Western Copper Corporation

Project Proposal

Carmacks Copper Project
Yukon Territory

Appendix D1

Report on Updated Design of the Heap Leach Pad and Events Pond (1997)

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

REPORT ON UPDATED DETAILED DESIGN
OF THE HEAP LEACH PAD AND EVENTS POND
(REF. NO. 1785/1)

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WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

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WESTERN COPPER HOLDINGS LIMITED
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REPORT ON UPDATED DETAILED DESIGN OF THE HEAP LEACH PAD AND EVENTS POND (REF. NO. 1785/1)

SECTION 1.0 - INTRODUCTION

1.1 GENERAL

The Carmacks Copper Project is an open pit copper mine and processing facility being developed by Western Copper Holdings Limited. It is located in the Yukon Territory, 38 km north west of the town of Carmacks. The project will comprise the operation of an open pit, crushing plant, acid heap leach and copper extraction facility, associated waste dumps, soil stockpiles, water storage facility, process water ponds, drainage ditches and sediment control ponds and miscellaneous structures to support mining operations.

The project general arrangement is shown on Drawing No. 1785.000.

1.2 SCOPE OF WORK

The scope of this report is to present an updated detailed design for the heap leach pad and events pond to support a Water Licence Application.

1.3 PREVIOUS WORK AND REVISED DESIGN CRITERIA

A detailed design for the heap leach pad and events pond was previously carried out and presented in "Report on Detailed Design" by Knight Piésold Ltd. dated August 1996. At the request of Western Copper Holdings Limited, the detailed design criteria for the leach pad and events pond were reviewed with respect to the current permitting requirements in the Yukon and updated to incorporate the following:

- LEAKAGE RATES

The updated leakage rates are summarized below:

	Quarterly Average (per leak detection cell)	Annual Average (per leak detection cell)
• Double lined ponds	150 US gpd(600 ℓ/day)	50 US gpd(200 ℓ/day)
• Leach pads (sub-base $k = 10^{-6}$)	75 US gpd(300 ℓ/day)	25 US gpd (100 ℓ/day)

- LINER SYSTEM

In order to achieve the leakage rates described above the liner system for the entire leach pad was revised to include the following components from top to bottom:

◊ Overliner (1,000 mm thick with solution collection pipes spaced at 10 metre centres).

◊ Inner composite liner (60 mil HDPE synthetic liner in direct contact with a 300 mm thick soil liner ($k = 1 \times 10^{-5}$ cm/s)).

◊ Geotextile (filter between the overlying soil liner and the gravel LDRS).

◊ Gravel leak detection and recovery system (LDRS) - (minimum 500 mm thick, $k=5 \times 10^{-1}$ cm/s).

◊ Outer composite liner (60 mil HDPE synthetic liner in direct contact with a 300 mm thick soil liner ($k = 1 \times 10^{-6}$ cm/s)).

- CONFINING EMBANKMENT

  Reduced embankment height. Crest elevation lowered from elevation 800m to 780m.

- SOLUTION COLLECTION

  Via gravity through confining embankment to the events pond. A control valve station will be installed on the pipeline exiting the confining embankment to control solution via gravity flow to the SX plant.

- SOLUTION STORAGE

  Events pond storage volume increased to 160,000 m^3, sufficient for total solution storage.

1.4 REFERENCE DOCUMENTS

The following documents have been referred to, or are relevant to this report, and should be read in conjunction with this report:

- "Report on 1992 Surficial Geotechnical Investigations" Knight Piésold Ltd., May 1993, Ref. No. 1782/2.

- "Report on Preliminary Design", Knight Piésold Ltd., May 1, 1995, Ref. No. 1783/1.

- "Western Copper Holdings Ltd., Carmacks Copper Project Initial Environmental Evaluation Addendum No. 3," Hallam Knight Piésold Ltd., October 1995.

- "Report on 1996 Geotechnical And Hydrogeological Investigations" Knight Piésold Ltd., June 1996, Ref. No. 1784/1.

- "QA/QC Program and Technical Specifications", Knight Piésold Ltd., June 1996.
- "Report on Updated Detailed Design Criteria", Knight Piésold Ltd., July 3, 1996, Ref. No. 1784/5.
- "Report on Detailed Design" Knight Piésold Ltd., August, 1996, Ref. No. 1784/2.

SECTION 2.0 - UPDATED DESIGN OF HEAP LEACH PAD AND EVENTS POND

2.1 DESIGN OBJECTIVES

The principal objectives of the design of the heap leach pad are to:

- Ensure protection of the regional groundwater and surface water flows both during operations and in the long-term.
- Provide permanent, secure storage and total confinement of the leach ore within a fully engineered facility.
- Effectively collect and convey solutions to the process plant or the events pond by gravity drainage, while ensuring maximum recovery.
- Provide safe and secure solution transportation to and from the heap.
- Minimize the quantity of surface water runoff entering the facility and coming into contact with the process solutions by constructing the facility in three stages and by providing surface water diversion around each phase.
- Staged development of the facility to minimize the environmental disturbance at any one time during operations and to distribute capital expenditures over the life of the facility.
- Meet or minimize leakage rates for individually-monitored areas (cells) on the leach pad and events pond as per the State of Nevada regulations (as interpreted by the RERC).
- Reclaim the facility to a condition compatible with the original land use. The facility must also be stable during extreme precipitation events and design seismic events.

- Monitoring of all aspects of the facility to ensure that the design objectives are met and that there are no adverse environmental impacts.

2.2 DESIGN BASIS

The design of the heap leach pad is based on providing storage for approximately 14 million tonnes of leach ore at a dry density of 1.7 tonnes/m^3. The leach pad could further be expanded beyond this capacity by expanding in the vertical direction as well as towards the west. The leach ore production rates as provided by Kilborn, are summarized in the following table:

Summary of Carmacks Ore Production	
Year	**Tonnes x 1000**
-1	289.9
1	1,746.0
2	1,460.9
3	1,569.6
4	1,875.4
5	1,862.9
6	1,730.9
7	1,797.7
8	1,776.7
9	0
Total	14,109.8

The design mine life is 10 years. Solution application onto the heap occurs year round at 0.0244 m^3/hr-m^2 with a design flow rate onto the pad area of 1,137 m^3/hr. The leach ore will be crushed to minus 19 mm particle size and placed on the pad in 8 meter high lifts. The active area under primary leach will be 46,500 m^2.

2.3 GENERAL ARRANGEMENT

The heap leach facility has been designed for the valley heap leach method which involves the preparation and placement of leach ore behind a confining embankment. Leaching of the ore is performed with subsequent lifts progressing up slope. Solution storage capacity is provided in an external solution pond designated the events pond located down gradient from the heap leach pad. The valley heap leach method was selected for use in steep terrain and for severe climatic conditions. The location of the heap leach facility with respect to the overall project site is shown on Drawing 1785.000.

The heap leach pad will comprise an area of approximately 330,000 m^2 lined with an engineered double composite liner system with a leak detection and recovery system (LDRS) and surrounded by a 2 m high perimeter berm on two sides and a perimeter bench on the east side. Across the downstream portion of the heap leach pad, a confining embankment will be constructed across the drainage course to a crest elevation of 780 m. The confining embankment 22 metres high as measured from the downstream toe and approximately 350 metres long will provide stability for the heap. Solutions from the leach pad will be collected by a network of solution pipes within the overliner and conveyed to the events pond and/or directed to the process plant via gravity flow solution pipes. The design includes an events pond with a high integrity engineered double composite liner system with LDRS located downstream of the heap leach pad. The events pond is connected to the leach pad via gravity flow solution pipes and a double lined spillway. Diversion ditches collect and convey runoff around the facility to a sediment control pond.

