Western Copper Corporation

Project Proposal

Carmacks Copper Project
Yukon Territory

Appendix F

Conceptual Closure and Reclamation Plan
(Updated 2006)

Western Copper Corporation

CARMACKS COPPER PROJECT
YUKON TERRITORY

CONCEPTUAL CLOSURE AND RECLAMATION PLAN
REVISION No.2

OCTOBER 2006

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1. INTRODUCTION

1.1 Project Summary

This report was originally prepared in June 1997 by Western Copper Holdings Ltd. The report has since been modified in May 2005, in August 2006 (Revision No.1) and again in October 2006 (Revision No.2) to reflect the current status of the project and planned conceptual closure measures.

The Carmacks Copper Project is a proposed open pit copper mine and processing facility being developed by Western Copper Corporation (WCC or Western). It is located in the Yukon Territory, 38 km northwest of the town of Carmacks.

The project will comprise an open pit, crushing plant, acid heap leach and copper extraction facility and events pond, associated waste rock storage area, soil stockpiles, drainage ditches and sediment control ponds, and support facilities. The projected mine life is 8 years, followed by the mine closure

The general arrangement of the project is shown in Drawing No. 1785.000.

1.2 Closure Objectives

The overall objectives in mine reclamation and closure are:

- protection of public health and safety;
- prevent, minimize or mitigate adverse environmental impacts;
- reclaim the site such that, in time, the reclaimed land is comparable visually and for land use purposes to the undisturbed surrounding land; and,
- long term stability of the heap leach and waste rock storage area and site water quality.

For the Carmacks Copper Project, these objectives will be embodied in the design, development and operational phases of the project. The design, construction and operation of the mine and associated facilities will be performed recognizing and understanding the mine closure requirements and with a view to minimizing the post closure efforts to achieve the reclamation and closure objectives.

The ideal scenario at closure is to be able to achieve the above objectives in a “walk-away” scenario, that is, one in which there will be no further requirements for monitoring and maintenance. It is envisaged that a period of post reclamation "active care" will be required until it has been satisfactorily demonstrated from the results of site monitoring that reclamation measures have achieved the required outcomes and are self-sustaining.

This document describes the concepts that have been developed for the closure and reclamation of the Carmacks Copper Mine. The scenarios addressed include both temporary shutdown and final closure. The long-term objective of a "walk-away" closure condition has been shown to be technically feasible. Further testing and investigation will continue during development and operation in order to implement these concepts smoothly at ultimate closure. At this time, therefore, an initial active care system is proposed to rinse and neutralize the heap, followed by a passive care system. The conceptual closure and reclamation plan for the project is shown in Drawing 100-13-60.

Also described in this document are the testing programs and engineering designs that have been incorporated into the proposed project development for reclamation and closure planning purposes. The Conceptual Closure and Reclamation Plan may be modified during the detailed design progress or as data and experienced is obtained through operation of the facilities.

1.3 Closure Issues

Closure issues can be considered in terms of the following major areas:

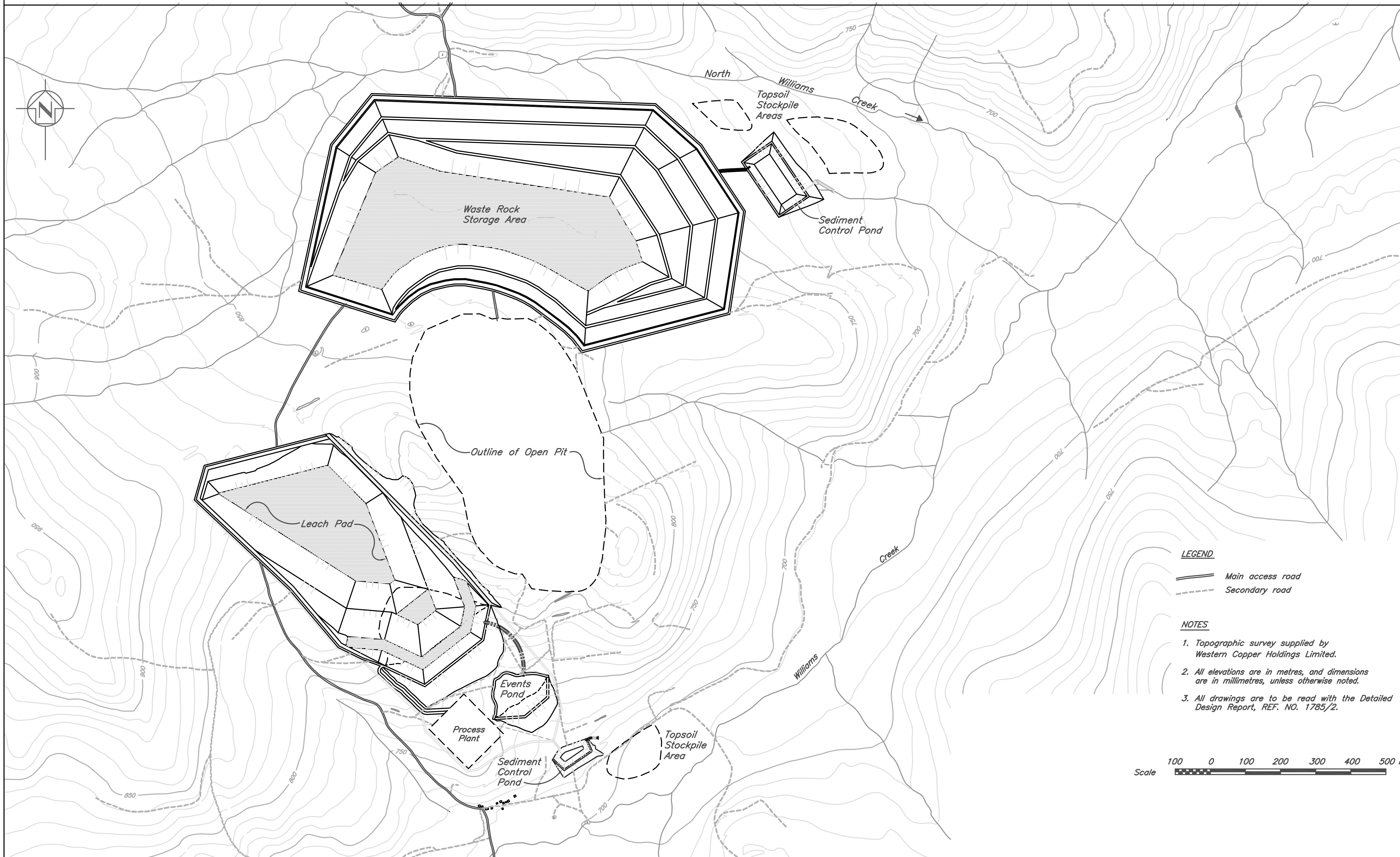
- issues associated with (geo)chemical stability;
- water quality;
- issues associated with physical stability; and,
- issues associated with land use, aesthetics and public health and safety.

For the Carmacks Copper Project chemical stability and water quality are the major issues to be addressed at closure.

At the closure of this copper mine there are no major water retaining structures, diversions or tailings impoundments for which physical stability must be ensured in the long term. The only facilities for which physical stability must be addressed are the spent ore heap and associated water management facilities, and the rock waste storage area.

For most of the site, including reclamation of the disturbed areas of the mine site and rock waste storage area, the primary issue relating to physical stability is the control of erosion.

Reclamation of the spent heap requires special consideration in that the ore has been chemically altered by the leaching process. Reclamation of the spent ore heap is discussed herein primarily in terms of the issues associated with water chemistry of the effluent from the leached material. The characteristics of the spent ore will determine the treatment process steps required to achieve the effluent water quality requirements.



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, "General Arrangement", Drawing #1784.000

General Arrangement

Drawing Number: 1785.000

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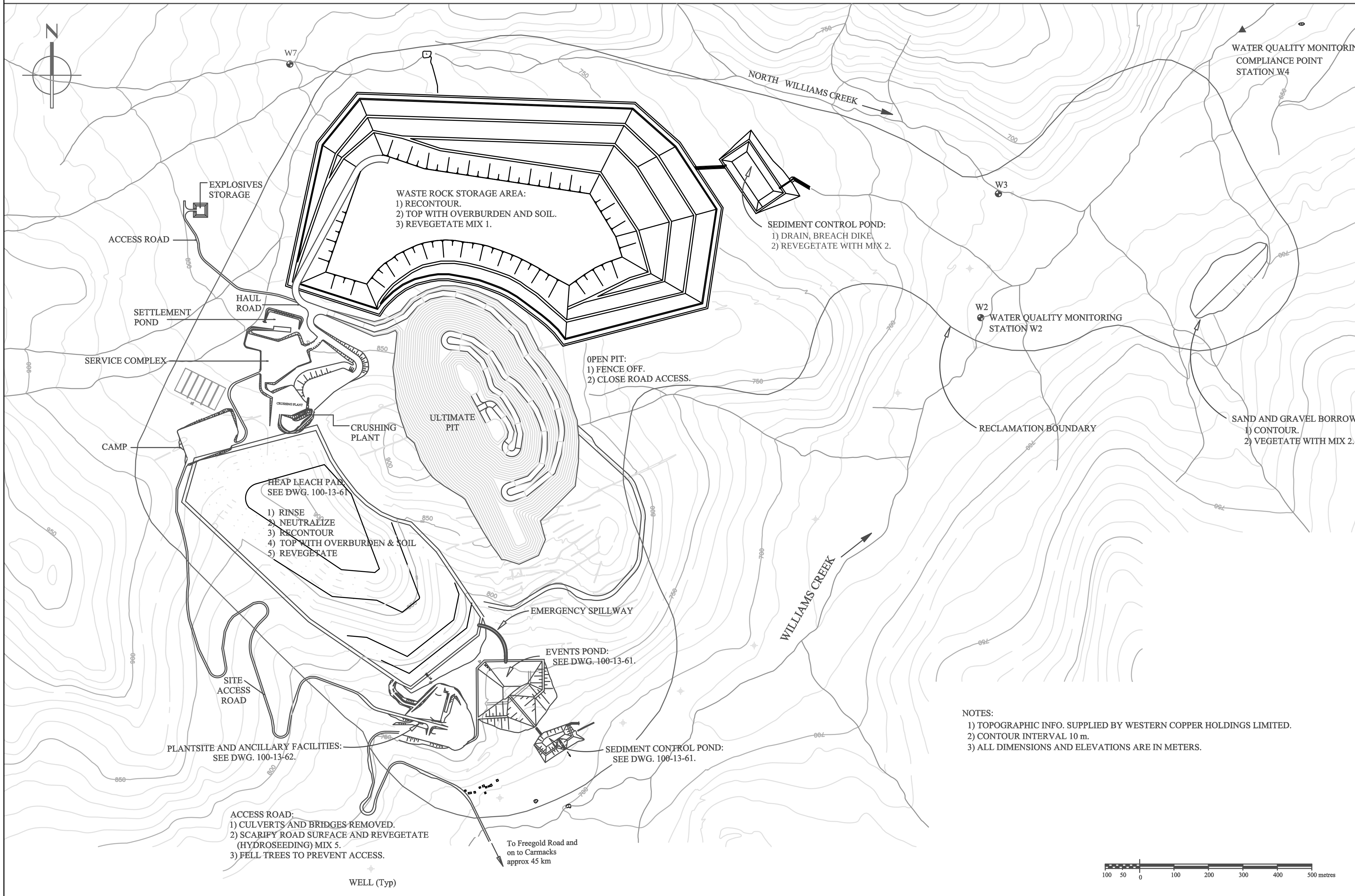

Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

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"Overall Site Conceptual Reclamation/Closure Plan", Drawing #100-13-60 Rev B

Overall Site Conceptual Reclamation/Closure Plan

Drawing Number:
100-13-60

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Date: Feb. 1, 2005

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2. MINE WORKINGS

2.1 Description

The mine consists of a single open pit from which approximately 14 million tonnes of ore and 70 million tonnes of waste rock will be extracted.

The location and configuration of the pit is shown in drawing 1785.000.

2.2 Closure Issues

Issues to be addressed for closure of the open pit are:

- control of access for personnel safety and wildlife protection considerations; and
- pit water chemistry.

Investigations to date have shown that there is essentially no groundwater recharge to the open pit. Refer to IEE Addendum No. 3, Knight Piesold Report Ref. No. 1783/3 which provides a hydrogeological summary for the open pit. Based on recharge from precipitation alone, it is estimated that it will require over 300 years for the pit to fill. Seepage from the pit into the groundwater regime would be is expected to be very low due to the low permeability of the wall rock.

Based on investigations to date, it is not anticipated that there are water quality concerns associated with the pit water in the long term (IEE Addendum, June 1995, Section 4.2). Waste rock and therefore the pit wall rock is primarily strongly acid consuming as shown in the above named report and as a result any water accumulated at the bottom of the pit is expected to be neutral to alkaline. It is possible that there may be dissolved metals associated with some portion of the water draining from the pit walls in the pit pond., However, given that overall the pit water is anticipated to be alkaline it is expected that the metals will precipitate out or be present at very low concentrations..

2.3 Conceptual Closure Measures

At closure the pit will be allowed to flood, requiring at least 300 years based on current estimates.

To control inadvertent access by subsistence and recreational land users, the pit will be completely blocked off with large boulders placed around the pit perimeter or fenced off with a locked gate.

Areas along the top perimeter of the pit which were disturbed during initial stripping will be revegetated as required to reduce erosion and encourage regrowth of native plant species.

2.4 Remaining Issues and Investigations

Monitoring of pit water chemistry will be done regularly during operation. Since the data to date indicate that any water chemistry issues would be associated with metal leaching rather than long-term acid generation, monitoring during operation should indicate whether there are long-term concerns that need to be addressed and how this might best be accomplished.

3. HEAP AND PROCESSING FACILITIES

3.1 Description

The heap leach pad has been designed (EBA Engineering Ltd., March 2005) to:

- protect both the surface water and regional groundwater during operations and in the long term; and,
- provide a stable facility during extreme precipitation events and design seismic events during operation and after closure.

Details of the design and construction of the heap are provided in EBA Engineering Ltd, March 2005 report. The conceptual reclamation plan for the heap leach facility is shown in drawing 100-13-61.

The heap leach facility is designed for the valley heap leach method which involves preparation and placement of the ore on a pad behind a confining embankment. Leaching of the ore is performed with subsequent lifts progressing up slope. The heap is designed to hold approximately 14 million tonnes of oxide copper ore.

The heap leach pad covers an area of approximately 330,000 m^2 and comprises an engineered double composite liner system with a leak detection and recovery system. The pad is surrounded by a 2 m high berm on two sides and perimeter bench on the east side. There is a lined events pond, also with leak detection and recovery, downstream of the heap leach pad.

Runoff around the facility is diverted in ditches and routed to a sediment control pond. The design also includes a foundation drainage system installed beneath the heap leach pad to intercept and remove potential shallow groundwater flow, although no natural groundwater springs have been encountered to date.

3.2 Closure Issues

In the closure of a heap leach facility, the primary issues to be addressed are:

- physical stability of the leach pile;
- water management for both the heap and events ponds
- erosion and dust control from the heap;
- establishment of vegetation; and

- decommissioning of the events pond.

The issue of physical stability of the heap is addressed within the Heap Leach Pad Design Report (EBA Engineering, 2005).

The specific issues to be addressed in the consideration of water management for this copper heap leach are:

- rinsing of residual process solutions to remove acid and dissolved metals;
- neutralization of residual acidity in the rock mass;
- potential for acid rock drainage from sulphide oxidation;
- ore weathering and leach recovery ; and
- sludge disposal from treatment plant.

The test work addressing each of the above geochemical issues is discussed in detail in Lawrence and Beattie, 1996 and Beattie, 2001 and more recently in Alexco 2006a and Alexco 2006b. The testing and conclusions are briefly summarized below to provide explanation of proposed closure measures.

3.2.1 Heap Rinsing and Neutralization

At the completion of the initial leach testing program in 1996, the two metallurgical test columns were each rinsed over a 6 or 12 month period (for columns PC2 and PC1 respectively) with fresh water and then alkaline solutions, to evaluate requirements for rinsing at closure. Testing was also done to evaluate water treatment (neutralization) to reduce acidity and precipitate dissolved metals from both process (raffinate) and rinse solutions. The details of this testing are provided in the appendices to Lawrence and Beattie, 1996.

The testing showed that a combination of rinsing and water treatment (neutralization) is required to remove residual process solutions, reduce the release of dissolved metals from the heap rinse solutions and meet discharge water quality requirements. Water treatment using lime neutralization is successful at removing dissolved metals and acidity from the process and rinse solutions.

Complete rinsing and neutralization of the spent ore was not accomplished in the 1996 testwork; (how this will be accomplished in the field is outline below). Briefly, the heap decommissioning investigations indicated that:

- rinsing with water can remove the majority of the acidity and dissolved metals from the heap;
- however, longer term flushing with neutralized rinse solutions does not achieve “acceptable” discharge quality in the rinse solutions as metal concentrations remain elevated (e.g. Cu at > 20 mg/L) and pH values acidic (pH < 4.5);
- conventional alkali addition for water treatment is effective in removing dissolved metals and acidity from both raffinate and rinse solutions;
- re-circulation of neutralized rinse solutions appears to significantly and adversely affect the geochemistry of the spent ore, resulting in weathering of the gangue, buffering of drainage water at pH 4, and rendering ineffective further removal of copper from the spent ore.

More recent evaluation of the metallurgical data, water chemistry and further detoxification test work conducted by Beattie, 2001 on spent ore indicated that:

- process solutions can be rinsed from the columns using water rinses (without pH adjustment);
- in the latter stages of rinsing, the pH is controlled by weathering reactions in the alumino-silicate minerals, clays and feldspars with the dominant control primarily aluminium and silicate ions in solution;
- these alumino-silicates could also contribute to the apparent residual neutralization capacity of the spent ore;
- neutralization of the drainage water further accelerates the natural weathering of these minerals and changes the solution chemistry. This is supported by observation of rapid particle degradation of the spent ore when neutralized solutions are added to the columns;
- these buffering reactions are also probably limiting the removal of residual soluble copper from the column.
- Sodium carbonate is effective at altering the leached solids so that effluents have a neutral pH (not buffered at pH4 as previously experienced). 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 with lime in the events pond 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 etc to

diffuses from the rock particles. An effluent pH near pH 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.

Test columns completed in 2005 and reported by Alexco in 2006 (Alexco, 2006a) were designed to take advantage of the previous detoxification test work with the results summarized below.

The test results presented provide evidence of significant progress and demonstration on the ability to effectively rinse and neutralize the Carmacks Copper spent ore material. Most significantly are the results of Column 9 demonstrating all the parameters in the MMER list of standards, for direct discharge, were met. The main conclusions of the test results indicate:

- The use of sodium carbonate (Na_2CO_3) over lime (CaO) is superior for alkaline addition and no plugging problems are observed with Na_2CO_3 as is the case with CaO.
- Allowing the spent ore to rest after leaching is complete and before initial fresh water rinsing provides a higher initial pH compared to commencing fresh water rinsing immediately.
- Additional fresh water pulses continue to reduce soluble copper levels to the point where MMER standards are met.
- Acceptable copper and pH standards are met within reasonable timelines of 200 column days.
- Pulsing of fresh water appears to be more effective, likely due to some diffusion controlled mechanism of copper as well as the creation of new solution pathways and more effective overall rinsing;
- The addition of a carbon source did not provide any obvious benefit for stabilization of copper. However the assessment of this part of the program was not optimized and it should be further investigated;
- The optimum rinsing process at this point appears to consist of:
  - Initial fresh water pulse to flush residual acidity;
  - Adjustment of pH by pulsing an alkaline solution of 5% sodium carbonate;
  - Continued pulsing of fresh water followed by rest periods until copper has reached acceptable levels;
- The environmental testwork indicates the residual acid from leaching was effectively rinsed and the spent ore has very low or no acid generating potential which is consistent with the oxide nature of the material.
- It has been demonstrated to be technically feasible to

- o rinse the free acidity and
- o reduce metals to acceptable standards.

Alexco Resource Corp., Memorandum – Heap Rinsing Additional Information, June 2006 discusses scale up the detoxification test work and demonstrates that detoxification can occur year round.

The test work is described in more detail in Alexco 2006a and 2006b and Section 3.5 Remaining Issues and Investigations.

