Western Copper Corporation

Project Proposal

Carmacks Copper Project
Yukon Territory

Appendix C

Carmacks Copper Project Performance Standards and Design Criteria Parameters (2005)

Western Silver Corporation

Carmacks Copper Project

Performance Standards and Design Criteria Parameters

April 2005

CONTEXT OF THIS DOCUMENT

This document, prepared by Western Silver Corporation, is a revised version of a report prepared by Western Copper Holdings Ltd. entitled "*Carmacks Copper Project Design Criteria and Parameters*" (October, 1998) and subsequently presented to Yukon Government (YG), Energy, Mines and Resources in August 2004. The rationale for the selection of project design criteria and parameters is not presented in this document. The reader is referred to the Carmacks Copper Project listing of reports for further details and information.

The purpose of this document is to provide a summary of project performance standards and objectives, and engineering design objectives and criteria. The project performance standards and design criteria are being presented for discussion with government authorities to ensure that regulatory requirements are being met.

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1.0 INTRODUCTION

1.1 GENERAL

The Carmacks Copper Project is a proposed open pit copper mine and solvent extraction and electro winning (SXEW) processing facility being developed by Western Silver Corporation (formerly Western Copper Holdings Ltd.). It is located in the Yukon Territory, approximately 38 km northwest of the town of Carmacks. 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, and miscellaneous facilities to support mining operations. A crushing plant may also be constructed for ore and fill processing.

This document is being presented as part of the Project Description for discussion with Yukon regulators to determine the overall performance standards and design criteria that will guide the construction operation and decommissioning of the project. The standards and criteria presented here are intended to support a Yukon Environmental Assessment Act Screening and Water License Application. It presents performance standards and objectives for environmental protection consistent with industry best practices, and the design criteria and parameters that will be used to update the analysis and design of the mine facilities for presentation to the review and regulatory committees. These criteria and parameters consider primarily the geotechnical and operational aspects of the design of the mine facilities, and do not address the SX/EW plant processing plant or its associated infrastructure. More detailed information will be presented in the project description and design reports.

The definition of a performance standard is a numerical limit or narrative statement adopted from criteria or objectives in a legally enforceable form, such as in a regulation, statute, contract or other legally binding document (Environment Canada, 1991). The distinction between design criterion and a design parameter is the difference between the intended output and input.

1.2 PROJECT DESCRIPTION

Active mining at the Carmacks Copper project is estimated to be for eight years, producing about 60 million tonnes of waste rock, and 13.3 million tonnes of copper ore. Using shovels and trucks, the mine will remove an overall average of about 20,500 tonnes per day of waste rock and overburden year round from the open pit to the appropriate stockpiles. 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 ore on a 31.5 ha lined heap leach pad in 8-m lifts. Studies are underway to consider the possibility of crushing the ore before it is conveyed to the leach pad.

Once on the heap, 540 m^3/hr of raffinate (a barren acid solution) from the process plant will be applied to the surface of the ore at rate of 0.204 L/min/m^2 by a system of buried drip emitters. After leaching through the ore, the pregnant leachate solution (PLS) will be collected in a network of pipes on top of the leach pad liner and flow either directly to the process plant or to the events pond below the heap.

After mining ceases, the heap will be leached for about two more years. When the leaching is no longer economical, the heap will be rinsed for about three years then decommissioned. *In-situ* biological treatment will be undertaken in the heap to neutralize and stabilize metals. Active water treatment may be required for a period of time to reach effluent performance standards; however, a long-term passive treatment (infiltration gallery) is proposed for final closure. Preliminary metallurgical test work indicates that the heap can be rinsed and neutralized.