2.4 STAGED DEVELOPMENT

The heap leach facility design uses staged development in order to defer capital costs. The proposed staged development of the facility is shown on Drawing 1785.209 and the ore loading plan is shown on Drawing 1785.210. Four stages of construction are foreseen:

- Stage II Preproduction

- Stage II Production End of Year 2
- Stage III Production End of Year 4
- Stage IV Closure

A summary of the main construction activities to be carried out for each stage of development is summarized as follows:

(i) Stage I (Preproduction):

- Strip foundation to mineral soil up to El. 830 m.
- Complete permafrost delineation program in foundation.
- Excavate perimeter bench.
- Construct diversion ditches around facility.
- Construct sediment control ponds.
- Construct confining embankment to crest El. 780 m.
- Construct foundation drains to El. 830 m.
- Construct leach pad area to El. 830 m.
- Construct leak detection and recovery system (LDRS) to El. 830 m.
- Construct spillway and events pond.
- Construct gravity flow solution pipeline.

(ii) Stage II (End of Production Year 2):

- Strip foundation to mineral soil up to El. 850 m.
- Construct temporary diversion ditches around facility.
- Extend foundation drains to El. 850 m.
- Extend leach pad area to El. 850 m.
- Extend LDRS to El. 850 m.

(iii) Stage III (End of Production Year 4):

- Strip foundation to mineral soil for remaining pad area.
- Construct final diversion ditches around facility.
- Extend foundation drains to final limits.

- Extend LDRS to final limits.
- Extend leach pad area to final design limits.

(iv) Stage IV (Closure):

- Reshape heap slopes to final slope configurations.
- Decommission heap using an engineered system defined during operational research programs.
- Install long-term monitoring systems.

2.5 FOUNDATION DRAINAGE SYSTEM

A foundation drainage system will be installed beneath the heap leach pad to intercept and remove potential near-surface groundwater flows. Site observations to date have not identified areas of natural groundwater springs within the leach pad area which would result in soft, saturated ground and provide a poor foundation for the leach pad. It is possible, however, that localized perched water tables may be encountered during construction which will be connected into the foundation drainage system.

The foundation drainage collection system will comprise a series of perforated corrugated polyethylene tubing (CPT) drain pipes which will be configured as shown on Drawing 1785.203. The drain pipes will be laid in excavated trenches and will be surrounded by select drain gravel wrapped in geotextile. The foundation drains will be located in trenches following the local depressions in the ground surface. These drains will convey any intercepted groundwater seepage under the embankment to a foundation drainage collection sump located at the toe of the confining embankment. The foundation drainage collection sump will discharge into the events pond.

Once the foundation drains are installed they will be overlain by a compacted soil liner, followed by the high integrity engineered double composite liner system with LDRS which will ensure that any groundwater remains isolated from the overlying solutions.

The foundation drainage collection system will be installed in stages and covered with adequate frost protection material.

During operations, any outflow from the foundation drainage system, if it occurs, will be monitored on a regular basis for water quality and quantity.

The locations and details of the foundation drainage system are shown on Drawing 1785.203. The exact locations of the foundation drains across the leach pad site will be determined in the field by the Engineer to ensure that an optimum dewatering drainage system is provided.

2.6 WATER MANAGEMENT

2.6.1 General

The principal objectives of the water management plan for the heap leach facility are:

i) to protect and remove near surface groundwater beneath the facility;

ii) to minimize the amount of surface inflows into the facility; and

iii) to minimize the freshwater required as make-up.

The results of the water balance modelling of the facility have indicated that annually the facility is in a water deficit that requires the addition of make-up water to maintain the balance. Specific aspects of the design which have been adopted to meet the water management objectives for the heap leach facility are as follows:

- The heap leach facility will be developed in four stages to minimize the catchment area available at any one time for surface water inflows into the facility.

- Temporary diversion structures will be constructed to intercept surface runoff from the catchment areas above the heap leach pad.

- The quantity and quality of surface water, leakage through the inner liner, and groundwater in and around the facility will be monitored.

- Provide adequate solution storage for:

  - ◊ inflow of 100 year wet period of the most critical duration at the most critical period of time during the cycle of heap development;
  - ◊ full drain down; and
  - ◊ operating volume.

The results of the water balance modelling are discussed in the following sections.

2.6.2 Water Balance Model

The water balance model simulates the operation of the heap leach facility on a monthly basis. The model evaluates the annual process solution storage requirements and fresh water make-up requirements for the heap leach facility. The precipitation details and assumptions used in the model are summarized in Table 2.1. The design assumptions used in the water balance remain virtually unchanged from the preliminary design and are summarized in Table 2.2.

A series of water balances have been calculated to determine the annual storage required for the process solution and freshwater make-up for the heap leach facility. Water balances have been linked together over 9 years to monitor any cumulative operational conditions of the heap.

2.6.3 Water Balance Results

Using the model described above, the simulations of the heap leach facility were undertaken using two different annual synthesized precipitation conditions: the average annual return period, and the 1 in 100 year wet period of the most critical duration at the most critical time. The 9 year (average year) linked water balance is given in Table 2.3. The results show that the facility will be a net consumer of water with a required average annual make-up commencing at 192,531 m^3 then decreasing to 118,490 m^3 in year 4. The average maximum accumulation of precipitation in the solution storage areas is 15,006 m^3 after the full leach pad is developed after year 3. The water balance for the final year, Year 9 of operations, gives the final solution volume in the facility after leaching is finished and complete draindown of the leach pad is complete. This volume under average conditions is 56,399 m^3.

The critical year of development for water management will be the year after full development of the leach pad area. This is the time when the maximum catchment area is available for precipitation and snow melt to accumulate and when there is the least ore to impede and attenuate the drainage of the water to the ponds.

A water balance for Year 4 of operations with a 100 year wet return period annual precipitation is given in Table 2.4. The water balance assumes that the higher precipitation is proportionally distributed over the year. The results show that the facility will still be in water deficit and will require 93,101 m^3 of make-up water. The required storage for excess precipitation in this case is 34,405 m^3.

In order to determine the inflow of the 100 year wet period of the most critical duration at the most critical period of time during the cycle of heap development, annual water balances have been calculated for Year 4 of operations incorporating the following applied hydrological conditions:

- 100 year return wet April with remainder of year average (resulting in an annual precipitation of 562 mm which has a return period of 150 years).

- 100 year return wet April plus rainfall in May, to result in a 100 year return wet April/May, with remainder of the year average (resulting in an annual precipitation of 601 mm which has a return period of 750 years).

- 100 year return wet April plus rainfall in May/June, to result in a 100 year return wet April/May/June, with remainder of the year average (resulting in an annual precipitation of 618 mm which has a return period of 1,600 years). Identified as Case A in the modelling.

- 100 year return wet May, plus 100 year return wet June, plus rainfall in April, to result in a 100 year return wet April/May/June, with remainder of the year average (resulting in an annual precipitation of 618 mm which has a return period of 1,600 years). Identified as Case B in the modelling.