3.2.2 Ore Weathering

The weathering and resultant physical degradation of the ore during rinsing with neutralized solutions and, to a lesser degree, in the early stages of leaching resulted in an increase in fines in the column. In addition, precipitates were reported to have formed as a result of acid leaching in the early leach stages (Lawrence and Beattie, 1996, Section 5.1). Precipitates also formed as a result of the neutralization reactions, some of which were recycled to the column in the early stages of the treated water rinsing. The particle degradation and formation of precipitates within the column would limit permeability in local areas which would reduce both the leach recovery and local rinsing and neutralization.

During operation, however, reagent addition will be controlled to limit these degradation and precipitation reactions. As noted in the detailed testing report (Lawrence and Beattie, Section 5.2.2, and Beattie 2001), the degradation of the ore does not occur during the leaching stage but rather in the decommissioning (heap neutralization) stage. Test work conducted in 2006 indicates that initial rinsing followed by neutralization with sodium carbonate and then subsequent rinsing is the approach to decommissioning of the heap. Testing will continue through development and operations to optimize detoxification procedures

Some weathering and precipitation reactions are inevitable and can result in lower permeability zones in the heap. In these localized zones, the lower permeability will result in lower metal recovery and less complete rinsing both for decommissioning and in the long term, to infiltrating solutions. Thus, formation of precipitates and particle degradation must be avoided both during operation and decommissioning. Additional collection piping within the heap lifts has been suggested as a means to deal with this.

3.2.3 Metal Leaching and Acid Generation Potential

Samples of the composite ore for the metallurgical testing program were tested to determine acid generation and metal leaching potential. Details of the testing are presented in IEE Addendum, Section 4.2.4 (Hallam Knight Piesold, June 1995). The results show that the ore samples are net acid consuming with very low sulphur content. Tests reported by Lawrence (Lawrence and Beattie, 1996) show neutralizing potentials (NP) values ranging from 7.3 to 54 kg $CaCO_3$/t at the conclusion of leaching. Mineralogical analysis of leach residues indicates essentially no residual iron sulphide.

Further test work conducted by Alexco 2006a indicates that the residual acid from leaching was effectively rinsed, that the spent ore residue has very low sulphide sulfur concentrations (0.02%) and the spent ore has very low or no acid generating potential which is consistent with the oxide nature of the material.

Thus, no net acid generation from sulphide oxidation is anticipated from the spent heap. Further metallurgical and heap decommissioning testing will include analysis of the spent ore for acid base account and sulphur species. Further neutralization testing of the heap would be part of the program.

3.2.4 Sludge Disposal

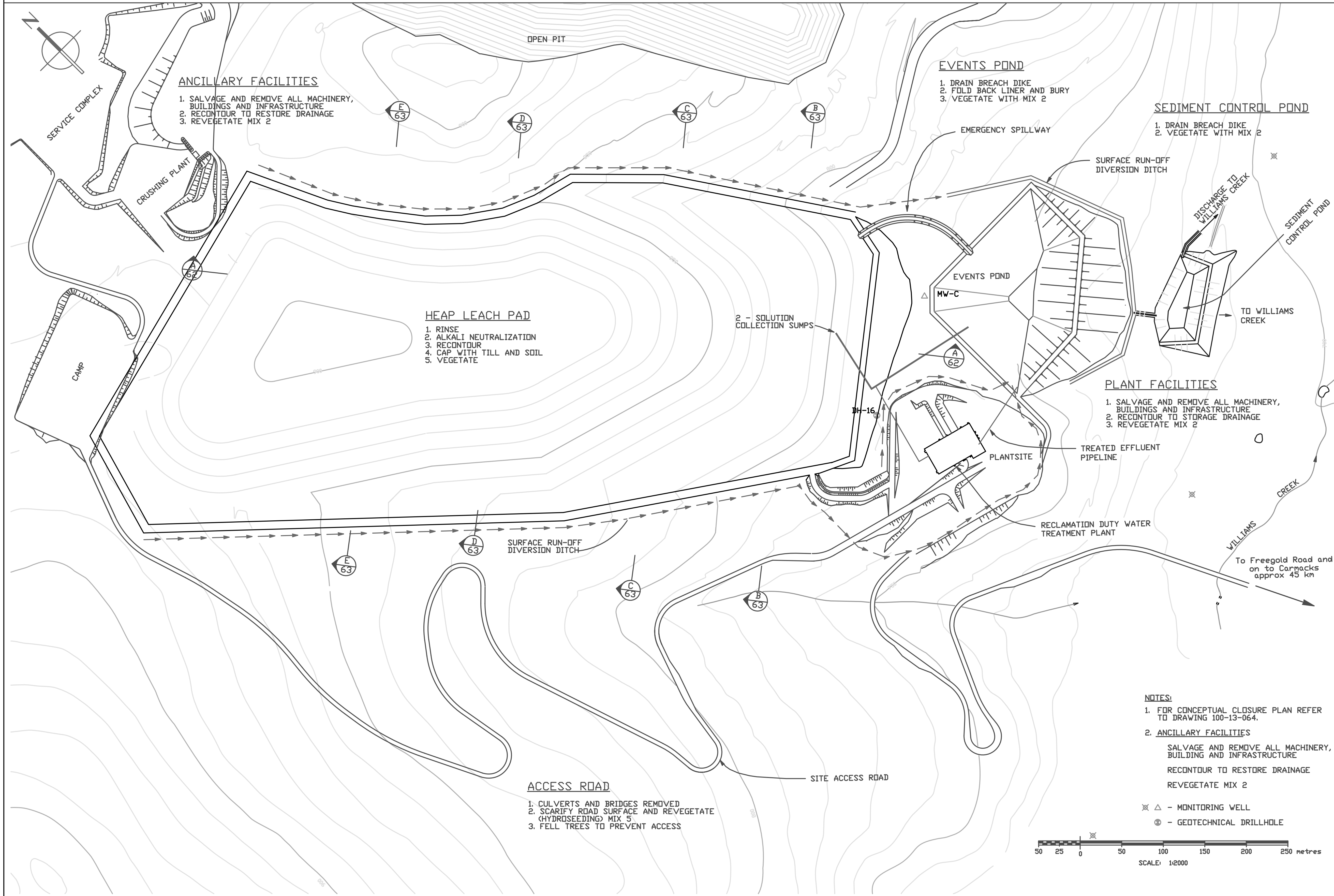
The current concept is to haul sludge off-site, disposal of water treatment precipitates will be dictated by results of the research, chemical stability and legislative requirements at that time. A test program is planned once treatment plant precipitates have been generated. The results of these tests will dictate precipitate handling.

Western Copper is committed to conducting additional research into the chemical stability of closure precipitates and treatment plant sludges as part of their Reclamation Research Program and committed to defining an acceptable method, consistent with the nature of the sludge and then current legislation, for the safe disposal of the material for mine closure. Shipping accumulated sludges off-site to a waste reduction firm or a smelter, will be included in this evaluation.

Options for sludge management at the end of the mine include depositing into the leach pad after closure and rinsing of the heap is complete. The leach pad is ideal for final disposal and storage of the sludge due to its lined containment and leak detection system. In addition, after the heap is rinsed, neutral pH conditions will ensure sludge stability is maintained. Another option is to mix the sludges from the treatment and sedimentation pond system with cement to create a solid stable mixture (solidification). Following closure, events pond and sediment ponds will be drained, any sludges would be solidified and the double liner folded back on itself to contain the sediments and permanently buried. An overburden layer will be placed over top and vegetated.

The testing of chemical stability of treatment sludges is discussed in Lawrence and Beattie (1996), and Hallam Knight Piesold (1995).

Additional water treatment testing has been conducted on the raffinate (Alexco, 2006a) and the decommissioning solutions to evaluate both the treatment chemistry (reagent requirements) and the sludge production and chemical stability of sludge. These solutions and precipitates will be generated from actual process solutions. It is expected that additional testwork will be conducted during operations to further characterize the sludge and refine the disposal option.



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Original drawing from Kilborn,
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"Heap Leach Facility Conceptual Reclamation Plan", Drawing #100-13-61 Rev B

Heap Leach Facility Conceptual Reclamation Plan

Drawing Number: 100-13-61

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Revised by: HD | Checked by: DDC

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3.3 Conceptual Closure Measures

Testing to date shows that a “walk-away” closure scenario for the heap decommissioning is technically feasible in the long term. The proposed closure at this time is based initially on demonstrated active care technology followed by a passive care system to demonstrate the long term chemical stability of the heap prior to a full “walk-away” closure. Drainage from the heap will be collected and treated as described in Section 3.3.2 Water Treatment to reduce solutions inventories. The heap will be rinsed and then neutralized and a cover placed over the pile. Contingency measures are planned that can, if needed, stabilize metals out of heap (limestone trench, biological treatment cells, infiltration gallery) for final polishing for long term release.

At this time, the proposed conceptual closure measures for the heap leach facility comprise:

- rinsing of the heap with re-circulated water from which copper is recovered at each cycle using the SX/EW plant;
- neutralization and alkali addition to rinse waters for distribution to the heap;
- continued rinsing of the heap with water;
- treatment and release of excess solution inventory in the latter cycles of rinsing;
- after heap rinsing is completed, contouring and capping of the heap to promote runoff and reduce infiltration;
- collection and water treatment of any surface water drainage from the heap prior to discharge into the environment; and
- contingency out of heap treatment measures (limestone trench, biological treatment cells, infiltration gallery) for long-term release of heap effluent to the environment.

3.3.1 Heap Rinsing

The objective of rinsing the heap is to reduce the residual acidity and dissolved metals that could migrate from the heap through meteoric waters after the heap has been decommissioned. Typically, a combination of water rinsing followed by rinsing cycles with treated water is used, although some sites have found that water rinsing alone is more effective (Li, Jacob and Corneau, 1995). As discussed above, in laboratory testing fresh water rinsing significantly reduced contained metals and acidity in drainage from the metallurgical columns and then rinsing with a sodium carbonate in subsequent cycles of solutions demonstrated that the heap rinsing and neutralization process.

Once the economic copper values have been removed from the heap effluent through the SXEW process and the majority of free acid has been consumed through solution recirculation, fresh water rinsing will continue to be employed. The water treatment plant will treat the effluent rinse solution to acceptable discharge standards to ensure a proper water balance during fresh water rinsing is maintained.