1.3 DESIGN OBJECTIVES

The principal objectives of the design for the various mine facilities are to:

- Use industry best management practices to meet existing environmental laws and regulations;
- Ensure protection of the regional groundwater and surface water quality and flows both during operations and in the long-term;
- Stage the development to minimize the environmental disturbance at any one time during operations, and to distribute capital expenditures over the life of the facility;
- Monitor the operation to check that the design objectives are met and that environmental impacts are predictable and acceptable; and
- Reclaim the facilities to a condition compatible with the original land use, ensuring long-term stability under extreme precipitation and design seismic events.

The principal objectives of defining performance standards are as follows:

- The protection of health and safety of public and area fauna by the elimination of unacceptable health hazards;

- Reclaiming for future use the areas where infrastructures (buildings, chemical and fuel storage, roads, sediment ponds, solution treatment facilities, tailings facilities, waste rock storage areas (WRSA), heap leach pads, open pits) are located;

- Absence or mitigation in the production and circulation of substances that could damage the receiving environment;

- The restoration of the site to a condition that is visually acceptable to the community; and

- In the long term, eliminating the need for monitoring and maintenance.

Performance standards will be established for effluent quality, receiving water quality, groundwater quality, and revegetation.

2.0 GENERAL DESIGN CRITERIA AND PARAMETERS

2.1 DESIGN LIFE AND CONSEQUENCE CATEGORIES

The design life of the mine facilities is approximately 12 years, (8 year mine life; 2 years residual leaching; 2 years heap detoxification and decommissioning) with long-term closure monitoring following. It is expected that the site would be monitored for a further period of time after decommissioning to demonstrate the effectiveness of closure measures.

The embankments at the Carmacks Copper site will not impound fluids for long periods during operations. The following measures will achieve this:

- Low-level outlets within the heap confining embankment will prevent fluid impoundment during normal operations.
- Solution in the events pond and sediment ponds will be used as makeup water in the heap.
- Water in the sediment ponds will drain through decant structures in the abutments.

According to the classification method proposed by the Canadian Dam Safety Association (CDSA, 1999), the consequence category for the heap leach and events pond embankments is “high”.

2.2 SITE HYDROLOGY

Details of the site hydrology are presented in the Clearwater Consultants Ltd. Design Memoranda CCL-CC2 (March 13, 1998) and CCL-CC2A (April 28, 1998). Average values for key hydrologic parameters are summarized in the table below for a typical elevation of 850 m at the Williams Creek site. Values for extreme wet and dry conditions are presented in the source documents.

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

2.3 SPILLWAYS

Emergency overflow spillways will be provided for all water and solution storage reservoirs to prevent uncontrolled overtopping of embankments. The heap and event pond spillways will be sized to pass the peak flow from a 100-yr return period storm. Embankment crest elevations will be determined by adding 500 mm of freeboard to the maximum routed water elevation.

2.4 DIVERSION CHANNELS

Surface water diversion channels will be provided around key project facilities to divert natural runoff water away from the structures. The channels will be designed with 250 mm freeboard above the peak flows from a 100-yr return period storm event. Diversion channels will be consistent with the design hydraulic capacity of the structure and will be based on the maximum flow velocities expected in the local channel.

2.5 SEDIMENT CONTROL

Sedimentation below the leach pad and events pond areas, waste dumps and plant site will be controlled with conventional settling ponds. The settling ponds will be sized to remove inflowing suspended sediments down to fine silt sizes for events up to a 10-yr return period 24-hr duration storm. Emergency spillways will be provided for each pond as described in Section 2.3.

2.6 SEISMIC CRITERIA

2.6.1 Maximum Credible and Design Basis Earthquakes

The heap confining embankment and events pond dam have a “high” consequence category as described by CDSA. Accordingly, these two embankments will be designed to withstand accelerations resulting from the greater of 50 percent of the Maximum Credible Earthquake (MCE) from a deterministic analysis or the acceleration from an earthquake with a 1000-yr return period from a probabilistic analysis. The sediment control pond embankments and the waste rock storage area have “ very low” to “low” consequence categories, and will also be designed to withstand earthquake accelerations with a 475-yr return period.