The results of these water balances are presented in Tables 2.5, 2.6, 2.7 and 2.8 respectively, and are summarized as follows:

YEAR 4 OF OPERATIONS

Hydrological Condition (See Table 2.1)	Maximum Storage Required for Precipitation (m^3)
Average Annual Precipitation	15,006
100 year Return Wet Year	34,405
100 Year Return Wet April	75,549
100 Year Return Wet April/May	83,555
100 Year Return Wet April/May/June (Case A)	83, 555
100 Year Return Wet April/May/June (Case B)	78,715

The results show that the freshet period of April/May, as expected, is the most critical period for the water balance. The 100 year return wet April/ May which includes the 100 year return April is the critical duration hydrological event which determines the solution storage requirements.

A similar series of water balances were calculated for the final year of operation, Year 9, incorporating the hydrological conditions previously described. In the final year, the placement of ore ceases in the fall and leaching continues over the winter months through April. Final draindown occurs at the end of the year and the resulting solution volume is the quantity which will be treated and used for rinsing the spent ore heap or discharged when water quality criteria are satisfied. The results of all of the water balances are given in Tables 2.9, 2.10, 2.11, 2.12 and 2.13, and are summarized as follows:

YEAR 9 OF OPERATIONS

Hydrological Condition (See Table 2.1)	**Maximum Storage Required for Precipitation (m^3)**
Average Annual Precipitation	56,399
100 year Return Wet Year	103,920
100 Year Return Wet April	116,942
100 Year Return Wet April/May	129,636
100 Year Return Wet April/May/June (Case A)	135,170
100 Year Return Wet April/May/June (Case B)	135, 170

These results indicate that after the loading of the pad is complete and all of the ore has been wetted by the leaching process, there is no longer a consumption of water by the leach pad. Water treatment will be required at this stage to remove water from the system and prevent accumulation of solution beyond the design storage capacity. The treatment requirements are addressed in the closure plan for the leach pad facility.

2.7 SOLUTION MANAGEMENT

Solution will be conveyed from the heap leach pad to the events pond via a gravity drainage system as shown in Drawing No. 1785.222. A valve station will be installed on the pipeline exiting the confining embankment to control solution flow via gravity to the SX plant. Under normal operating conditions the solution will be directed to one of two HDPE manhole sumps, and then routed through two 375 mm diameter pipes, where it will be directed to the SX plant or discharged below the minimum operational solution level of the events pond. From the events pond, the solution will be pumped to the plant, processed and recycled to the heap. Figure 2.1 shows a schematic diagram of the solution management.

Both HDPE liners will be welded to the sumps to prevent leakage. A slotted screen will be placed above the sump intake surrounded by drain rock which has a filter relationship with the leach ore. The solution collection pipes will penetrate the slotted screen through the use of an elbow or tee. In addition, the inner HDPE pipe will run inside an outer HDPE pipe, to provide additional strength and safety against leakage. The pipes have been designed to pass the maximum leach pad removal flow rate of 1,117 m^3/hr, while maintaining an in-pipe water level only slightly above the level of water in the events pond.

Total storage requirements and storage available in the system have been summarized below:

Production Years 1 to 8

Storage Volume Requirements	Volume (m^3)
• Maximum solution storage requirement from water balance	83,555
• Complete active leach area draindown	57,000
• Operational Storage (12 hours operational)	14,000
TOTAL STORAGE REQUIRED	154,555
Storage available	
• Events Pond	160,000
TOTAL AVAILABLE STORAGE	160,000

Production Year 9

Storage Volume Requirements	Volume (m^3)
• Maximum solution storage requirement from water balance	135,170
TOTAL STORAGE REQUIRED	135,170
Storage available: • Events Pond	 160,000
TOTAL AVAILABLE STORAGE	160,000

In the calculation of the solution storage requirements, it has been conservatively assumed that the leaching moisture content equals the saturated moisture content of the ore resulting in a maximum potential draindown of 57,000 m^3.

Potential In-Heap Storage

In-heap storage will not occur during normal operating conditions. However, under extreme operational conditions when the gravity pipeline is flowing at the maximum capacity of 1,117 m^3/hr, temporary storage in the ore pore volume may occur. The pore volume storage has been calculated using the following data obtained from the metallurgical testing of the leaching process in column tests:

- Ore specific gravity 2.7
- Dry density of the ore 1.7 t/m^3

The saturated moisture content by weight for the minus 19 mm crushed leach ore was calculated to be 25%. The residual moisture content by weight for the minus 19 mm crushed leach ore was 16%. Therefore, the storage capacity within the pore volume by weight is 9% or 0.144 m^3 of solution/m^3 of leach ore.

The storage volume of leach ore below the spillway invert elevation of 779 m is 97,000 m^3 which could provide temporary emergency saturated storage for 14,000

m^3 of solution and is not included as available storage for the solution storage requirements.

Events Pond Storage

The events pond design has been updated to provide storage for all process solution requirements which includes a major storm event or a process breakdown resulting in a complete draindown of the heap, or both. The leach pad will be directly linked to the events pond by a double-lined spillway and gravity flow solution pipeline. Under normal operating conditions, the events pond will only retain the minimal operational volume. Solution stored in the events pond will be used preferentially as make-up water in the process plant. The events pond is downstream from the heap leach pad, as shown on Drawing 1785.200. The stage-storage capacity curve for the events pond is shown on Figure 2.2. The available design storage is 160,000 m^3 .

Sediment Control Pond

In order to prevent turbid surface runoff from impacting the environment downstream of the heap leach facility, appropriate measures will be taken to control runoff and remove sediments prior to discharge into the natural water course, as shown on Drawing 1785.200. The measures will include the construction of a sediment control pond, which will be required prior to the start of construction.

The design parameters which have been used in the design of the sediment control pond include:

- 1 in 10 year, 24 hr rainfall with a 100% runoff coefficient (36 mm);
- A catchment area of 39 ha;
- A total runoff volume of 14,000 m^3; and
- The provision of storage capacity for the entire storm volume (above).

A spillway is included in the design with a capacity for passing the peak flows resulting from a 1 in 200 year 24 hr storm event. Monitoring of the flows will be carried out to ensure that the receiving environment is not impacted.

2.8 CONFINING EMBANKMENT DESIGN

The confining embankment is approximately 20 metres high as measured from the downstream toe to the crest. It will be constructed across the drainage course up to an elevation of 780 m. The general layout of the embankment is shown on Drawing 1785.201. Sections and details are included on Drawings 1785.205 and 1785.206.

The embankment will comprise an engineered earthfill and rockfill zoned structure constructed from locally derived borrow sources. A sloping earthfill zone will be constructed on the upstream face using select, low permeability earthfill that will be moisture conditioned and compacted in thin lifts to produce a seal zone. The seal zone will be tied into the outer soil liner of the pad. Additional features of the embankment design include a graded filter zone between the core and the structural random fill zones, and an outer shell consisting of non-frost-susceptible (NFS) structural random fill. Drainage facilities will be installed along the upstream toe of the embankment and immediately downstream of the core zone to control potential seepage. A drainage blanket will cover the foundation below the structural zone. The bulk of the embankment fill is designated as random fill which will act as the structural zone. This material will be placed and compacted in controlled lifts to provide a strong, dense, and stable engineered fill. The material descriptions, placement and compaction requirements, and grading envelopes for the construction materials are summarized on Drawing 1785.219 and described in detail in the technical specifications (Knight Piésold report Ref. No. 1784/4). Borrow pit locations were previously identified in the Knight Piésold document "Report on Detailed Design, Ref. No. 1784/2" and will provide the materials necessary to satisfy the Stage I construction items. Additional materials for ongoing construction have been identified at the site and will be confirmed during Stage I construction activities.

The upstream slope will be dressed and shaped to a 3H:1V slope to provide a smooth surface free of sharp protrusions for installation of the engineered liner system. The downstream slope of 2H:1V will be covered with coarse rockfill to armour the slope and provide long term erosion protection.