Once the heap effluent pH has been maintained at a pH of 6-7, further rinsing with freshwater will occur to ensure the long term pH of solutions and stabilization of metals. The heap solution inventory will be reduced. A number of contingency measures are planned to polish the final effluent coming off the heap, if required. It is expected that even with a cover, the heap will continue to discharge over the long term.

Monitoring will confirm heap effluent quality to ensure performance standards are met. In the unlikely event that heap drainage water quality does not meet discharge standards, then contingency water treatment and polishing of effluent will be put into effect. This includes limestone drains, biological treatment calls and infiltration galleries.

3.3.2 Water Treatment

3.3.2.1 Treatment Circuit

The circuit for water treatment during closure and reclamation is described in Appendix A of this report. The following is a summary of the process description for the decommissioning and closure.

The treatment plant flowsheet is shown in Figure 400-03-11, “Reclamation Duty Water Treatment Plant” (Appendix A). The plant includes the following major facilities:

- seepage collection system
- one collection pond
- two stirred treatment reactors
- clarifier
- sand filter
- sludge filter press
- sludge dryer
- treated water retention pond
- utilities and ancillaries including reagent supply, air compressors, emergency and line power, drinking water, etc.
- 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
- alternative & supplementary reagents including:
    - caustic soda
    - soda ash
    - sodium phosphate
    - lime and limestone
    - commercial precipitant
- alternative sludge collection and disposal methods.

Seepage will be collected from the leach pad gravity drain pipes, taking advantage of the double liner and collection systems installed for the heap leach operation. The area of the leach pad behind the confining embankment serves as the low point collection point for the entire pad area.

The seepage will drain from the leach pad via gravity pipeline, through a metering system, into the two water treatment reactors operating in series. The seepage passes through neutralization reactors 1 and 2 in series, and emerges at a controlled pH of 9.0. Caustic pellets are metered to the reactors from a bin feeder, or solution from an adjacent storage tank will be added to both reactors via a circulation loop.

The resultant slurry will be treated by a mechanically driven clarifier. Clarifier under-flow will be re-circulated to maintain a suspended sludge bed. The clarifier sludge product will be bled from the re-circulating under-flow to the sludge receiver.

The sludge will be pumped from the sludge receiver, at about 8 to 10 percent solids, to the sludge press filter area. This filter area will include a sludge sump, a covered storage pad for dried sludge, the filter press, and the sludge dryer.

Clarifier overflow will be polished in a continuous backwash sand filter. Backwash will be returned to the clarifier, and filtrate will monitored and sampled before it passes through a raffinate tank which will decant into the event and sediment ponds below the heap, for final discharge to the environment.

At the filter area, sludge will be pumped from the sump by air operated diaphragm pumps to the filter press, where a competent filter cake will emerge at about 20 to 25 percent solids. The filter cake drops into a dryer feed bin which will be equipped with paddles that extrude the material onto dryer feed belt. The dried sludge, to about 40 to 60 percent solids, discharges from the dryer directly into large transport bags for shipment and kept in a covered storage area until a suitable load is accumulated.

A flocculant mixing and dosing system will be enclosed in an existing building adjacent the clarifier. This building will also include a small control room, the MCC room and a laboratory. Other facilities in the building will include plant and instrument air compressors, diesel electric generators, and acid wash area for filter cloths.

Except for large ponds and related equipment, and outside storage pads, all process tanks and equipment will be protected from the elements and will operate automatically with minimal operator assistance. The operating schedule for the plant will be seasonal during the months of April to October of each year.

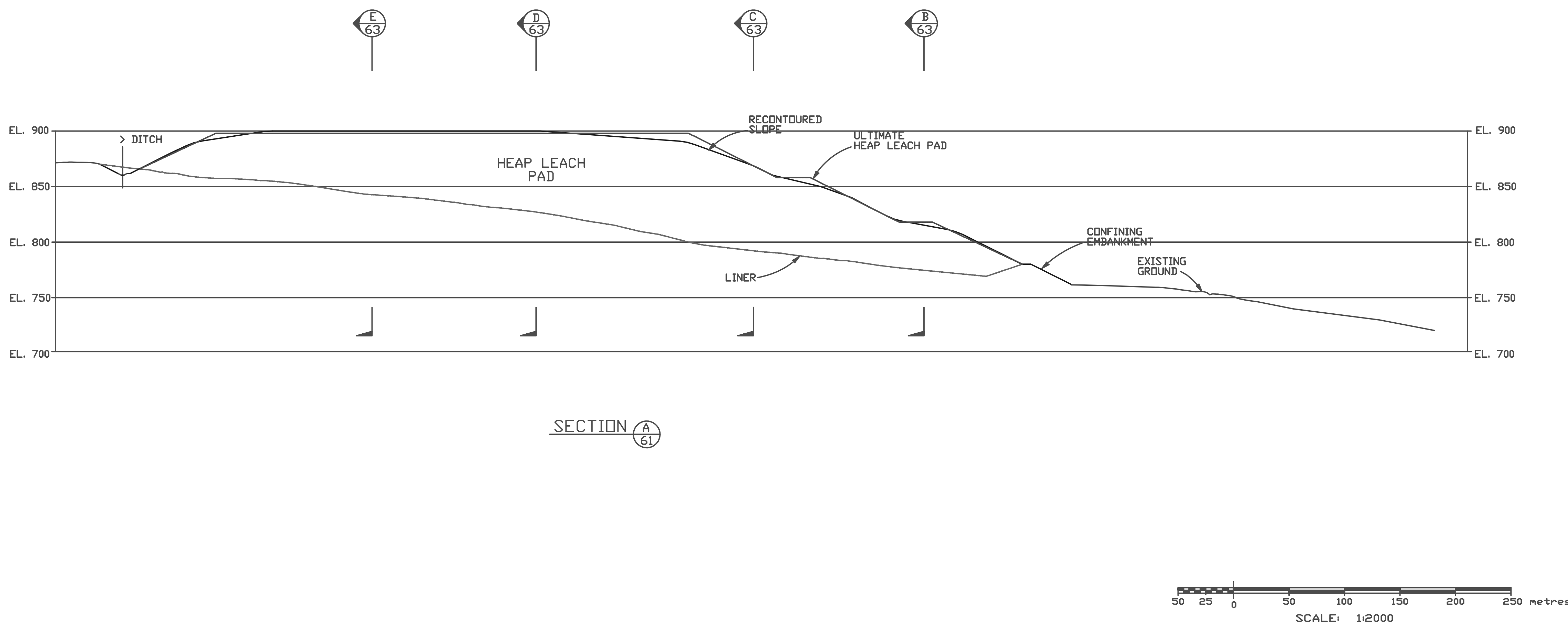
3.3.2.2 Water Chemistry

Laboratory testing has shown that the treatment process will result in the precipitation of contained metals as hydroxides and sulphates, and will produce a supernatant which will be within levels specified by the Metal Mining Effluent Regulations (MMER) and will be non-toxic at 100 percent concentrations. Analysis of the treated raffinate is shown in Table 4.12 from the IEE Addendum, (Hallam Knight Piesold, June 1995). In addition, results of raffinate treatment for the column tests and pilot test are provided in the appendices to Lawrence and Beattie, 1996. Additional related test work was conducted in 2006 and demonstrated similar results for effluent treatability (Alexco, 2006c).

3.3.3 Contouring and Soil Cover

Following rinsing as previously described, the top surface of the heap leach pad will be re-graded to promote the controlled runoff of precipitation, eliminate areas where ponding of water may occur and to minimize seepage. The finished grade surface is shown on the attached drawings 100-13-62 and 100-13-63. 75% of the surface area will have an average slope of 40% or steeper and 25% of the surface area is at 7% or steeper. These types of slopes are consistent with the topography of the undisturbed area adjacent to the heap.

The top surface of the heap will then be covered with a cover system. Recent cover design has favoured a store and release cover system over a traditional compacted cap design due to concerns with freeze/thaw in climate conditions at site. The advantage of a store and release cover is that a low permeability compacted layer is not required to reduce infiltration levels to acceptable and manageable long term rates. The store and release cover will reduce infiltration into the heap by storing precipitation (similar to a sponge) in the cover material and then releasing the water back to the atmosphere through evapotranspiration of plants. The cover comprises a thick layer (often up to 1 m) of material placed in a loose state and revegetated with selected local species that have deep root penetration and high moisture uptake characteristics. Specific design parameters have not been completed for a store and release cover on the Carmacks Copper heap. A recent store and release cover system was constructed at a nearby Yukon heap leach operation for closure and will be a valuable tool for providing the necessary design parameters and data on actual field performance.



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 Facility Conceptual Reclamation Section A-A", Drawing #100-13-62 Rev A