From probabilistic analyses conducted by the Pacific Geoscience Centre the maximum ground accelerations associated with the 475-yr and 1000-yr return period earthquake is estimated to be 8.5 percent and 10.3 percent of gravity, respectively. Using deterministic methods, the maximum credible design acceleration is 13.2 percent of gravity and will be used for stability analysis purposes with a corresponding factor of safety greater than 1.

The heap confining embankment and events pond dam will be designed to withstand horizontal accelerations of 10.3 percent of gravity and satisfy a minimum factor of safety of 1.15 or greater. Similarly, the other embankments and waste rock storage area will be designed for 8.5 percent of gravity.

2.6.2 Allowable Deformations and Seismic Coefficients

For lined waste impoundments in the U.S., Seed and Bonaparte (1992) describe the current practice as using an allowable seismic displacement of 150 to 300 mm. A displacement of 150 mm will be allowed at the crest of the heap confining embankment and the events pond dam.

The following table summarizes project allowable crest displacements.

Embankment	Consequence Category	CDSA Max ground Accel, %g	Allowable Disp, m
Heap confining embankment	High	10.3	0.15
Events pond dam	High	10.3	0.15
Sediment pond dam	V. low-low	8.5	1.0
Waste rock pile	V. low-low	8.5	3.0

2.7 GEOTECHNICAL STABILITY

For the steady-state static loading condition at the “high” consequence structures-the heap confining embankment and events pond dam-the factor of safety will be at least 1.5 for all failure mechanisms.

For the seismic loading condition, the factor of safety for the heap confining embankment and events pond dam will be greater than 1.0 at the maximum credible earthquake and at least 1.15 using the maximum design earthquake seismic coefficients.

For the end of construction static loading condition, all structures will have a factor of safety of at least 1.3, regardless of consequence category.

2.8 PERMAFROST

Where the soils are unfrozen, or frozen but with a moisture content not greater than 17 percent, construction can proceed without any special foundation treatment. Prior to construction in the heap and extent ponds area, test holes will be drilled in a 50-m grid pattern to bedrock or a maximum depth of 25 m, whichever is shallower. In the waste rock storage area, test holes will be drilled in a grid pattern prior to construction. A construction quality assurance and quality control (QA/QC) manual will be developed and submitted prior to construction.

2.9 EFFLUENT WATER QUALITY

All effluent, which is discharged from the project, both during operation and at final decommissioning, shall meet the following effluent quality standards, which are provided in Schedule IV of the *Metal Mining Effluent Regulations*.

Authorized Limits of Deleterious Substances (as stated in the Metal Mining Effluent Regulations)

Item	Column 1 Deleterious Substances	Column 2 Maximum Authorized Monthly Mean Concentration	Column 3 Maximum Authorized Concentration in a Composite Sample	Column 4 Maximum Authorized Concentration in a Grab Sample
1	Arsenic	0.50 mg/L	0.75 mg/L	1.00 mg/L
2	Copper	0.30 mg/L	0.45 mg/L	0.60 mg/L
3	Cyanide	1.00 mg/L	1.50 mg/L	2.00 mg/L
4	Lead	0.20 mg/l	0.30 mg/L	0.40 mg/L
5	Nickel	0.50 mg/L	0.75 mg/L	1.00 mg/L
6	Zinc	0.50 mg/L	0.75 mg/L	1.00 mg/L
7	Total Suspended Solids:	15.00 mg/L	22.50 mg/L	30.00 mg/L

NOTE: All concentrations are total values.

2.10 RECEIVING WATER QUALITY

The project shall be operated and decommissioned in such a manner that the long-term water quality of lower Williams Creek shall meet the objectives of the Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life, prepared by the Canadian Council of Minister of the Environment, 1999, updated 2002.

2.11 GROUNDWATER QUALITY

The project shall be operated and decommissioned in such a manner that the long-term groundwater quality down gradient of the heap and WRSA shall meet the objectives of the Yukon Environment Act, *Contaminated Sites Regulations,* Aquatic Life criteria (Schedule 3).