2.9 LINER SYSTEM DESIGN

2.9.1 General

The design and performance objectives for the liner system have been determined by the following:

- State of Nevada minimum liner design criteria as interpreted by the RERC.
- State of Nevada regulations as interpreted by the RERC for detected rates of leakage, and monitoring of this leakage.
- Location (including depth) to beneficial water resources.
- Unsaturated zone conditions.
- Climatic conditions.
- Slope of liner.
- Height of heap placed on liner.
- Heap construction methods.
- Hydraulic head controls.
- Life of operation for facility.

2.9.2 Liner Design

The engineered double liner system selected for the leach pad is shown schematically in Figure 2.3. It consists of the following:

1. A composite inner liner system comprising a 60 mil smooth High Density Polyethylene (HDPE) geomembrane placed directly on a 300 mm thick low permeability ($k = 1 \times 10^{-5}$ cm/s) soil liner.

2. Below the inner liner, a Leak Detection and Recovery System (LDRS) layer will be constructed. A geotextile will be placed between the inner soil liner and the LDRS drainage layer to prevent migration of the finer soil particles into the drainage layer. The

drainage layer will comprise a 500 mm thick sand and gravel zone with an average permeability of 0.5 cm/s.

3. A composite outer liner system comprising a 60 mil smooth HDPE geomembrane placed directly on a 300 mm thick compacted low permeability($k = 1 \times 10^{-6}$ cm/s) soil liner.

The inner HDPE geomembrane will be protected by a 1000 mm thick overliner of minus 19 mm crushed low grade ore.

The entire pad is subdivided into 32 cells of approximately 10,000 m^2 surface area each. The double composite liner system will be used across the entire pad floor except on the upstream slope of the heap leach pad confining embankment, and at the spillway from the heap leach pad to the events pond. At these areas, the liner system will be as follows from top to bottom:

1. A 60 mil smooth HDPE geomembrane.

2. An HDPE geonet drainage layer.

3. A composite liner comprising a 60 mil smooth HDPE geomembrane placed directly on a low permeability soil liner.

2.9.3 Leakage Detection Cells

In applying the updated design criteria for leak detection, the heap leach pad was sub-divided into 32 independently monitored areas or "cells" separated by small cell division berms. Each of these cells has an independent leakage detection system comprising a drain gravel layer beneath the inner composite liner system which conveys the leakage to a perforated collection pipe within a LDRS collection ditch.

Cells 1 and 2 as shown on Drawing 1785.204 drain towards the lowest portion along the upstream slope of the confining embankment. The removal of LDRS solutions is by submersible pump in a sump comprising a sloping

150 mm dia SDR 17 HDPE pipe located between the two liners on the confining embankment. The pump will be activated by level switches to prevent the build up of water in the LDRS. This flow from the pump will be directed to the plant site in a pipeline and will be continuously monitored.

The LDRS flows from the remainder of the LDRS cells are collected in 100 mm diameter CPT pipes with each cell having a dedicated drain pipe. The LDRS ditches flow by gravity at 0.5 % towards the LDRS collection sump structures, located along the right and left sides of the leach pad. The flow rates are measured prior to discharging into a 1 cubic meter HDPE sump. A float switch within the sump triggers a submersible pump which pumps the accumulated solution via a pipeline onto the heap. Cell layouts, LDRS collection ditches, and the LDRS collection sumps are shown on Drawing No. 1785.204. Sections and details are shown on Drawing 1785.207.

The LDRS gravel layer for an average cell has sufficient flow capacity to convey 43,000 litres/day of solution. This is well in excess of the maximum anticipated leak detection flow of 240 to 1,600 litres/day from the events pond or 300 litres/day from a leach pad cell and collection pipework within the LDRS gravel layer is therefore not required.

2.9.4 Predicted Leakage Rates Through the Liner System

It is important to note that two different leakage rate conditions have been evaluated: leakage through the inner composite liner system, which is collected and monitored through the LDRS; and leakage through the outer composite liner system. Foundation drains located along the upstream toe of the confining embankments are included in the design as a safety measure to capture and recover shallow leakage flows.

The leakage rates through the inner and outer liners have been calculated for the leach pad and the events ponds using the empirical equations proposed by Bonaparte *et al.* (1989). The formulae used are listed below:

$Q = 3\ a^{0.75}\ h^{0.75}\ k_d^{0.5}$ Soil overlying geomembrane

$Q = 0.21\ a^{0.1}\ h^{0.9}\ k_s^{0.74}$ Geomembrane overlying soil

$Q = C_B\ a\ (2\ g\ h_{ave})^{0.5}$ Geomembrane overlying geonet

where:

- Q = steady state rate of leakage through one hole in the liner (m^3/s)
- a = area of the hole (m^2)
- h = hydraulic head on top of the geomembrane (m)
- k_d = hydraulic conductivity of the material overlying the geomembrane (m/s)
- k_s = hydraulic conductivity of the material underlying the geomembrane (m/s)
- C_B = dimensionless coefficient ($C_B = 0.6$)
- g = acceleration of gravity ($g = 9.81\ m/s^2$)

The engineered double soil liner system for the heap leach pad is as described in section 2.9.2, and is shown schematically on Figure 2.3 and Figure 2.4. For the inner liner therefore, the overlying material is the overliner with a permeability of k_d=1 x 10^{-4} m/s. The underlying material is a soil liner with a permeability of k_s=1 x 10^{-7} m/s. For the outer liner, the overlying material is the drain gravel and the underlying material is the soil liner with a permeability of k_s=1 x 10^{-8} m/s. The average allowable leakage rates per leak detection cell are summarized below:

Allowable Average Leakage Per Cell		
	Quarterly Average	**Annual Average**
Events Pond	600 litres/day (150 US gallons/day)	200 litres/day (50 US gallons/day)
Heap Leach Pad	300 litres/day (75 US gallons/day)	100 litres/day (25 US gallons/day)

The liner system for the events pond is identical to that of the heap leach pad, except that it has been designed to operate as a single cell.

The above three formulae were applied and the formula which gave the lowest flow governed in each case. The calculations for leakage are presented in Figures 2.5 and 2.6 for the leach pad and events pond areas, respectively and are summarized in Table 2.14. The leakage rate calculations have assumed worst case conditions for a head build up in the overliner and LDRS drainage layer of 1 metre and 0.5 metre respectively. This represents a condition where the drainage layers are not functioning as intended by the design and results in a conservative analysis. The calculations are based on a US EPA guideline that states that the leakage through a liner should be evaluated by assuming that the defects in the liner are equivalent to one hole with an area of 10 mm^2 per acre (4047 m^2) of liner. This very conservative assumption has been used in the prediction of the performance of the liner systems for the leach pad and events pond. It is understood that similar liner systems operating in the Yukon are experiencing leakage rates significantly less than these leakage rates.

The predicted leakage rates per cell were calculated using the above assumptions and are summarized below:

Location	Predicted Leakage	Allowable Annual Average	Allowable Quarterly Average
Heap Leach Pad Inner Liner	94 ℓ/day (24.7 US gpd)	100 ℓ/day (25 US gpd)	300 ℓ/day (75 US gpd)
Heap Leach Pad Outer Liner	9 ℓ/day (2.4 US gpd)	N/A	N/A
Events Pond Inner Liner	151 to 1,583 ℓ/day (39.9 to 418.1 US gpd)	200 ℓ/day (50 US gpd)	600 ℓ/day (150 US gpd
Events Pond Outer Liner	5 ℓ/day (1.4 US gpd)	N/A	N/A

From the above table it should be noted that, for the events pond, a pumping rate of 235 m^3/hr will be required to remove events pond solutions in excess of the operational volume of 14,000 m^3. This pumping capacity is required to ensure that the additional leakage caused by the additional pond volume does not exceed the maximum allowable quarterly average daily leakage. The pumping rate of 235 m^3/day will ensure that the maximum storage volume will be pumped down to the operational volume level in less than 25 days to ensure that the design leakage is not exceeded.