Heap Leach Facility Conceptual Reclamation Section A-A

Drawing Number:
100-13-62

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: Feb. 1, 2005

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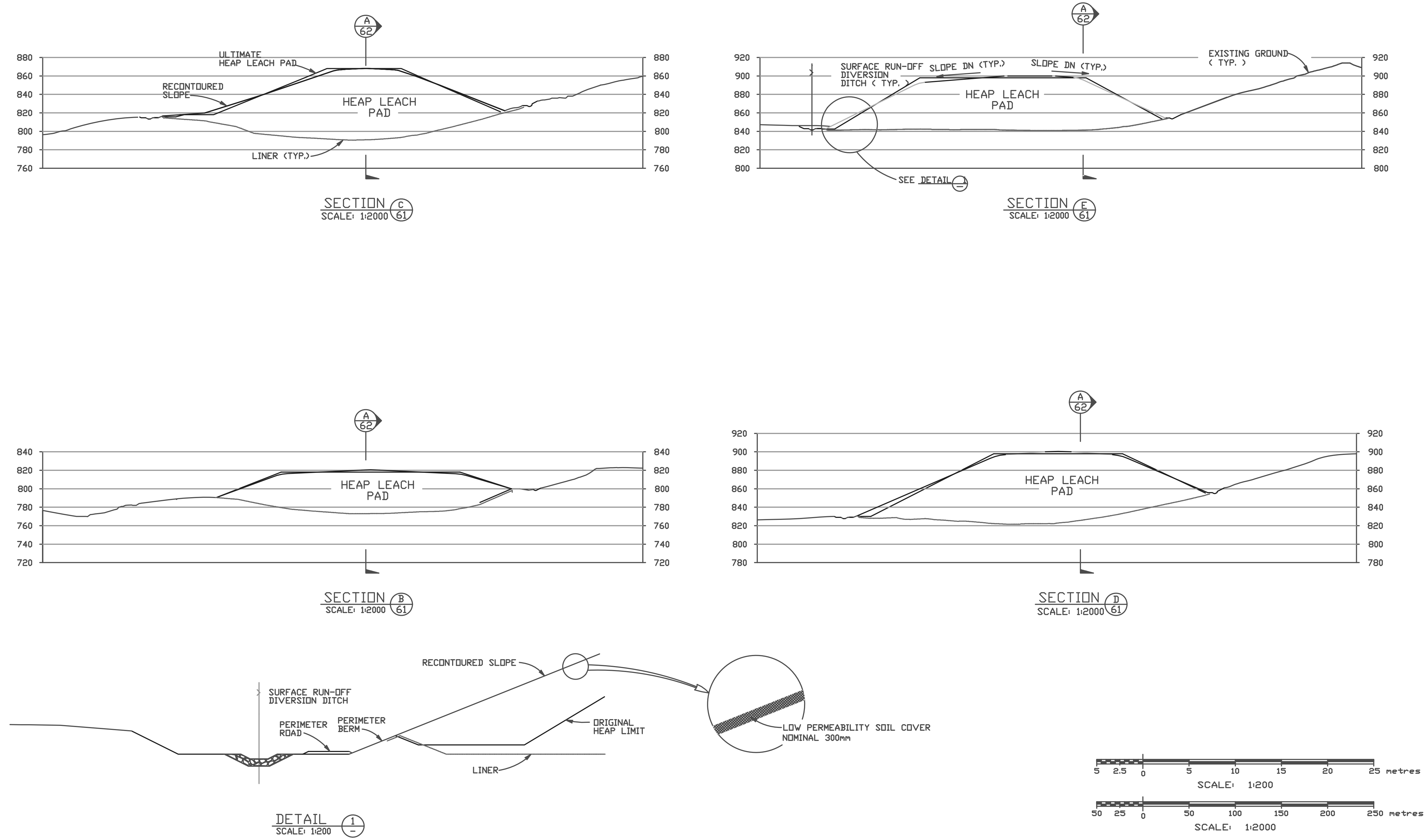

Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

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"Heap Leach Facility Conceptual Reclamation Sections", Drawing #100-13-63 Rev A

Heap Leach Facility Conceptual Reclamation Sections

Drawing Number:
100-13-63

ACCESS CONSULTING GROUP

Revised by: HD	Checked by: DDC

Date: Feb. 1, 2005

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3.3.4 Water Management

Water management and water collection for the proposed heap design are discussed in Knight Piesold Report 1785/1, Sections 2.6 (Water Management), 2.7 (Solution Management) and Section 2.16 (Closure). The design includes the installation of a permanent gravity flow solution pipeline that would be constructed in the initial phase of heap pad construction and would be modified to remain after closure. During the decommissioning phase however, the pipes would be used to convey rinse solution from the pad to the plant for copper removal and, in the latter stages, for neutralization and metal removal in the Reclamation Water Treatment Plant as described in Appendix A.

Once heap seepage is treated for release it will then mix with surface runoff from the surrounding area before entering Williams Creek. Treated effluent from the water treatment plant or the neutralize heap will meet MMER standards.

In addition to infiltration through the heap which reports to surface waters as described above, there are two further pathways by which drainage from the heap facility which is not collected could report to the receiving environment:

- runoff from the heap to surface waters; and,
- leakage through the heap and liner system into the groundwater.

One objective of the placement of a store and release cover (evapo-transpiration cover) layer on the heap at closure is to minimize the amount of water which infiltrates into the heap. Seepage would occur during the months of April to August as the remainder of the year the top of the heap would be frozen. Peak seepage flows would be partially retained within the heap, below the crest of the confining embankment until it flows via gravity pipeline into the water treatment plant. The water treatment plant would be sized accordingly to suit the expected average seepage values.

The objective of the design for a store and release cover is to prevent water seepage into the heap by providing a large mass in which to store water in the cover and encouraging deep rooted plants to take up water. Such a cover, if properly constructed and functioning as designed, would result in lower seepage rates, ideally negligible.

3.3.5 Infiltration Gallery

Once the heap has been rinsed, and the larger draindown volume has been released through chemical treatment and direct discharge, the long-term management and release of the heap effluent will transition to passive release with the possible use of contingency measures such as treatment in an infiltration gallery. The long-term infiltration rate through the covered heap is expected to be less than 20,000 m^3 per year. This equates to an annual average of 1.0 litres per second. In practice, higher flows will occur during the spring freshet and low to minimal flows in the late summer and winter months. In an infiltration gallery, the heap effluent will be collected and distributed or injected into the groundwater system through a series of ditches and higher permeability zones. The collection and distribution system will be covered with sufficient material for freeze protection. The infiltration gallery can be designed to sustain the higher peak spring flows or alternatively a buffering pond can be used ahead of the gallery to provide more uniform long-term flows into the infiltration gallery.

Although the heap effluent is planned to be rinsed and pH adjusted to near neutral conditions, a limestone rock drain and ditch is another contingency that could be used to maintain a neutral pH in the effluent prior to entering the infiltration gallery and groundwater system. A passive system for introduction of a carbon source (sugar/alcohol mixture) could also be constructed as another contingency measure and used to provide additional biological reduction of remaining contaminants in the heap effluent.

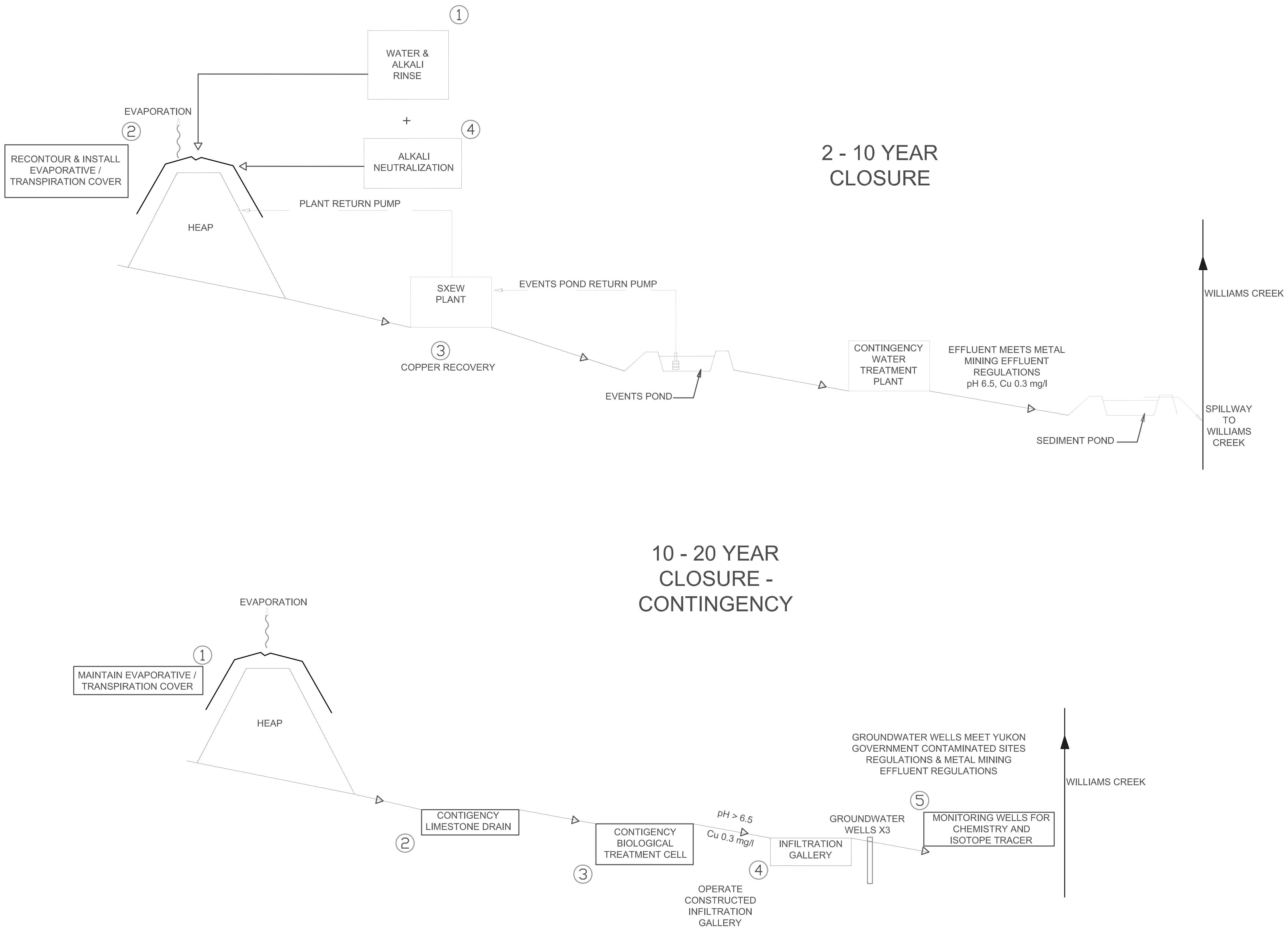
With the introduction of additional carbon sources, any remaining contaminants are biologically reduced in the anaerobic zone prior to entering the deeper groundwater system. A conceptual drawing for the long term heap leach facility is shown in drawing ACG-WS-01.001

TABLE 3.1
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
PRECIPITATION DETAILS USED IN ANALYSIS

C:\ACG\Projects\WCH-01\Old reports\KP\11178\4\Data\WATBAL\[WTBALNR_revised March 10_05.XLS]Precip

DESCRIPTION	VALUE			
Precipitation Distribution				
Mean annual precipitation (mm)	375			
Mean annual rainfall (mm)	233			
Mean annual snowfall (mm)	143			
Proportions of Total Precipitation:				
Rainfall	0.62			
Snowfall	0.38			
Monthly Combined Rainfall & Snowmelt	Mean (mm)	Coefficient of Variation		Standard Deviation (mm)
Jul	75	0.60		45
Aug	53	0.50		27
Sep	36	0.60		22
Oct	4	0.40		2
Nov	0	0.60		0
Dec	0	0.90		0
Jan	0	0.90		0
Feb	0	0.70		0
Mar	0	0.80		0
Apr	100	0.80		80
May	61	0.70		43
Jun	47	0.40		19
Total (mm)	376	0.2		75
1 in 100 Year Monthly Rainfall & Snowmelt (mm)	Monthly Distribution			
	April	May	June	Total
April	286			286
May		161		161
June			91	91
April / May	286	100		386
April / May / June Case A	286	100	64	450
April / May / June Case B	198	161	91	450
1 in 100 Year Annual Rainfall & Snowmelt (mm)	RP = 100 Years		550	
1 in 100 Year April + Average May to March (mm)	RP = 150 Years		562	
1 in 100 Year Apr/May + Average June to March (mm)	RP = 750 Years		601	
1 in 100 Year Apr/May/Jun + Average July to March (mm)	RP = 1600 Years		618	