2.12 REVEGETATION

General standards that will be followed with respect to revegetation are as follows:

- Vegetation is self sustaining and comprises native seed mixes;
- The vegetative cover is capable of self-regeneration without continued dependence on fertilizer or re-seeding;
- The establishment of a vegetative cover with sufficient density and species diversity to stabilize the surface against the effects of long term erosion;

- The successive vegetation must be similar to naturally occurring habitats in the surrounding area;
- Plant material does not show detrimental uptake of metals; and
- Points of compliance for revegetation will ensure that:
  - -fertilizing/seeding completed;
  - -vegetation established; and
  - -vegetation accepted.

Refer to Appendix A for the performance standards and criteria that YG has set as the minimum standards for the project.

3.0 HEAP LEACH FACILITY

3.1 DESIGN BASIS

The heap will be designed to store approximately 13.3 million tonnes of ore at a dry density of 1.9 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 an approximate rate of 9,872 tonnes per day for up to 300 days per year. Periods of higher or lower loading rates are expected due to operational considerations. 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 either haul trucks or conveyor. It is anticipated that approximately 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 GENERAL ARRANGEMENT

The ore will be placed on the valley-fill heap in 8-m lifts by conveyors and leached in subsequent lifts, progressing up slope for the first lift 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 a leak detection and recovery system (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 approximately 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 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.

3.3 GEOTECHNICAL AND HYDROGEOLOGICAL PROPERTIES

The following documents form the basis for selecting the principal geotechnical and hydrogeological properties for final design of the leach pad, heap confining embankment, waste rock storage area, events pond dam and other foundation structures:

- Knight Piésold, Ref. No. 1783/1, May 1995 'Report on Preliminary Design' – Laboratory test work and index test results, including foundation materials, pre- and post-leach ore, geosynthetic/soil interfaces, and geosynthetic/geosynthetic interfaces.

- Knight Piésold, Ref. No. 1784/1, June 1996 'Report on 1996 Geotechnical and Hydrogeological Site Investigations' – Laboratory test work and index test results, including permeability, coefficient of consolidation, coefficient of volume compressibility, and uniaxial compressive strength of bedrock.

The table below provides a list of materials and interfaces to be considered during design and the principal geotechnical and hydrogeological parameters adopted for each.

Zone	Material Requirements	Placement and Compaction
Drainage Blanket Filter Zone	Sand and gravel or rockfill from designated borrow areas or required excavations. Selected or processed material.	Placed in maximum 500 mm lift thickness and compacted with a vibrating smooth drum roller.
Random Fill Zone A	Selected earthfill or rockfill from designated borrow areas, required excavations and/or from preproduction stripping of the ore body.	Placed in maximum 500 mm lift thickness and compacted to a minimum 95% modified Proctor maximum dry density.
LDRS Drainage Layer	Sand and gravel from designated borrow areas or required excavations. Processed material.	Placed in one lift to a uniform density, free from excess voids.

3.4 LINER SYSTEM

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: we have designated these zones 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 liner system will be comprised of the following components:

<u>Upper Works</u>
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;

- Leak detection and recovery system (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;
- Leak detection and recovery system (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;
- Leak detection and recovery system (LDRS) comprising a high transmissivity tri-planar geocomposite;
- 12 oz nonwoven polypropylene geotextile;
- 60 mil textured HDPE lower liner; and
- Subgrade.

3.5 LEAKAGE CRITERIA

For the valley leach pad, leakage through the upper composite liner system, which will be collected and monitored through the LDRS; will be estimated. The permeability of the various layers used in the design is as follows:

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

Using the methods described by Giroud and Bonaparte (1989b), the allowable leakage rate into each cell of the LDRS is 100 L/day averaged over a 12-month period, and 300 L/day averaged over a 3-month period. The estimated leakage rates will be achieved by placing solution recovery pipes in the overliner and the LDRS layers to reduce the hydraulic heads on, and thus the flow through, the underlying liners. The collection pipe systems within the overliner and LDRS layers will flow by gravity to the perimeter of the pad and then to the plant. Flow rates from individual cells of the LDRS will be monitored daily during operations.