2.10 STABILITY ASSESSMENT

2.10.1 Cases Analyzed

Stability analyses have been updated to evaluate the overall stability of the new heap leach pad configuration and to assess stability of placing the first lift of ore. The stability assessment concentrated on the smooth HDPE geomembrane - soil liner and the smooth HDPE geomembrane - geonet interfaces since these represent the corresponding weak layers in the model. The assessment involved static and pseudo-static (earthquake) conditions for the critical sections with the following modes of failure:

(i) Confining embankment slope failure.
(ii) Confining embankment foundation failure.
(iii) Heap slope failure.
(iv) Heap foundation failure.
(v) Heap slope failure along geomembrane liner contact.
(vi) Heap mass failure along geomembrane liner contact.

Analyses for the previously outlined cases were performed using a limit equilibrium method-of-slices which computes minimum factors of safety by evaluating a range of potential slip surfaces. The computer program SLOPE/W was used to perform the calculations. Spencer's method of analysis was selected as this method satisfies both force and moment equilibrium (SLOPE/W manual, version 3.0, 1991).

2.10.2 Modelling Parameters and Assumptions

Typical ranges of frictional values for individual materials such as the crushed ore, soil liner, foundation soils, overburden, and frictional interface angles between geomembrane materials are based on world-wide project experience and are supplemented by information from a literature survey. The results have been summarized in Table 2.15. Site specific testwork on individual materials has also been completed to provide a basis for the values used in modelling. These values, as well as modelling parameters, are summarized in Table 2.15.

The stability assessment has examined the effects induced by an increase in water levels within various designed components. A worst case foundation groundwater condition was conservatively chosen at ground elevation. A hydrostatic head of 1.0 m was applied to the smooth HDPE - soil liner and the smooth HDPE - Geonet interfaces. The smooth HDPE - Geonet interface and the heap leach ore were given a hydrostatic head based on the maximum worst case water level behind the confining embankment at elevation 780 m. These piezometric conditions, which were used in all the modelled cases, account for the following: i) possible mounding above the liner, ii) constrictions in the drainage layer, iii) hydrostatic pressures on the liner, and iv) maximum water table elevations. As discussed in Section 2.7, in-heap storage will not occur under normal operational conditions. However, this water level was modelled to ensure that the stability criteria were satisfied under extreme conditions.

A minimum factor of safety of 1.3 has been adopted for the static cases. A minimum factor of safety of 1.0 is used for the pseudo-static (earthquake) cases, with a maximum ground acceleration of 0. 13g.

2.10.3 Results

After considering the heap leach pad layout, three geometric configurations were identified as possible critical sections as shown in Figure 2.9. For each of the three geometric configurations, potential critical slip surfaces were generated to analyze the modes of failure summarized above. The results for the most critical slip surfaces, and the corresponding calculated minimum factors of safety for the three sections are shown on Figures 2.8 to 2.10. For all cases, a heap slope failure sliding along the liner interface was the most critical mode.

A stability analysis for the first lift of heap ore was also completed to check that an eight meter lift placed at the angle of repose would not compromise stability. As long as the first eight meter lift of ore is placed in an upslope direction or parallel to contours the minimum factor of safety of 1.3 is satisfied.

The calculated minimum factors of safety for the various cases have been summarized below:

CASES	Calculated Minimum Factors of Safety			Minimum Required Factors of Safety
	Section 1	Section 2	Section 3	
Static Conditions	1.4	1.7	1.4	1.3
Seismic Conditions	1.0	1.4	1.1	1.0

It should be noted that for Section 1, under pseudo-static conditions, a safety factor of marginally less than 1.0 is obtained. The resulting displacements, however, would be very small (4 mm). These are considered to be acceptable, and therefore the proposed heap leach pad configuration has satisfied the initial stability design criteria using conservative material properties, pore water pressures, and pseudo-static (seismic) conditions.

2.11 SETTLEMENT ASSESSMENT

Settlement at the heap leach facility was previously calculated in the Knight Piésold document "Report on Detailed Design, Ref. No. 1784/2". The settlement predictions included a thaw settlement component and a consolidation component. The configuration analyzed in that report would produce greater settlements than would be produced by the updated design due to the configuration of the confining embankment. The results presented in Report No. 1784/2 were acceptable, and therefore the results for a settlement analysis for the current configuration of the heap leach facility is therefore acceptable. On this basis, a settlement assessment of the updated configuration was not required for this report.

Figures 2.11 and 2.12 show the results of the settlement calculations as given in Report No. 1784/2.

2.12 DRAINAGE AND RUNOFF DIVERSION

Direct precipitation onto the leach pad will infiltrate into the heap and is accounted for in the water management of the facility. Surface runoff from outside the perimeter berm and perimeter road will be collected and directed to the sediment control pond prior to release into the natural drainage courses. The sediment control pond will be unlined and constructed from sand and gravel to allow exfiltration into the natural drainage course. A riprap-lined spillway from the sediment control pond is included in the design to discharge runoff from storms greater than the design storm.

The design criteria for the sediment control pond, diversion ditches, and spillway are summarized below:

Sediment Control Pond

- 1 in 10 year, 24 hr rainfall with a 100% runoff coefficient (36 mm);
- A catchment area of 39 ha;
- A total runoff volume of 14,000 m^3; and

- The provision of storage capacity for the entire storm volume (above).

Diversion Ditches

- Peak flows from a 1 in 200 year 24 hour return period storm event.

Spillway

- A spillway is included in the design with a capacity for passing the peak flows resulting from a 1 in 200 year 24 hr storm event.

2.13 GEOTECHNICAL INSTRUMENTATION

Geotechnical instrumentation will be installed to monitor the performance of the heap leach facility during the construction stage and throughout the life of the project. The main purpose of the instrumentation will be to provide data to assess the stability of the heap leach pad and to evaluate the effectiveness and performance of the overliner and the foundation drains.

Vibrating wire piezometers will be installed in the following locations:

i) the leach pad and events pond embankment foundation;
ii) the leach pad and events pond foundation drains; and
iii) the overliner.

Instrumentation requirements are shown on Drawing 1785.220 with sections and detailed provided on Drawing 1785.221.

Surface movement monuments will be installed at the locations shown on Drawing 1785.220. Periodic surveying of the location of these monuments will be required to monitor the stability of the slope.

2.14 EVENTS POND DESIGN

The events pond has been designed with a storage capacity of 160,000 m^3. The events pond comprises: installation of a foundation drainage system independent of the leach pad system, a prepared basin surface, construction of an earthfill confining embankment, and lining of the basin facility with a double composite liner system with a leak detection and recovery system (LDRS). The events pond area will be stripped of vegetation, down to mineral soil. At that time, a permafrost delineation program will be implemented to evaluate the permafrost foundation condition as described in Section 2.2 of the Knight Piésold document" Report on Detailed Design Criteria, Ref. No. 1784/5" dated July 3, 1996. The locations of the drill holes in the events pond footprint area are shown on Drawing 1784.201. The basin will be shaped, and the subgrade will be prepared to a smooth surface, free of protruding rocks, roots, etc. which could damage the liner. A zoned confining embankment will be constructed using similar materials defined for the leach pad confining embankment.