Notes:
(1) Monthly coefficients of variation (cv's) determined from regional streamflow records.
(2) 1 in 100 year monthly values calculated on the assumption that extreme monthly rainfall and snowmelt values are normally distributed. Multiple month cv's calculated from regional streamflow records (ie. Apr/May cv = 0.6, Apr/May/Jun cv =0.5).
(3) RP = Return Period



Project Description & Environmental Assessment Report

Carmacks Copper Project
Yukon Territory

WESTERN SILVER CORPORATION

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

Conceptual Heap Leach Facility Closure

Drawing Number:
ACG-WS-01.001

ACCESS CONSULTING GROUP

Drawn by: HD	Checked by: DDC
Date: Aug. 30, 2006	

File: D:\Project\AllProjects\WCH-01\cad\conceptual_closure_dwgs\ACG_WS_1_1.dwg

3.3.6 Plant and Ancillary Facilities

The plant and ancillary facilities that are not required for future use will be dismantled and removed. Above ground foundations will be broken down to ground level, covered with local glacial tills and seeded. Recontouring will restore pre-mine drainage patterns and revegetation will follow the seed mixture for mixed deciduous/coniferous forests.

Water treatment facilities will remain intact until the heap leach pad has been neutralized and water quality is appropriate for release to the long term infiltration gallery.

The sand and gravel borrow areas south of the water storage dam will be recontoured and seeded with a mixture using indigenous plant species.

3.4 Water Chemistry/Seepage

3.4.1 Surface Water

Specific design parameters for a store and release cover have not yet been determined. Store and release covers have been constructed at a nearby Yukon heap leach operation for closure purposes. Seepage infiltration through these covers will be developed through detailed design and review of actual performance data from this operation.

3.4.2 Groundwater

In the longer term, if there are disruptions in the heap liner integrity, there is a potential for leakage from the heap through the double liner system to surrounding ground. Estimates have been made of potential leakage and are reported in detail in Knight Piesold, No. 1785/1, Sections 2.9.4 and 2.15. However it should also be noted that the lower most silt liner is constructed to a thickness of 300 mm ($k = 1x10^{-6}$ cm/s).

Although it is clear from the contaminant transport modelling and the leakage and seepage estimates above that the impact of a small leak or seep from the heap is minimal because of the relatively small volume and flux through such a leak. To address potential concerns for long term closure, additional attenuation testwork will be conducted as part of the Conceptual Closure and Reclamation Plan.

3.5 Remaining Issues and Investigations

Heap rinsing, neutralization, nutrient addition, and passive treatment requirements in the long term are the main issues to be further optimized for heap closure. Laboratory testing continues and will be done to:

- develop representative spent ore samples;
- evaluate heap rinsing with water and requirements for copper removal from water (untreated) rinse solutions;
- optimize rinse and rest cycles;
- further investigate carbonate addition;
- design contingency measures such as a long term infiltration gallery; and
- test sludge stability for possible on-site disposal
- conduct revegetation trials to identify appropriate species for seeding.

There are a number of options to be considered for water treatment; which are dependent on the types of reagents utilized:

- air and oxygen for oxidation prior to precipitation;
- caustic soda;
- soda ash may be useful as a latter stage treatment for removal of some metals such as cadmium;
- sodium phosphate for iron removal;
- limestone and lime;
- TMT (trimercapto-s-triazine, trisodium salt) as an additive for metal removal and sludge stabilizer;
- Portland cement and fly ash as alternative alkali sources and to form a more “cemented” sludge than with alkali addition alone.

Options for reagent usage are discussed in Appendix A.

4. WASTE ROCK STORAGE AREA

4.1 Description

The waste rock storage area (WRSA) is located immediately to the north of the open pit on a gentle north-east facing slope. The site was chosen to minimize haul distance from the pit, ensure stable foundation conditions, and also to minimize potential impact on existing surface drainage courses.

The WRSA covers an area of approximately 70 ha and is designed to provide permanent storage for approximately 70 million tonnes of waste rock. Waste rock will be deposited year round, at a rate of approximately 7.5 million tonnes per year. The dumps will be constructed in lifts with a maximum thickness of 25 m, with benches between successive lifts to flatten the overall slope to 2.25H:1V.

Surface drainage ditches are used to drain the footprint of the dump. Surface runoff and shallow seepage from the WRSA will be collected in perimeter ditches and conveyed to the sediment control pond during operation.

Details of the design of the waste rock storage area are provided in Western Copper Holdings Limited, June 1996, Appendix A (Knight Piesold Report 1785/2).

Geochemical characterization testing of the waste rock is provided in the IEE Addendum, Section 4.2 (Hallam Knight Piesold, June 1995). The test results show that the waste rock samples are consistently net acid consuming and, in many cases, are strongly acid consuming. However, ICP analysis of the samples indicates that two of 23 samples (Table 4.5) have higher concentrations of copper than would be expected from the geology of the property. These samples appear to be located in or near the ore zone (Figures 4.3, hole 125, sample 1 and Figure 4.6, hole 157, sample 23) and are more representative of low grade mineralization than waste rock.

4.2 Closure Issues

The issues of physical stability associated with the waste rock storage area are primarily associated with the design and construction of the dumps on potentially thaw unstable ground. These issues are addressed as part of construction of the dumps and are not closure issues. At closure, the remaining physical issues are:

- control of erosion; and,

- water management.

Issues of chemical stability that are relevant to closure include:

- drainage water chemistry; and,
- potential for acid rock drainage (ARD) to develop over time.

Static geochemical testing has shown that ARD is not anticipated from the waste rock. The testing to evaluate drainage water chemistry from the waste rock has been limited to short-term extraction testing. These tests, while more aggressive than site conditions in terms of leach extraction, show that there are potentially leachable metals although still at concentrations less than “Special Waste” material. Review of waste rock sampling and analysis shows that this extractable copper is derived from two low grade mineralized samples noted above rather than samples characterizing the bulk of the waste. (see Table 4.9, comp. 1 from hole 125, including sample 1 and comp. 6 from hole 157, including sample 23, Hallam Knight Piesold, June 1995). This low grade material under normal operating conditions would be would be placed on the leach pad, thus there is no reason for the samples to bias the bulk of the rock test results. Drainage from such a pile can readily be directed to the leach pad treatment system or the pit. Once the prominence of this material is reduced in the rock waste data set there is no reason to expect significant leachable copper from the dump. However, monitoring would be required during operation to evaluate site drainage water chemistry. For long-term evaluations, kinetic (column leach) testing may be required.

As part of on-going test work, further samples will be selected to confirm the above.

4.3 Conceptual Closure Measures

Reclamation of the WRSA may be initiated during the early stages of production as this will lower final reclamation costs, improve short term stability, and reduce surface erosion and sedimentation. The following are preliminary recommendations for progressive reclamation and final closure of the WRSA:

- maintain sloped grading of bench surfaces to minimize surface water infiltration and erosion of downstream slopes;
- maintain surface water collection ditches and the sediment control pond to control surface drainage during operations and reclamation;
- the operational slopes, consisting of benches and raises, will be maintained at 2.25H:1V and will not be re-graded at closure. This approach removes the problems associated with the re-grading of long slopes and the corresponding erosion of drainage channels by runoff down long slopes;

- surface runoff collection ditches and the sediment controls pond will remain operational until vegetation on the storage area has reached a self sustaining growth.

When monitoring results have indicated that the waste rock storage area runoff and seepage are of suitable quality for direct release to the environment the surface runoff collection ditches will be backfilled with waste rock and the sediment control pond embankment will be breached.

4.4 Remaining Issues and Investigations

Remaining investigations for reclamation of the WRSA are:

- Continue to confirm drainage water chemistry for the waste rock; and
- revegetation trials to identify appropriate native species for seeding.

Monitoring during operation will be performed on an on-going basis to evaluate long-term drainage water chemistry.

5. INFRASTRUCTURE

5.1 Access Roads

Western Copper will consult with the Little Salmon Carmacks First Nation and the community to determine their desire for treatment of the road after closure. Should elimination of the access road be desired, the following concepts are applicable:

- removal of all culverts,
- bridges and approaches;
- scarifying ad decompact the road; and
- restoring drainage patterns and seeding.

To discourage travel, the road can be bermed and ditched.

As suggested for linear developments, access roads at the project will be tested for revegetation with a seed mixture including a native selection of Yukon wheatgrass, violet wheatgrass, northern fescue, sheep fescue, yellow locoweed, showy locoweed, arctic lupine and glaucous bluegrass. Seed proportions will follow those suggested by Kennedy (1993).

Measures will be taken during design and construction to prevent permafrost degradation along access roads. However, if this occurs, reclamation of affected areas will be completed as necessary. This can usually be accomplished in relatively dry areas with a thin organic layer, such as exist at this location, by stripping the organic layer, replacing it with a sufficient depth of gravel to restore the natural thermal gradient and re-vegetating the area.

5.2 Ancillary Facilities

All ancillary site facilities including the camp, service complex, crushing plant will be salvaged and equipment and buildings or infrastructure removed. Sites will be recontoured to restore drainage and revegetated. Infrastructure not required for water treatment purposes will also be salvaged and removed, recontoured and revegetated from the plant site. Closure plans for ancillary facilities appears in Drawing 100-13-61.

6. REVEGETATION

6.1 Description

The mine site and facilities are located in an area dominated by white spruce on well drained slopes, black spruce on poorly drained slopes and lodgepole pine in several areas of previously burned vegetation. Stands are interspersed with paper birch, trembling aspen, and poplar.

Feathermoss dominates the understorey in dense black spruce stands, with willows and ericaceous shrubs in more open stands. Sedge and sphagnum tussocks are common in poorly drained areas. Ground cover on south facing slopes consists of sagewort; grasses and forbs occur in gullies and draws containing trembling aspen.

