heap leach pad	Underdrains	Flow	Daily
	Events pond	Storage volume	Water level	Daily
	Waste rock sediment pond	Outflow to storage reservoir	Water level or flow	Daily
	Waste rock sediment pond	Make-up water to mill	Flow	Daily
	Plant site sediment pond	Storage volume or overflow	Water level or flow	Daily
Water Quality	Receiving water quality sites W2, W3, W3, W4, W7, W9 and W10	Williams Creek North Williams Creek	Physical parameters (pH, Cond, Alk, TSS, TDS, Hard) Anions (NO_2, NO_3, NH_3, SO_4, TP, DP, Ortho-P)	Monthly
		Yukon River		
	Yukon River US/DS Williams Creek	Receiving water	Total and dissolved ICP metals	
	Effluent water quality sites Waste rock stilling pond	Effluent quality Overflow or pond water	Physical parameters (pH, Cond, Alk, TSS, TDS, Hard) Anions (NO_2, NO_3, NH_3, SO_4, TP, DP, Ortho-P)	Weekly
	Open pit sump	Sump water		
	Events pond	Pond water	Total and dissolved ICP metals	
	Plant site sediment pond	Overflow or pond water		
	Ground water quality sites Leach pad leak detection	Groundwater quality Recovery point	Physical parameters (pH, Cond, Alk, TSS, TDS, Hard) Anions (NO_2, NO_3, NH_3, SO_4, TP, DP, Ortho-P)	Quarterly
	Leach pad leak underdrains	Recovery point		
	Below plant site sed pond	Monitoring wells (to be installed)	Total and dissolved ICP metals	
	Below waste rock stockpile	Monitoring wells (to be installed)		
	Water treatment plant	Treated effluent		
Annual Biological Assessment	Receiving water quality sites W2, W3, W3, W4, W7, W9 and W10	Sediments	Six replicates, -65 u fraction, metals and LOI	Annually
		Benthic microinvertebrates	Three replicates, species composition and abundance	
		Fish tissue and hepatic tissue	Ten replicates, one species, muscle and hepatic	
		Fish community	Cu, Pd, Hg and Zn, and Hepatic MIMS	
Waste Characterization	Open pit	Waste Rock	Representative compost for static acid-base accounting Drill hole cuttings	Each bench
Physical/ Geotechnical Inspections	Pit wall movement - Permanent prism type EDM Targets	Survey target	Elevation data	Monthly
	Pit slope	Survey target	Geotechnical mapping data and pit walls stability inspection	Weekly
	Heap leach pad/events pond LDRS		Physical stability inspection	Daily
	Heap leach pad	Temperature probes	Heap temperatures data	Daily
	Heap leach pad surface ice development	Probe	Fall and winter inspection	Daily
	Heap leach pad ice lenses	Probe	Inspection for ice lenses uncovered on HLP as lifts are added	Continuous
	Heap leach pad /events pond and polishing ponds	Snow depth	Accumulated thermal snow cover data	Weekly
	Heap leach pad /events pond and polishing ponds	Depth gauge	Frost depth data	Weekly
	Diversion facilities		Physical inspection	Weekly
	piping and storage facilities		Physical inspection	Weekly
	PLS pipelines		Physical inspection	Daily
	Standby pumping and power facilities	Test run	Physical inspection	Monthly
	Leach solution pumping pressures	Pressure gauge	Pressure data	Continuous
	Process plant conveyor line		Physical inspection	Continuous
	Process plant and ancillary facilities		Monitoring of power consumption	Continuous
	Process plant and ancillary facilities		Monitoring of propane consumption	Continuous
Reclamation Research	Detoxification trials	Spent leach pad material	Flushing, neutralization and leachate chemistry	Annually ongoing
	Heap capping trials	Spent leach pad material	Materials testing, permeability and compaction	
	Precipitate disposal trials	Neutralization precipitates	Physical, chemical stability of precipitates	
	Soil Characterization	Soils and Overburden	Physical and chemical composition of soils and overburden	
	Recolinization assessment	Disturbed areas	Species, success, wildlife use, brouse and pellet groups	
	Vegetation trials	test plots	Growth, productivity and metal uptake	
Surveillance Monitoring	Operations area	Berms, ditches, pumps, pipe, lines, liners ponds	Environmental protection facilities and control systems	Annually ongoing

8.3 ENVIRONMENTAL MANAGEMENT SYSTEM

Western Silver will prepare an environmental management system for the project. The EMS is intended to provide guidance to supervisory and environmental personnel regarding environmental protection and health and safety measures for the project.