The engineered liner system for the embankment is identical to that for the heap leach pad, as shown schematically in Figure 2.3. The LDRS will recover leakage along the low point of the embankment toe from a collection pipe and ditch which will drain to a sump.

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

The events pond is shown in plan on Drawings 1785.214 and 1785.215 with typical sections and details on Drawing 1785.216 and 1785.217..

Leakage rates through the inner and outer liners were estimated and presented in Section 2.9.3.

Under normal operational conditions the events pond will contain only 14,000 m^3 (12 hrs) operational solution volume. During storm events, however, the pond will fill to some level above this (depending on the severity of the storm) and for the maximum storage level in the pond the maximum leakage rate as shown in the table in section 2.9.3 would apply. In this case, the pumping rate of 235 m^3 per hour would be implemented in order to remove the excess solution in the pond and minimize the leakage rate into the LDRS.

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

Stability analyses have been carried out for the event pond for both static and pseudo-static (earthquake) conditions. The analysis assumes that thawing of the foundation will result in high thaw generated pore pressure modelled with a r_u of 0.4 for the post construction state. An acceptable minimum factor of safety of 1.3 for static condition has been adopted in this design. The material parameters used in the analyses and the results of the stability analyses are shown on Figures 2.13 and 2.14. The calculated factors of safety are summarized as follows:

Case	Factor of Safety	Minimum Required Factor of Safety	Yield Acceleration
Static	1.4	1.3	N/A
Pseudo-static	1.0	1.0	0.13g

2.15 HYDROGEOLOGICAL IMPACT ASSESSMENT

A hydrogeological model of the heap leach pad area has been developed based on i) the results of the site investigation programs, ii) measured depths to groundwater and measured and, iii) interpreted permeabilities for the various geological units. Detailed descriptions of the regional groundwater system and site groundwater conditions were provided in the Knight Piésold document "Report on 1996 Geotechnical and Hydrogeological Site Investigations, Ref. No. 1784/1". The model used the two dimensional program, SEEP/W, which is an industry standard program for seepage analysis using finite element techniques. The finite element mesh represents a section down the centre of the leach pad site as shown on Figure 2.15. The section, finite element mesh and seepage parameters are shown on Figure 2.16.

The assumptions used in the model are as follows:

- The glacial-fluvial sand and gravel deposits found in several of the test trenches is directly beneath the leach pad and events pond soil liners and is continuous over the entire leach pad area. The sand deposit is classified as SM-SW and has a typical range of permeabilities of 10^{-5} to 10^{-7} m/s (10^{-3} to 10^{-5} cm/s). The main concern is that this layer may act as a conduit for seepage of leaks beneath the leach pad, and therefore the highest (most conservative) permeability in the range of permeabilities was used in the model, for each soil type.

- The fine grained overburden is classified as SC and has a typical range of permeabilities of 10^{-7} to 10^{-9} m/s (10^{-5} to 10^{-7} cm/s). Again, the highest (most conservative) permeability in the range of permeabilities was used in the model, for each soil type.

- The frozen soil, as delineated in the field investigation, is impermeable ($k = 10^{-15}$ m/s).

- The weathered/decomposed granite was assigned a high permeability of 10^{-6} m/s. This is 1 to 2 orders of magnitude higher than the measured permeabilities for the fresh granodiorite.

- The permeabilities for the granodiorite bedrock reflect the permeabilities measured in the field.

- The bedrock at depth is considered to be impermeable, ($k = 10^{-15}$ m/s).

The hydrogeological model was calibrated by varying the groundwater recharge surface infiltration rate until the resulting groundwater surface reasonably matched the groundwater surface measured in the field. The result of the calibration is shown on Figure 2.17. Two surface infiltration rates were used in the model. A higher rate was used in the upper part of the leach pad area as a larger recharge area feeds this section. The infiltration rates are equivalent to 180 mm per year for the upper section and 60 mm per year for the lower section. These are 48% and 16% of the annual precipitation which, when the larger infiltration area of the upper section is taken into consideration are reasonable groundwater recharge rates. The model also predicts a perched water table above the frozen soil zones, as would be expected. The model indicates that 91% of the groundwater flow is deep in the bedrock (Q_B) and that 9% of the groundwater flow is in the thawed overburden (Q_T) above the frozen soils in the lower section of the leach pad area.

After construction of the leach pad and events pond, the groundwater recharge area for the leach pad site will be reduced from 703,000 m^2 to 393,900 m^2 by construction of the leach pad and events pond liner system. This is shown on Figure 2.15. The placement of the liner system will therefore reduce the recharge of the groundwater by 56% which will result in a significant depression of the existing groundwater regime.

The calibrated hydrogeological model was used to predict the leakage pathways for concentrated leak points located in the following locations:

- At the deepest point in the leach pad area,
- In the leach pad area at the 780 metre contour elevation area,
- At the top limit of the leach pad,
- At the deepest point in the events pond.

The volume of the leaks was calculated on the basis of the following assumptions:

- The area of the hole or tear in the HDPE liner is 0.01 m^2 (100 mm x 100 mm).

- The hole in the geomembrane liner coincides with an area of soil liner which has a permeability 1 order of magnitude higher than the maximum permeability called for in the Technical Specifications. This corresponds to a value of 1 x 10^{-7} m/s (1 x 10^{-5} cm/s).

- The head on the outer liner in the deepest point of the leach pad and the events pond assumes that the inner liner and LDRS drainage layer has completely failed and the maximum possible heads of 15 m and 16 m are acting on the leaks respectively.

- The head on the leak in the leach pad area has been arbitrarily assumed to be 5 metres which is 10 times the design value of 0.5 metres.

The predicted quantities of leaks for worst-case conditions are as follows:

Location of Leak	Leak Flow (m^3/s)	Leak Flow (m^3/day)
Deepest point in leach pad area.	1.0 x 10^{-5}	0.87
Leach pad at the 780 m elevation contour.	3.7 x 10^{-6}	0.32
Leach pad at top limit of heap leach pad.	3.7 x 10^{-6}	0.32
Deepest point in events pond.	1.1 x 10^{-5}	0.92

The results of the hydrogeological modelling are depicted on Figures 2.18 to 2.21 inclusive and are in the form of predicted phreatic surfaces, equipotentials and flow vectors.

The results of a modelled leak in the deepest point of the leach pad area are shown on Figure 2.18. The leakage flows on top of the frozen soil with 60% of the leakage flows confined to the perched water table in the overburden above the frozen soil and 40% of the leakage flow entering the deeper regional groundwater in the bedrock.

The results of a modelled leak in the leach pad area at the 780 metre contour elevation and at the upper limit of the leach pad are shown on Figures 2.19 and 2.20. The leakage flow almost entirely enters the deeper regional groundwater in the bedrock with only minor flows above the frozen soils in the perched water table.

The results of a modelled leak in the events pond are shown on Figure 2.21. The leakage flow is confined entirely above the frozen soil in the perched aquifer in the overburden.

The main surficial control of the modelled leakage flows is the frozen soil layer. As this frozen layer thaws, a larger percentage of leakage flow from the deepest point of the leach pad and the events pond will enter the deeper regional groundwater.