The total area affected by mine operations, including temporary haul roads and material storage is estimated to be 170.5 ha as presented in Table 6.1.

6.2 Closure Issues

- re-vegetate areas susceptible to erosion forces
- revegetate heap leach pad
- encourage natural revegetation in all other areas, including rock dump areas

6.3 Conceptual Closure Measures

Revegetation will follow “Guidelines for Reclamation/Revegetation in the Yukon” (Kennedy, 1993) and “Mine Reclamation in Northwest Territories and Yukon” (Steffen, Robertson and Kirsten (B.C.) Inc., 1992).

Experience at other mine sites in the Yukon indicates that fall seeding should be done to optimize initial vegetation growth. The areas presented in Table 6.1, with the exception of the open pit, will be revegetated.

The seed mixtures under consideration for reclamation of erosion susceptible areas are:

- lodgepole pine on the south and east facing slopes; and,
- white spruce on the north and west facing slopes.

Both of these mixtures comprise native seed mixtures of Yukon wheatgrass, violet wheatgrass, northern fescue, arctic lupine, yellow locoweed, and glaucous bluegress. Both seed mixtures have been identified as appropriate for the Yukon in areas of the Pelly River vegetation zone. Nutrient amendments will be added as necessary.

The pad will be revegetated with seed mixtures compatible with the mixed deciduous/coniferous vegetation areas. Native plant species in this association will include Yukon wheatgrass, northern fescue, violet wheatgrass, sheep fescue, glaucous bluegrass, sweetgrass, and arctic lupine. This will be optimized based on test plots.

6.4 Remaining Issues and Investigations

Additional work to be completed to define the revegetation program includes:

- soil characterization - some reclamation research work was initiated during the baseline program with cataloguing of the indigenous plant species, however, work is still required to characterize the available soils in the various biogeoclimatic and vegetation zones;
- testing of overburden from the open pit as this is the largest source of material for reclamation on site;
- establishment of test plots on various disturbed materials to evaluate seed mixtures and fertilizer requirements;
- documentation of natural recolonization.

Since test plot information is normally based on small scale optimum conditions, the information acquired from test plots must be applied successfully on a successively larger scale before they can be deemed applicable. These scale-ups are termed reclamation trials and are normally applied to areas of 1 to 2 ha in size. A series of reclamation trials will be implemented before mine closure on areas that have been completed, for example, inactive portions of the WRSA, unused exploration roads, and margins of diversion channels. Information obtained from reclamation trials can then be scaled up to reclaim areas as they become available for progressive reclamation during operation. In this manner, the company will be able to optimize species composition and ensure self-sustaining vegetation communities for closure.

Table 6.1
Carmacks Copper Project
Projected Area of Disturbance at End - of - Mine Life (Year - 9)

Reclamation Unit	Area (ha)
Open Pit (Ultimate)	29.5
Waste Rock Storage Area	69.6
Heap Leach Pad	37.2
Plant and Ancillary Facilities	13.3
Surface Water Distribution (8 wells)	0.004
Sand and Gravel Borrow	2.5
Access and Haul Roads	12.3
Exploration Trail	6.1
Total Estimated Disturbed Area	**170.5**

7. CLOSURE SCHEDULE

7.1 Schedule

Progressive reclamation will begin during operations to promote slope stabilization and reduce erosion during the life of the mine. Disturbed slopes will be stabilized and revegetated. Progressive reclamation of the WRSA will occur during operations.

Table 7-1 shows the project closure and reclamation schedule. For the first two years after mine closure (years 9 and 10) the heap will continue to be leached. When leaching is no longer economical, the heap will be rinsed for about four and a half years with water and then a carbonate addition, then decommissioned and covered with a soil cover. Monitoring of the heap leach pad will continue until the long term predicted water chemistry from the heap effluent meet discharge criteria, at which time the treatment facility and settling pond will be removed, recontoured and revegetated. Equipment and infrastructure will gradually be removed upon closure.

Once final heap closure is attained, the main access road could be scarified and reclaimed. Effluent monitoring, bio-monitoring and geotechnical assessment will occur annually for a minimum of 15 years to ensure that revegetation is successful, that slopes are stable, and heap chemistry is assured.

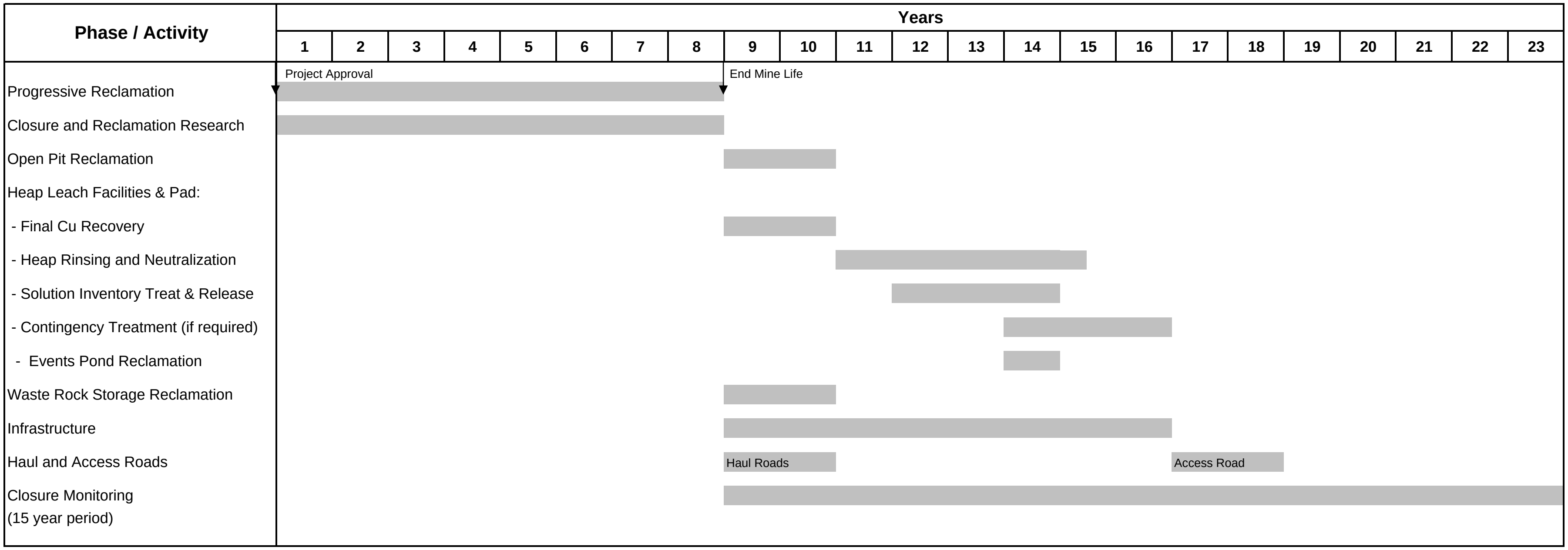
7.2 Suspended Operations or Premature Closure

Reclamation and revegetation will be ongoing so that in the event of suspended operations or a premature closure, revegetation will be well advanced in disturbed areas.

In the event of suspended operations, the heap leach will be drained down. However, no further reclamation will be carried out until operations recommence or a decision is made to proceed with full closure. Water collection from the heap will continue. Water treatment will be implemented if the water balance requires discharge of water from the pad and ponds.

In the event of a premature closure, a temporary closure plan based on material stability will be instigated. All materials, including stockpiles, reagents, and stored fuel will be secured and on-site monitoring will take place until mining recommences or full closure is initiated.

Table 7-1 Carmacks Copper Project Closure and Reclamation Schedule



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WESTERN COPPER HOLDINGS LIMITED

CARMACKS COPPER PROJECT

APPENDIX A

“DESCRIPTION OF WATER TREATMENT PROCESS FOR RECLAMATION DUTY”

1.0 INTRODUCTION

Following mine closure, the Carmacks leach pad will be covered over to seal it from direct exposure to precipitation. However, some seepage may occur, and this water treatment plant is presented as a means for handling such seepage, until such time as the heap has been rinsed and neutralized.

The proposed water treatment system will be a caustic precipitation plant for bulk removal of metals and for pH adjustment. The process is illustrated on the attached drawing, "Reclamation Duty Water Treatment Flow Diagram," 400-03-11. The water treatment plant has been divided into 4 parts:

- Reagent/Water Treatment Reactors;
- Flocculant System;
- Filter Press System;
- Clarifier/Sand Filter System.

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.

- 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 & supplementary reagents including:
  - Caustic soda
  - Soda ash

  - Sodium phosphate
  - Lime and limestone
  - Commercial precipitant

- Alternate sludge collection and disposal methods.

2.0 PROCESS DESCRIPTION

Seepage will be collected from within the leach pad via the gravity solution pipelines installed during initial heap construction, which takes advantage of the double liner and leakage collection systems installed for the heap leach operation. The confining embankment, used for the heap leach operation serves as the low collection point for the pipeline to the treatment plant.

The seepage will be pumped through a metering system to the two water treatment reactors which will operate in series. The seepage passes through neutralization reactors 1 and 2 in series, and emerges at a controlled pH of 9.0. Caustic pellets are metered to the reactors from a bin feeder, or solution from an adjacent storage tank will be added to both reactors via a circulation loop.

The resultant slurry will be treated by a mechanical drive clarifier. This clarifier may be fitted with Lamella-type inclined plates to improve settling performance. Clarifier underflow will be re-circulated to maintain a suspended sludge bed. The clarifier sludge product will be bled from the re-circulating underflow to the sludge receiver.

The sludge will be pumped from the sludge receiver, at about 8 to 10 percent solids, to the sludge press filter area. This filter area will include a sludge sump, an covered storage pad for dried sludge, the filter press, and the sludge dryer.

Clarifier overflow will be polished in a continuous backwash sand filter. Backwash will be returned to the clarifier, and filtrate will then pass through a lined concrete raffinate tank and decant into the event and sediment ponds below the heap, before final discharge to Williams Creek. This discharge will meet MMER standards.

At the filter area, sludge will be pumped from the sump by air operated diaphragm pumps to the filter press, where a competent filter cake will emerge at about 20 to 25 percent solids. The filter cake drops into a dryer feed bin which will be equipped with paddles that extrude the material onto dryer feed belt. The dried sludge, to about 40 to 60 percent solids, discharges from the dryer directly into large transport bags for shipment and kept in a covered storage area until a suitable load is accumulated.