The EMS will outline the:

- Corporate commitment and various policies;
- EMS goals and objectives;
- Organization responsibilities;
- Detail plans and programs for the project, including Health and Safety Plans, Spill and Emergency Response Plans, Construction QA/QC Plans, Operational Plans, Environmental Monitoring Plans, Maintenance Plans and other plans as required;
- Implementation strategy to identify capabilities, and support mechanism to achieve the goals and objectives;
- Measurement and evaluation mechanisms; and
- Review and improvement mechanisms.

The EMS for the project will be completed prior to project development and be available for use during construction

9.0 CLOSURE

Access Consulting Group[1] (ACG) of Whitehorse, Yukon, has prepared this Project Description in conjunction with Western Silver Corporation, ALM Group, and EBA Engineering Consultants Ltd. Western Silver has relied extensively upon previous reports and engineering design work prepared by competent professionals for the Carmacks Copper project. In particular, engineering designs and drawings completed by Kilborn Engineering and Knight Piésold Engineering are still accurate for the project and have been used to support the project description. Where appropriate, new engineering designs or data have been presented in the support of the project. The following people contributed to the report:

Access Consulting Group
Dan Cornett (Environmental Assessment Manager)
Robert McIntyre (Senior Engineering Technologist)
Nichole Speiss (Environmental Scientist)
Heather Desmarais (GIS Mapping)
Colette MacMillan (Administrative)
Nicole Berndt (Administrative)

Western Silver Corporation
Dale Corman (Chairman and Chief Executive Officer)
Jonathan Clegg (Project Manager)

ALM Group
Clynton Nauman (Chief Executive Officer)
Brad Thrall (President)

EBA Engineering Consultants Ltd.
Richard Trimble (Project Director)
Mark Watson (Senior Geotechnical Engineer)
J.P. (Paul) Ruffell (Senior Project Engineer)

ACG would like to acknowledge the sound advice and guidance provided by Dale Corman and Jonathan Clegg of Western Silver, Clynton Nauman and Brad Thrall of ALM Group, and Richard Trimble of EBA Engineering Consultants. We trust this document fulfills your present requirements. If you have any questions or require further details, please contact the undersigned at Tel: (867) 668-6463.

COLLEGE OF APPLIED BIOLOGY
Daniel Cornett
R.P. Bio
#1350
CAB

Dan Cornett, B.Sc., P.Bio., CCEP
Principal, Access Consulting Group

[1] Access Consulting Group is a registered trade name for Access Mining Consultants Ltd.

10.0 REFERENCES

The following reports with an * are available on the CD-ROM submitted in conjunction with this report.

*Access Consulting Group, *Western Copper Holdings Limited, Carmacks Copper Project, Baseline Data Compilation Report,* 14 January 1998

Agriculture Canada, *Soil Landscapes of Canada, Yukon.* Publication 5281/B., 1992.

*Antiquus Archaeological Consultants Ltd., *Western Copper Holdings Limited, Williams Creek Copper Oxide Project, An Archaeological Impact Assessment for the Proposed Williams Creek Copper Oxide Project; Williams Creek Valley, Near Carmacks, Yukon Territory*; Volume III of IEE, 31 January 1993

*Anitquus Archaeological Consultants Ltd., *An Archaeological and Heritage Resource Overview Assessment of the Proposed Carmacks Copper 138 kV Transmission Line Project Route Options Near Carmacks, Yukon Territory,* 1 May 1995.

Archer Cathro & Associates Ltd., *Williams Creek Copper Oxide Project, Yukon Territory, Preliminary Submission; Prepared for Regional Environmental Review Committee, Yukon Territory;* August 1991

Basham, P.W., D.H. Wichert, F.M. Agin and M.J. Berry. 1982. *New probabilistic strong seismic ground motion maps of Canada: a compilation of earthquake source zones. Methods and Results.* Earth Physics Branch Open File 82-33. Ottawa.

Basham, P.W., D.H. Wichert, F.M. Agin and M.J. Berry. 1985. *New probabilistic strong seismic ground motion maps of Canada.* Seismological Society of America. Bulletin 75(2): 563-597.

*Beattie Consulting Ltd. *Metallurgy of the Williams Creek Oxide Copper Deposit;* May 1994.