The hydrogeological impacts of the simulated leaks as presented above are presented in Table 2.16. The table presents the impact of the portion of the leakage which infiltrates to the deep, regional ground water regime. The leaks into the perched water tables will be collected in the groundwater drains in the foundation of the leach pad confining embankment and the events pond. Table 2.16 gives the transmission times and dilution of the leaks in the groundwater at Williams Creek.

The limitations of the hydrogeological model as presented above are as follows:

- It is a two dimensional representation of a three dimensional problem,
- The potential influence of the open pit has not been considered,
- It does not model the complex variation of the surficial geology in detail.

Nevertheless, the model is considered valid and conservative because:

- The two-dimensional representation, with a variation in recharge infiltration rates to account for variations in recharge areas, agrees very well with the measured field conditions,

- Currently, there has been no groundwater encountered during exploration drilling in the open pit area to the depth of the bottom of the proposed pit. Excavation of the pit can therefore have no effect on the modelling of any potential leakage.

- Even though the intricate complexities of the overburden geology have not been modelled, the analysis is considered conservative because it assumes that the permeable zones are continuous.

Potential impacts of uncontrolled leakage as described and modelled above may be mitigated as follows:

- The design includes for a foundation drain along the upstream toe of the leach pad confining embankment and the events pond embankment. The depths of these drains will be determined in the field by the Engineer and will penetrate any permeable surficial materials and will collect shallow near surface leakage flows from potential leaks in the leach pad area and events pond. The foundation drains discharge into sumps. In the event that contaminated seepage is detected, a submersible pump can be quickly installed in the sumps to recycle the water to the leach pad or the events pond.

- All areas except upstream slope of heap embankment have a double composite liner system to minimize leakage, as well as an LDRS to collect leakage through the inner liner. Daily monitoring of the LDRS is planned and if leakage rates are exceeded in the LDRS then site specific investigations will be undertaken to identify and mitigate the leakage.

- Under normal operating conditions, the events pond will contain only a relatively small operating volume (14,000 m^3). Any leakage which shows up in the foundation drains will repaired as soon as the water is used up in the process.

2.16 CLOSURE

The previous closure plan for the heap proposed the excavation of a wedge of leach ore immediately upstream of the confining embankment in order to construct the inlet of the drain pipe. A three dimensional stability analysis was completed to demonstrate the stability of the excavation. The updated design proposes a permanent gravity flow solution pipeline to be constructed in the initial phase of construction. At closure these pipes will be used to convey solution to the process plant for detoxification and treatment. Therefore, it will not be necessary to excavate a wedge through the confining embankment at closure.

2.17 ADDITIONAL ITEMS TO BE UPDATED

This report has addressed the issues related to the updated design of the heap leach pad and events pond. Prior to proceeding with tendering and construction of this updated design the following items will have to be updated:

i) The material balance as given in "Report on Detailed Design", Knight Piésold Ltd., August 1996, Ref. No. 1784/2 is no longer applicable. For example, soil liner material and drain gravel quantities have increased due to the revised liner cross-section. Adequate quantities have been identified for Stage I construction. Additional borrow areas for soil liner material and LDRS drainage material for ongoing construction will be delineated as part of the Stage I construction activities. Previously excavated test pits and trenches in the waste rock storage area have identified materials which satisfy the requirement for soil liner material. Previous site investigations have identified sand and gravel deposits in the area which would be produce suitable LDRS drainage material.

ii) An updated Technical Specification must be issued.

iii) An updated QA/QC Program must be issued.

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TABLE 2.1
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
PRECIPITATION DETAILS USED IN ANALYSIS

18-Apr-97

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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

TABLE 2.2
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
WATER BALANCE ANALYSIS DATA

18-Apr-97

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DESCRIPTION	VALUE
General Details:	
Daily ore production (tpd)	8,816
Lift Height (m)	8
Bulk Density of Heap Ore (t/m^3)	1.7
Initial Ore Moisture	4%
Leaching Ore Moisture	25%
Residual Ore Moisture	16%
Leachate Application Rate ($m^3/hr/m^2$)	0.0244
Leach Cycle Time (days)	120
Maximum Solution Flow to Plant (m^3/hr)	234
Maximum Solution Flow on Pad (m^3/hr)	1,137
Maximum Solution Flow off Pad (m^3/hr)	1,117
Maximum Area Under Leach (m^2)	46,598
Porosity of Heap	40%
Catchment Areas:	
Leach Pad Area Year 1 (m^2)	132,000
Leach Pad Area Years 2 & 3 (m^2)	219,000
Leach Pad Area Years 4 & up (m^2)	310,000
Events Pond Area (m^2)	15,500
Runoff and Evaporation Coefficients:	
Leach Pad Runoff Coefficient	100%
Heap Evaporation Coefficient for Area Under Leach	100%
Heap Evaporation Coefficient for Heap and Overliner	5%

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.3

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 1 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816	tonnes
Lift Height =	8	m
Bulk Density of Heap Ore =	1.7	t/m³
Initial Ore Moisture =	4%	
Leaching Ore Moisture =	25%	
Residual Ore Moisture =	16%	
Leachate Application Rate =	0.0244	m³/hr/m²

Leach Cycle Time =	120	days
Maximum Solution Flow to Plant =	234	m³/hr
Maximum Solution Flow on Pad =	1,137	m³/hr
Maximum Solution Flow off Pad =	1,117	m³/hr
Maximum Area Under Leach =	46,598	m²
Porosity of Heap =	40%	
Annual Precipitation =	376	mm

Catchment Areas :			Runoff Coeff. :
Leach Pad Area Prepared =	132,000	m²	100%
Events Pond Area =	15,500	m²	
Heap Evap. Coeff. for Area Under Leach =	100%		
Heap Evap. Coeff. for Heap and Overliner =	5%		

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18-Apr-97

	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	0	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,489,904
E	Stacked Leach Ore Volume Previous Month (m³)	0	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	876,414
F	>>> Total Storage on Pad (m³)	0	160,762	321,525	477,101	637,864	637,864	637,864	637,864	637,864	637,864	715,652	876,414	
G	Area Available for Leach (m²)	0	20,095	40,191	59,638	79,733	79,733	79,733	79,733	79,733	79,733	89,456	109,552	109,552
H	Area Under Leach (m²)	0	20,095	40,191	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	132,000	111,905	91,809	85,402	85,402	85,402	85,402	85,402	85,402	85,402	85,402	85,402	85,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	9,900	6,996	4,752	528	0	0	0	0	0	13,200	8,052	6,204	49,632
2	As Initial Ore Moisture	0	5,418	5,418	5,418	5,418	5,418	5,418	5,418	5,418	5,418	5,418	5,418	59,596
3	As Draindown	0	0	0	0	0	12,190	12,190	12,190	12,190	12,190	12,190	12,190	85,331
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	11,063	13,235	10,728	6,008	5,418	17,608	17,608	17,608	17,608	32,358	26,605	24,540	200,387
6	Make-up Water from Freshwater Supply	0	14,676	25,123	27,854	28,444	16,253	16,253	16,253	16,253	1,503	13,428	16,489	192,531
7	>>> Total Water In (m³)	11,063	27,911	35,851	33,861	33,861	33,861	33,861	33,861	33,861	33,861	40,034	41,029	392,918
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	0	1,427	1,326	0	0	0	0	0	0	0	4,334	5,033	12,119
9	Evaporation from Heap and Overliner	653	397	151	0	0	0	0	0	0	0	397	461	2,060
10	In Heap	0	33,861	33,861	33,861	33,861	33,861	33,861	33,861	33,861	33,861	33,861	33,861	372,476
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	2,188	36,786	35,851	33,861	33,861	33,861	33,861	33,861	33,861	33,861	40,034	41,029	392,918
13	Change in Water Storage: Positive/(Negative)	8,875	(8,875)	0	0	0	0	0	0	0	0	0	0	0
14	>>> Total Water Out (m³)	11,063	27,911	35,851	33,861	33,861	33,861	33,861	33,861	33,861	33,861	40,034	41,029	392,918
15	Solution Storage Requirement	8,875	0	0	0	0	0	0	0	0	0	0	0	8,875