3.6 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.
- To provide adequate anchoring resistance to withstand the pullout forces generated by gravity and thermal expansion and contraction of the HDPE geomembranes.

3.7 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.

4.0 EVENTS POND

4.1 DESIGN BASIS

Active solution storage will not be within the heap, but in the events pond below the heap confining embankment. 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).

This capacity will be available each year at the start of the winter season.

Details of the leach pad water balance and the determination of design solution storage volumes will be presented in the Clearwater Consultants Ltd. Design Memorandum CCL-CC4.

4.2 GENERAL ARRANGEMENT

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.

Immediately below the heap confining embankment toe, the events pond will have a lined area of about 62,000 m^2 and a storage capacity of about 160,000 m^3. This storage will 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.

The events pond will incorporate two HDPE geomembrane liners with a high-transmissivity geonet drainage layer placed in between. There will be an emergency spillway in the dam crest as described in Section 2.3.

4.3 LINER SYSTEM

The entire events pond will have a double liner with an integral LDRS. From the bottom up, the liner system will be comprised of the following components:

- Subgrade – areas of suitable *in-situ* material and areas that will be covered by borrow material backfilling excavations of unsuitable material;
  – random fill as defined in the technical specifications;
  – maximum particle size of three quarters of the approved layer thickness;

- HDPE Liner – the lower geomembrane liner will be 40 mil smooth HDPE and the top geomembrane liner will be 60 mil;
  – random fill as defined in the technical specifications;

- Leak Detection and Recovery System – high transmissivity polyethylene geonet placed between the two geomembranes;
  – leakage into the LDRS layer will be conveyed back to the pond via a sump at the low point of the events pond accessed by an inclined riser and submersible pump.

4.4 LEAKAGE CRITERIA

Using the methods described by Giroud and Bonaparte (1989b), the 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.

5.0 WASTE ROCK STORAGE

5.1 DESIGN BASIS

The waste rock storage area will cover an area of 70 ha and have a storage capacity of about 60 million tonnes. Waste rock will be placed year round at an annual rate of approximately 7.5 million tonnes.

Designs for the waste rock storage area will conform to the British Columbia Mine Waste Rock Pile Research Committee Investigation and Design Manual Interim Guidelines, May 1991.

5.2 GENERAL ARRANGEMENT

The waste rock storage area will be developed in horizontal lifts by trucks and bulldozers. The waste rock will be dumped in 25 m high lifts with intermediate benches wide enough to maintain an overall slope of approximately 2½ h: 1v. A 100-m wide stripped buffer will be maintained below the toe of the waste rock pile until the final configuration is achieved.

Most of the upper limit of the waste rock storage area is either immediately below the open pit or on a local drainage divide, so there is no need to divert upslope runoff. Ditches around the lower perimeter will collect surface runoff and seepage from the waste rock pile and drain to a sediment control pond. The sediment control pond will be routinely monitored for effluent quality.

6.0 OPEN PIT

The proposed open pit is approximately 800 by 400 m at the existing ground surface and will be approximately 275 m deep at its deepest point. Based on preliminary estimates, the layout of the pit calls for ultimate inter-ramp angles of 55 degrees with overall angles of 41 degrees in the northwest and southeast sectors and 45 degrees and 55 degrees in the northeast and southwest sectors respectively. Double benching will be used, with the bench height and catchment berm width being 12 m and 8 m respectively. Bench face angles will be blasted to 70 degrees. A study of pit optimization factors may alter the internal design and sequencing of the pit operation.