*Beattie Consulting Ltd. *Carmacks Copper Project, Report on Pilot Scale Column Testing of the Williams Creek Oxide Deposit*; February 1996

*Beattie Consulting Ltd. *Western Copper Holdings Leaching and Decommissioning of Samples from Carmacks Oxide Copper Project,* February 2001

Bonser, P.J., D.C. Holmes and W.M. Sharpe. 1977. <u>Drainage 1.</u> *Highway Technology Training Program.* BCIT Burnaby, B.C. 346 pp.

Bostock, H.S. *Physiographic regions of Canada, Geological Survey of Canada; Map 12544A, scale: 1:5,000,000.* 1970.

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines.

References (Cont'd)

Canadian Council of Ministers of the Environment (CCME). 2003. Canadian Environmental Quality Guidelines.

Canadian Standards Association (CSA), 1997. Risk Analysis Requirements and Guidelines.

*Clearwater Consultants Ltd., *Western Copper Holdings Limited, Carmacks Copper Project – Site Hydrology Revisions, Design Memorandum CCL-CC2,* 12 March, 1998

*Clearwater Consultants Ltd., *Western Copper Holdings Limited, Carmacks Copper Project – Heap Leach Facility Water Balance, Design Memorandum CCL-CC4*, 4 December, 1998

FEARO, 1994. The Responsible Authority's Guide to the <u>Canadian Environmental Assessment Act</u>. Prepared by the Federal Environmental Assessment Review Office, September 1994.

Fernuik et. al., *Comparison of Laboratory and In-situ Field Soil Liner Permeability Measurements;* 42nd Canadian Geotechnical Conference, Winnipeg, 1989

Gibson, J.E., *Water quality and hydrology survey of the Williams Creek Mineral Property,* 1991.

Hallam, Knight & Piésold Ltd., *Manual on Sampling and Handling Guidelines for Determination of Groundwater Quality;* 1 August 1996

*Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Community Profiles and Socioeconomic Impact Assessment;* Volume II of IEE, January 1994

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Environmental Mitigation and Impact Assessment;* Volume IV of IEE, October 1994

*Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Biophysical Assessment of the Carmacks Copper Site;* Addendum to Volume I, November 1994

*Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Initial Environmental Evaluation Addendum;* June 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Design Criteria (Ref. No. 1783/2)*; IEE Addendum No. 3, October 1995

References (Cont'd)

*Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Report on Hydrogeological Summary and Preliminary Impact Assessment (Ref. No. 1783/3);* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Report on Stability of Waste Rock Storage Facility (Ref. No. 1783/4)*; IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed QA/QC Program and Construction Specifications (Ref. No. 1783/5);* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Report on Initial Leach Pad Settlement Assessment (Ref. No. 1783/6);* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Drainage Net Selection (Ref. No. 1783/7);* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Report on Conceptual Design of Heap Leach Facility for Closure (Ref. No. 1783/8);* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Terrain Hazard Mapping;* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Carmacks Copper Operating Plans;* IEE Addendum No. 3, October 1995

*Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Winter Operation Temperature Profiles of a Pilot Test Leach*; IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Operational Monitoring Program Plan;* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Environmental, Geotechnical and Operational Triggers;* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Alternative Water Sources and Heating and Power Supply Alternatives;* IEE Addendum No. 3, October 1995

References (Cont'd)

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Spill and Contingencies and Emergency Responsibilities;* IEE Addendum No. 3, October 1995

Hallam Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Conceptual Reclamation and Closure Plan;* IEE Addendum No. 3, October 1995

Hegmann G. and Green J. E. - Axys Environmental Consulting Ltd., 1997. *Users Guide for Screening of Cumulative Effects – Yukon DIAND Northern Affairs Program*. Prepared for Department of Indian Affairs and Northern Development.

Heidebrecht, A.C., P.W. Basham, J.H. Rainer, M.J. Berry. 1983. *Engineering and applications of new probabilistic seismic ground motion maps of Canada.* Canadian Journal of Civil Engineering 10(4): 670-680.