A flocculant mixing and dosing system will be enclosed in an existing building adjacent the clarifier. This building will also include a small control room, the MCC room and a laboratory. Other facilities in the building will include plant and instrument air compressors, diesel electric generators, and acid wash area for filter cloths.

Except for large ponds and related equipment, and outside storage pads, all process tankage and equipment will be protected from the elements.

3.0 REAGENTS

The chemical processes available for the treatment of Carmacks seepage vary according to the reagents utilized. The ultimate effectiveness of each process must be demonstrated in laboratory testwork, using a representative seepage composition. However, test work undertaken as part of the IEE Addendum, (Hallam Knight Piesold, June 1995, Section 4.3) indicates that raffinate solution can be effectively treated using this technology. The most generally accepted practice for removing and stabilizing heavy metal laden effluent is by neutralization and precipitation of metals as metal hydroxides. Certain other reagents may be utilized as oxidants, coagulants, antiscalants, modifiers, and flocculants. Kilborn has examined several alkaline chemical options as discussed below.

3.1 Air and Oxygen

Metal precipitates are more stable when the metals have been oxidised to the highest possible oxidation state prior the formation of the insoluble hydroxides, carbonates, or sulphates. For example, ferric hydroxide is less soluble than ferrous hydroxide. These oxidized precipitates will be more suitable for mine backfill or landfill disposal alternatives because the metals are less subject to re-dissolution and mobilization.

Aeration has additional benefits. Oxygen is useful in conditioning metal hydroxides, gypsum, and jarosite sludge by promoting additional oxidation and hydrolysis.

However, it must be recognized that an oxidized metallic salt will require more reagent for precipitation. For example, precipitation of ferric iron will require 50 percent more reagent than precipitation of ferrous iron:

Ferrous: $Fe^{++} + SO_4^{--} + 2NaOH \text{ ---> } Fe(OH)_2 + Na_2SO_4$

Ferric: $Fe^{3+} + 1.5SO_{4--} + 3NaOH \text{ ---> } Fe(OH)_3 + 1.5\ Na_2SO_4$

This additional consumption will raise the cost of treatment.

Oxidation reactions in solution are limited by the solubility of oxygen in water. Vigorous mixing and air sparging are generally necessary to drive the reaction. The process may be carried out in stirred tanks with aerators in ponds and lagoons.

3.2 Caustic Soda

Sodium hydroxide provides the alkaline conditions necessary for the precipitation of most heavy metals. Sulphates and phosphates are not removed from solution, so there is generally less sludge volume. However, these sludges are often difficult to thicken and filter, and the metals are more easily re-dissolved if the solutions become acidic once again. A final stabilization with fly-ash or portland cement may be considered to minimize subsequent leaching of metals from the sludge.

Even at high pH levels, caustic soda precipitation leaves in solution low concentrations of cadmium, nickel, and zinc, as well as sulfosalts such as arsenates. Sodium hydroxide is generally the most expensive neutralization reagent.

3.3 Soda Ash

Although sodium carbonate does not generate high pH levels, it can more effectively reduce certain metals (especially cadmium) as carbonate. As a neutralizing agent, soda ash generates carbon dioxide, which may interfere with thickening if not properly vented or allowed to dissipate. However, when combined with stronger alkaline reagents, soda ash is very effective in conditioning solutions and producing stable, more easily managed sludge. Also, it is a less expensive reagent than caustic soda.

Soda ash does not remove sulphates, phosphates or sulfosalts from solution.

3.4 Sodium Phosphate

If iron levels persist in solution after alkaline treatment, a small addition of sodium phosphate or phosphoric acid may reduce the iron to the 0.3 mg/ml effluent requirement. This will increase the levels of phosphate in the effluent, but phosphate concentrations are not always regulated.

3.5 Limestone and Lime

Limestone provides a comparatively low cost means of adjusting the pH of acidic solutions. It is also useful in buffering strongly alkaline solutions because of the carbonate generated. Limestone will reduce the concentrations of sulphate, phosphate, and arsenate as calcium salts. By itself, limestone is not an effective precipitant for heavy metals, but it is useful as a passive treatment medium either before or after other more active treatment steps.

For example, it may be considered as a pre-treatment for the process by filling one or a series of launders or trenches with limestone. Such launders would effect a partial pH adjustment and metal sulphate precipitation, but the resultant sulphates would have to be removed or displaced by periodic washing, ripping or bulk removal. Aeration would be conducted upstream of these launders, and antiscalants would be employed to keep pipelines and equipment clean.
Lime, either as quicklime for as slaked lime, is a low cost and effective neutralization and precipitation reagent. Precipitation reactions produce hydroxides, sulphates, phosphates

and more complex salts often referred to as jarosite. These complex precipitated solids are also effective in removing difficult to precipitate metals such as cadmium and zinc.

Although reactions with lime produce larger volumes of precipitates, the resulting sludge generally can be conditioned to produce a solid material that is relatively non-reactive. The sludge can be further stabilized by mixing with cement or fly-ash.

3.6 Portland Cement and Fly Ash

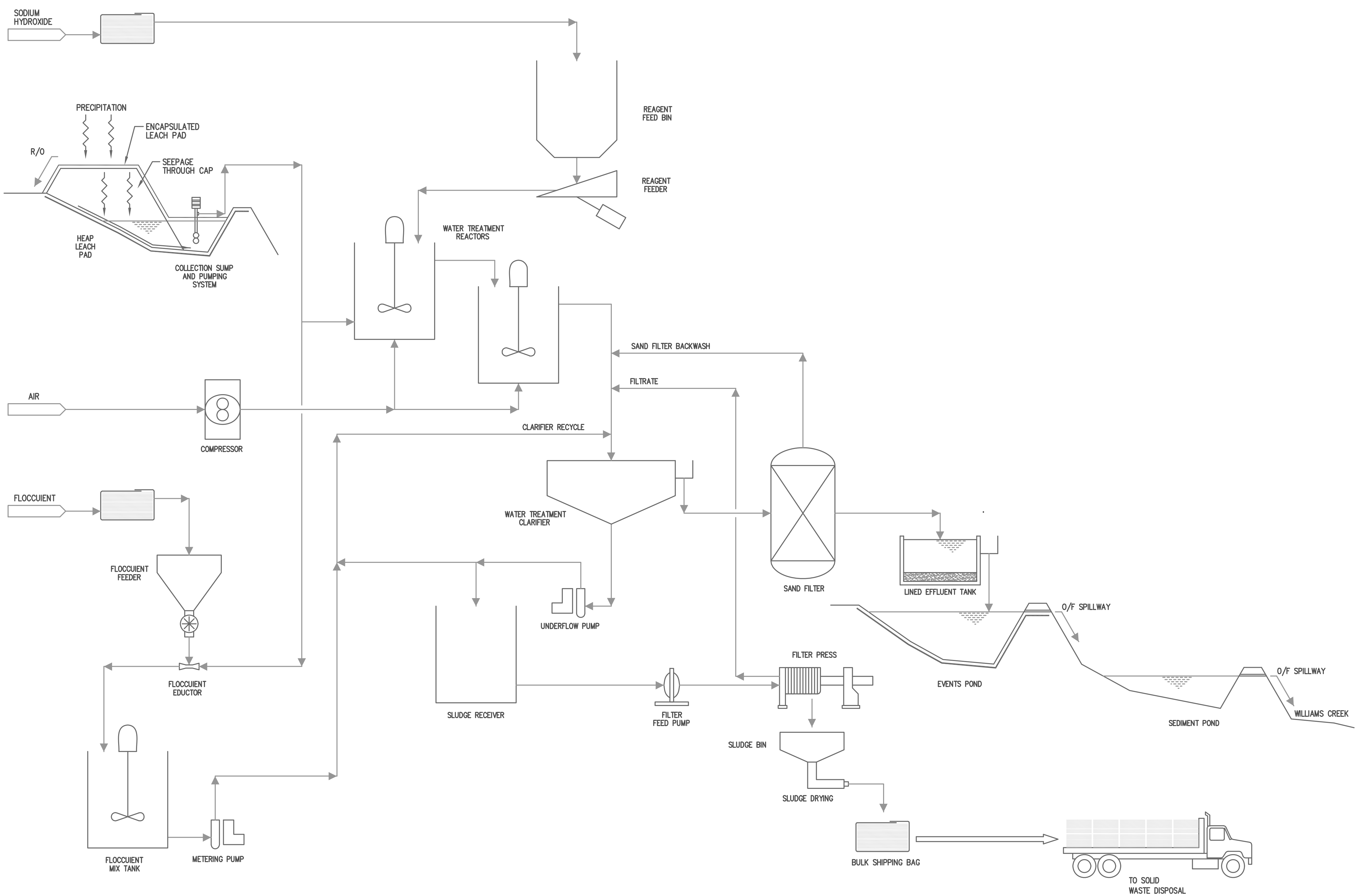
Pozzolanic materials such as portland cement and fly-ash can by used to neutralize, precipitate and stabilize heavy metals. Although highly alkaline, the materials are most effective in enmeshing the precipitates in the hydrated "cement" as highly insoluble hydroxides and silicates. Stabilization has proven to be and effective treatment method in most instances.

3.7 TMT

TMT (trimercapto-s-triazine, trisodium salt $C_3N_3Na_3S_3$) is a speciality chemical designed for efficient precipitation of metals from waste streams. Accompanied by pH correction, it produces a stable, easily settled sludge which will not be leached by dilute acids. As a trivalent molecule, each mole precipitates three moles of monovalent metals such as silver or mercury, or one and a half moles of divalent metals such as copper or ferrous iron. This chemical is marketed by the Degussa Corporation.

4.0 PROCESS CONTROLS AND OPERATION

All process equipment will be capable of operating with minimal operator assistance. Effluent sampling and monitoring will be monitored remotely by plant operations personnel residing in Carmacks. Flow measurement and water quality of influent/effluent will be recorded continually to ensure that the plant is operating correctly and to make adjustments to the process as needed.



Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

WESTERN SILVER CORPORATION

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

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"Reclamation Duty Water Treatment Flow Diagram", Drawing #400-03-11 Rev A

Reclamation Duty Water Treatment Flow Diagram

Drawing Number:
400-03-11

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Revised by: HD	Checked by: DDC

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