In developing these slope angles, various failure mechanisms, including failure along local structural discontinuities and deep-seated failures through the surrounding rock mass have been considered. Further open pit details are provided in Report on Pit Slope Stability (Knight Piesold Ref. No. 1782/3, January, 1993).

Water from the open pit 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 Section 2.9).

7.0 HAUL ROADS

Haul roads within and around the open pit, waste rock storage area 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.

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.

Bridges 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.

8.0 CLOSURE REQUIREMENTS AND RECLAMATION

8.1 HEAP LEACH FACILITY

Closure requirements for all facilities will be planned to satisfy the requirements of the performance standards and licences issued under the Quartz Mining Act and Yukon Waters Act and Regulations.

In-situ neutralization of the spent ore pile is planned and to be complemented with a passive infiltration gallery. Once the last ore is loaded and the full leach cycle is complete there will be a period when acid is no longer applied but copper recovery continues (Stage IV, Years 8 and 9). This stage will end when copper recovery is no longer economical.

At that time, the heap will be rinsed with water for a period yet to be determined but for the current analysis is assumed to be 3 years (Stage V). *In-situ* biological heap neutralization may follow using alcohols, sugars, and bacteria. The length of the rinsing and *in-situ* neutralization period will depend on economic and chemical criteria, focusing on the cost to achieve effluent that can be directly discharged and then subsequently treated using a passive system (infiltration gallery).

Following Stage V, the heap will be fully drained down, excess solutions will be neutralized, treated and released, and an evapotranspiration cover will be placed. At closure, the heap will be a stable rock pile that will not impound water except temporarily during high-precipitation or high-runoff events.

The evapotranspiration soil cover will cover the ore to reduce the volume of precipitation entering the heap and enhance water evaporation. The permeability of the cover will be finalized after further testing and analysis of the results. To allow placement of the cover, the heap slopes will be re-contoured to a continuous 2 ½ h:lv slope by regrading the intermediate benches and angle of reposes slopes. Runoff interception ditches will cross the final surface of the cover to prevent surface erosion. These ditches will be designed to convey peak flows from a 100-yr return period storm event of critical duration, and will be armored to prevent erosion.

Diversion channels surrounding the heap will be left intact and stabilized for closure to reduce the volume of upslope runoff entering the heap. Diversion channels will be designed to convey peak flows from a 100-year return period storm event of critical duration.

Spillways will be sized to accommodate a peak flow consistent with a CDSA 'moderate' consequence category structure with allowances for freeboard.

8.2 EVENTS POND

The events pond will be retained and used for storing spent ore seepage at closure. Spent ore seepage will be treated if required, in the water treatment plant and released to the sediment pond or allowed to evaporate seasonally in the events pond. Alternatively and in the longer term, neutralized heap seepage would be directed to an infiltration gallery. The events pond design criteria for solution storage will remain the same as the operational design criteria. These design criteria also consider the criteria for sizing the contingency water treatment plant. Physical stability criteria will be as those for operations. The pond spillway will be sized to pass the peak flow from a critical duration event of an approximately 475-yr return period. Since the solution volume will be less than during operations and the solution will be diluted, there will be no leakage criteria specified after closure.

When the spent ore seepage meets effluent discharge criteria and is suitable for direct release to the environment, the events ponds will be decommissioned by draining all fluids, sampling and testing any sediment, and disposing the sediment in a manner consistent with the regulations then in effect. Liners will be folded over, covered and the dikes breached to prevent water accumulation.

8.3 WASTE ROCK STORAGE AREA

The overall dump geometry will not be modified at closure. Surface water ditches and the sediment pond will remain until water quality, as a minimum, meets the *Metal Mining Liquid Effluent Regulations* effluent discharge criteria and is suitable for direct release. Diversions and the sediment pond will be stabilized with the closure design criteria remaining the same as during operations.

8.4 OPEN PIT

Preliminary calculations estimate that it will take over 300 years to flood the open pit from direct precipitation alone, assuming no exfiltration to ground water. Based on the current understanding of the ground water regime, ground water contributions to mine water are expected to be negligible. Consequently it is unlikely that the open pit can be flooded.