Kennedy, *Guidelines for Reclamation/Revegetation in the Yukon; 1993.*

Kilborn Engineering Pacific Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Initial Environmental Evaluation;* Addendum No. 4, September 1996

Kilborn Engineering Pacific Ltd., *Description of Water Treatment Process for Reclamation Duty;* September 1996

*****Kilborn Engineering Pacific Ltd., *Description of Water Treatment Process for Emergency Raffinate Treatment;* September 1996

Kilborn Engineering Pacific Ltd., *Conceptual Heap Leach Pad Closure and Reclamation Plan;* September 1996

Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Conceptual layout of Mine; (Report No. 1781/1),* January 1992

*****Knight Piésold Ltd., *Western Copper Holdings Limited, Williams Creek Project, Report on Pit Slope Stability (Ref. No. 1782/3);* January 1993

Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project; Report on 1992 Surficial Geotechnical Investigation (Ref. No. 1782/4);* May 1993

Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Preliminary Design (Ref. No. 1783/1);* Vol. I of II Main Report and Vol. II of II Appendices, 1 May 1995

*****Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Updated Detailed Design of the Heap Leach Pad and Events Pond (Ref. No. 1785/1);* 23 April 1997

References (Cont'd)

*Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on 1996 Geotechnical and Hydrogeological Site Investigations (Ref. No. 1784/1);* June 1996

Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Detailed Design (Ref. No. 1784/2);* Revised 14 August 1996

Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Updated Detailed Design Criteria (Ref. No. 1784/5);* 3 July 1996

Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, QA/QC Program and Technical Specifications (Ref. No. 1784/4);* 24 June 1996

Knight Piésold Ltd., *Report on Sonora Mining corp., Jamestown Mine, Tailings Storage Facility, Report on Basin Seal Test Pads;* November 1986

Lawrence, Richard W., PhD., Carmacks Copper Project, Report on Evaluation of the Mineralogy of a sample of Carmacks Acid Leach Residue*; 31 May, 1996

Little Salmon Carmacks First Nation, Carmacks Renewable Resources Council, YG, *Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory,* 2004 – 2009

Markel, R.L. and D.G. Larsen. *Moose population characteristics in the Casino Trail area – November 1987.* Yukon Fish and Wildlife Branch, Whitehorse. 18 pp.

Mining Association of Canada. Website Accessed January 4, 2004
URL: http://www.mining.ca/english/

MDA Consulting Ltd., *Environmental Assessment, Western Coppermine/Williams Creek, Yukon Region – Final Report,* March 2000

McNaughton, Ken, *Western Copper Holdings Limited, Williams Creek Project, Proposed Work, 1992 Field Work;* 1 May to 31 August 1992

NRCC. 1985. *Supplement to the National Building Code of Canada, No. 23178. Chapter 1: "Climatic information for building designs in Canada." and Chapter 4: "Commentary J: Effects of earthquakes."*

Oswald, E.T. and J.P. Senyk. *Ecoregions of Yukon Territory.* Fisheries and Environment Canada. 115 pp. + map, 1977

P. A. Harder and Associates Ltd., *Western Copper Holdings Limited, Initial Assessment of Aquatic Resources in Williams Creek;* January 1992

*P. A. Harder and Associates Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Biophysical Assessment of the Williams Creek Mine Site;* Volume I of the Initial Environmental Evaluation (IEE), January 1994

References (Cont'd)

Sitka Corp, Carmacks Copper Project Design Criteria and Parameters, October 1998

Slough, B.G. and R.M.P. Ward. *Lynx harvest study, 1988/1989 Progress Report*. Yukon Fish and Wildlife Branch, Whitehorse. 1990

Van Zyl, Dirk, Koval, Marshall, and M. Li, Ta (*editors*). 1992. *Risk Assessment/Management Issues in the Environmental Planning of Mines.* Society for Mining, Metallurgy, and Exploration, Inc.

Village of Carmacks, Yukon. Website Accessed April 25, 2005. URL: www.carmacks.ca

Western Copper Holdings Limited, *Carmacks Copper Project, Conceptual Closure and Reclamation Plan;* 30 June 1997

*Western Copper Holdings Limited, *Carmacks Copper Project, Waste Rock Storage Area;* 30 June 1997

Western Copper Holdings Limited*, Carmacks Copper Project, Technical Issue Response Document;* 30 June 1997

Western Silver Corporation, *Carmacks Copper Project Performance Standards and Design Criteria Parameters*, August 2004

Western Silver Corporation. Website Accessed December 2, 2004
URL: http://www.westernsilvercorp.com/projects_developmentproperties.php

Yukon Community Profiles. Website Accessed March 11, 2005.
URL: http://www.yukoncommunities.yk.ca

Yukon Electrical Company Ltd., *Carmacks Copper Transmission Line Project, Project Application and Initial Environmental Evaluation,* 20 March 1995

Yukon Government, Administrative Procedures for Environmental Assessment of Major Mining Projects in the Yukon, September, 2004.