Criteria for measures to close the pit will include the public safety. Steep slopes will be blocked with fences or large rocks to prevent inadvertent access.

8.5 PLANT SITE

Criteria for closure includes a chemically and physically stable land surface, land use capability consistent with the surrounding area, public health and safety, minimal hazards to wildlife and self-sustaining vegetation

It will be important to maintain access as required by the closure plan. Once safety issues have been dealt with, a significant criterion for road closures will be the desires of the Little Salmon/Carmacks First Nation and the local community. Where necessary, mine haul roads will be stabilized, scarified to minimize future erosion, and revegetated.

9.0 REFERENCES

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Carmacks Copper Project

Performance Standards and Design Criteria Parameters

Appendix A

YG Performance Standards for Carmacks Copper Project

APPENDIX A

Performance Standards for Carmacks Copper Project

- Work should be conducted by properly qualified professionals
- Where possible, progressive reclamation will be part of the plan

DESIGN STANDARDS

Issues	Performance Objective	YG Guideline/Standard
CRITICAL		
ML/ARD Concerns with Heap -Heap detoxification -Acid drainage - Operational and post-closure	Prevent significant impacts to downstream terrestrial and aquatic resources Prevent significant post-mining ecological and human health impacts on the mine site Minimize liability and environmental risk both during operation and after mine closure Adequate understanding and commitment from proponent to conduct required work No requirement for perpetual treatment	• Meet CCME guidelines in fish bearing waters • MMER last point of control • Assess the ML/ARD potential of all affected geological materials. ie excavated (mine wastes), exposed (mine walls) and post-leach (heap) • When necessary, develop plans for impact prevention (mitigation), operational material characterization, material handling, waste disposal, site reclamation, water management, monitoring and maintenance. • Identify the required work including the time frame, risks, liabilities, and post-mining alienation of resources. • Follow design requirements and conduct the work outlined in 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**

Issues	Performance Objective	YG Guideline/Standard
		Minesites in British Columbia.
Solution Control -Process Waters	Prevent discharge of noncompliant waters	• Provide storage capacity to contain normal operating levels + 10 year snowmelt + 100 year 24hr storm event **+** sufficient draindown capacity. (Proponent must substantiate their proposed draindown containment capacity based on sound reasoning and a risk assessment utilizing accepted methodology) • Leak detection and recovery system with contingency plans
Liner Design	Prevent discharge of noncompliant waters	• Liner System (including materials; conceptual construction methods and conditions; operation and maintenance procedures) achieving a permeability at least equivalent to a synthetic liner over a 12" soil liner with permeability of 10^{-6} cm/sec • Leak detection and recovery system with contingency plans
Physical Stability of heap and associated earth works, such as berms constructed to constrain leachate	Minimize risk of liner damage	• Suitable design, criteria based on Canadian **Dam Association's "Dam Safety Guidelines" (1999)**
Waste Rock Dump Stability	Physical Stability	• **BC Mine Waste Rock (1991) Interim guidelines**
Waste Rock ML/ARD Concerns	Prevent significant impacts to downstream terrestrial and aquatic resources Prevent significant post-mining ecological and human health impacts on	• Meet CCME guidelines in fish bearing waters • MMER last point of control • Assess the ML/ARD potential of all affected geological materials. ie excavated (mine wastes), exposed (mine walls) and

Issues	**Performance Objective**	**YG Guideline/Standard**
	the mine site Minimize liability and environmental risk both during operation and after mine closure Adequate understanding and commitment from proponent to conduct required work No requirement for perpetual treatment	post-leach (heap) • When necessary, develop plans for impact prevention (mitigation, operational material characterization, material handling, waste disposal, site reclamation, water management, monitoring and maintenance, and • Identify the required work including the time frame, risks, liabilities, and post-mining alienation of resources. • Follow design requirements and conduct the work outlined in 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.**
OTHER		
Terrestrial Reclamation Standards	As per attached Terrestrial Reclamation Standards	As per attached Terrestrial Reclamation Standards

Note:

1. Project proposal must be based on sound technical design and Industry Best Management Practices.

Terrestrial Reclamation Standards

Global Objectives

1. The protection of health and safety of public and area fauna by the elimination of unacceptable hazards.
2. Reclaiming for productive future use the areas where infrastructures (e.g., buildings, chemical and fuel storage, roads, sediment ponds, solution treatment facilities, tailings facilities, waste rock storage areas, heap leach pads) are located.
3. Prevent significant exposure to or release of substances that could damage the receiving environment.
4. Minimize liability and environmental risk.

Terrain Stability

Objective: Protection of health and safety through measures to prevent or otherwise protect from terrain hazards.

General Standards

1. Access to areas of unsafe drop-offs are blocked
2. Internal and external waste rock storage are re-contoured to a stable configuration

Erosion Control

Objective: Prevent erosion that significantly impacts drainage quality or impedes productivity of reclaimed site.

General Standards

1. Slopes are stabilized by contouring and leveling to provide land forms which conform to the surrounding terrain and provide suitable seedbeds
2. Lack of erosion features on re-sloped surfaces such as gullies and rills
3. Diversion ditches are constructed to guide drainage away from pit walls, where necessary
4. Vegetative mat is sufficient to control erosion
5. Adequate growth media (fines) is present to sustain re-vegetation
6. Appropriate pit ponds and decants are in place

Re-vegetation

Objective: To protect wildlife habitat through the reestablishment of a vegetation mat (food source, cover, hide etc,..) and self sustaining native vegetation.

General Standards

1. Vegetation is self sustaining and comprises native seed mixes
2. The vegetative cover is capable of self-regeneration without continued dependence on fertilizer or re-seeding.
3. The establishment of a vegetative cover with sufficient density and species diversity to stabilize the surface against the effects of long term erosion
4. The successive vegetation must be similar to naturally occurring habitats in the surrounding area
5. Plant material does not show environmentally significant uptake of metals
6. Points of Compliance
   -fertilizing/seeding completed
   -vegetation established
   -vegetation accepted
   - Vegetation must be self-sustaining for an appropriate period
   - if vegetation is not acceptable, measures will be taken to re-seed or apply further growth media where necessary

Roads and Trails

Objective: Decommissioning of access corridors when they are no longer required

General Standards

1. Removal of bridges, culverts & pipes. Streambeds re-established with appropriate stabilization of banks.
2. Stabilization of banks, road fills and cuts
3. Installation of diversion berms on steep slopes
4. Reclamation of the surface and seeding
5. Ensure road cuts are stable and access is restricted where there is a safety hazard
6. Access to be restricted with appropriate signage for areas posing a safety risk

Buildings and Infrastructure

Objective: Removal of all structures and re-establishment of vegetation mat.
Removal of all hazardous material

General Standards

1. Structures removed
2. Waste from dismantling is removed from the site and reused or stored in an authorized waste disposal site
3. All buried support infrastructures (tanks, pipes, underground services, etc.) should be removed or decommissioned in a safe, acceptable manner. All buried infrastructure remaining will be identified on site closure maps.
4. All non-toxic waste may be disposed of in an approved waste disposal site. The location and contents of disposal sites will be identified and recorded

5. In all areas where fuel and chemicals were stored and handled at the site, the soil has been tested for contaminants, and treated if required
6. Mining equipment, ore processing equipment, and heavy machinery has been removed from the site
7. After being emptied, decommissioned septic tanks are either removed or completely filled with gravel, sand, earth or inert material
8. Foundations covered with soil and self sustaining vegetation established.
9. Contaminated soils remediation will conform to the Yukon Contaminated Sites Regulations.
10. No hazardous materials remaining on site