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.3 (cont'd)

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 2 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m²
Residual Ore Moisture =	16%	Porosity of Heap =	40%
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	376 mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared =	219,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	1,031,991	1,192,753	1,353,515	1,509,092	1,669,854	1,669,854	1,669,854	1,669,854	1,669,854	1,669,854	1,747,642	1,908,405	
G	Area Available for Leach (m²)	128,999	149,094	169,189	188,636	208,732	208,732	208,732	208,732	208,732	208,732	218,455	238,551	238,551
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	16,425	11,607	7,884	876	0	0	0	0	0	21,900	13,359	10,293	82,344
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	12,190	12,190	12,190	12,190	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	154,024
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	35,626	30,467	26,480	18,976	19,006	19,006	19,006	19,006	19,006	42,456	33,310	30,027	312,371
6	Make-up Water from Freshwater Supply	7,925	11,104	12,403	17,574	17,544	17,544	17,544	17,544	17,544	0	3,910	14,160	154,795
7	>>> Total Water In (m³)	43,551	41,571	38,883	36,550	36,550	36,550	36,550	36,550	36,550	42,456	37,220	44,187	467,166
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	853	612	284	0	0	0	0	0	0	0	802	931	3,483
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	43,551	41,571	38,883	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,126	44,187	467,166
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	5,906	(5,906)	0	0
14	>>> Total Water Out (m³)	43,551	41,571	38,883	36,550	36,550	36,550	36,550	36,550	36,550	42,456	37,220	44,187	467,166
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	5,906	0	0	5,906

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.3 (cont'd)

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 3 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816	tonnes
Lift Height =	8	m
Bulk Density of Heap Ore =	1.7	t/m³
Initial Ore Moisture =	4%	
Leaching Ore Moisture =	25%	
Residual Ore Moisture =	16%	
Leachate Application Rate =	0.0244	m³/hr/m²
Leach Cycle Time =	120	days
Maximum Solution Flow to Plant =	234	m³/hr
Maximum Solution Flow on Pad =	1,137	m³/hr
Maximum Solution Flow off Pad =	1,117	m³/hr
Maximum Area Under Leach =	46,598	m²
Porosity of Heap =	40%	
Annual Precipitation =	376	mm

Catchment Areas :

			Runoff Coeff. :
Leach Pad Area Prepared =	219,000	m²	100%
Events Pond Area =	15,500	m²	
Heap Evap. Coeff. for Area Under Leach =	100%		
Heap Evap. Coeff. for Heap and Overliner =	5%		

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	2,063,981	2,224,744	2,385,506	2,541,082	2,701,845	2,701,845	2,701,845	2,701,845	2,701,845	2,701,845	2,779,633	2,940,395	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402	172,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	16,425	11,607	7,884	876	0	0	0	0	0	21,900	13,359	10,293	82,344
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	36,593	31,434	27,448	19,944	19,006	19,006	19,006	19,006	19,006	42,456	33,310	30,027	316,242
6	Make-up Water from Freshwater Supply	6,957	10,136	11,436	16,606	17,544	17,544	17,544	17,544	17,544	0	3,910	14,160	150,924
7	>>> Total Water In (m³)	43,551	41,571	38,883	36,550	36,550	36,550	36,550	36,550	36,550	42,456	37,220	44,187	467,166
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	853	612	284	0	0	0	0	0	0	0	802	931	3,483
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	43,551	41,571	38,883	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,126	44,187	467,166
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	5,906	(5,906)	0	0
14	>>> Total Water Out (m³)	43,551	41,571	38,883	36,550	36,550	36,550	36,550	36,550	36,550	42,456	37,220	44,187	467,166
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	5,906	0	0	5,906

TABLE 2.3 (cont'd)

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 4: AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816	tonnes
Lift Height =	8	m
Bulk Density of Heap Ore =	1.7	t/m³
Initial Ore Moisture =	4%	
Residual Ore Moisture =	16%	
Leachate Application Rate =	0.0244	m³/hr/m²

Leach Cycle Time =	120	days
Maximum Solution Flow to Plant =	234	m³/hr
Maximum Solution Flow on Pad =	1,137	m³/hr
Maximum Solution Flow off Pad =	1,117	m³/hr
Porosity of Heap =	40%	
Annual Precipitation =	376	mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared =	310,000	m²	100%
Events Pond Area =	15,500	m²	
Heap Evap. Coeff. for Area Under Leach =	100%		
Heap Evap. Coeff. for Heap and Overliner =	5%		

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	3,095,972	3,256,734	3,417,496	3,573,073	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,811,624	3,972,386	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	31,000	18,910	14,570	116,560
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	51,556	38,861	34,304	350,458
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	56	118,546
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	15,006	(4,688)	(10,318)	0
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	15,006	10,318	0	15,006

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.3 (cont'd)

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 5 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days		
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m^3/hr		
Bulk Density of Heap Ore =	1.7 t/m^3	Maximum Solution Flow on Pad =	1,137 m^3/hr		
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m^3/hr		
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m^2		
Residual Ore Moisture =	16%	Porosity of Heap =	40%		
Leachate Application Rate =	0.0244 m^3/hr/m^2	Annual Precipitation =	376 mm		

Catchment Areas :		Runoff Coeff. :
Leach Pad Area Prepared =	310,000 m^2	100%
Events Pond Area =	15,500 m^2	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m^3)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m^3)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m^3)	4,127,962	4,288,725	4,449,487	4,605,064	4,765,826	4,765,826	4,765,826	4,765,826	4,765,826	4,765,826	4,843,614	5,004,376	
G	Area Available for Leach (m^2)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m^2)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m^2)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m^3)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,24[illegible]	0	0	0	0	0	31,000	18,910	14,570	116,560
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	51,556	38,861	34,304	350,458
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	56	118,546
7	>>> Total Water In (m^3)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
	<WATER OUT OF SYSTEM> (m^3)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	15,006	(4,688)	(10,318)	0
14	>>> Total Water Out (m^3)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	15,006	10,318	0	15,006

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.3 (cont'd)

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 6 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days		
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr		
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr		
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr		
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m²		
Residual Ore Moisture =	16%	Porosity of Heap =	40%		
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	376 mm		

Catchment Areas :

		Runoff Coeff. :
Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	5,159,953	5,320,715	5,481,478	5,637,054	5,797,816	5,797,816	5,797,816	5,797,816	5,797,816	5,797,816	5,875,605	6,036,367	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	31,000	18,910	14,570	116,560
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	51,556	38,861	34,304	350,458
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	56	118,546
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	15,006	(4,688)	(10,318)	0
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	15,006	10,318	0	15,006

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 7 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816	tonnes	Leach Cycle Time =	120	days	Leach Pad Area Prepared =	310,000	m^2
Lift Height =	8	m	Maximum Solution Flow to Plant =	234	m^3/hr	Events Pond Area =	15,500	m^2
Bulk Density of Heap Ore =	1.7	t/m^3	Maximum Solution Flow on Pad =	1,137	m^3/hr	Heap Evap. Coeff. for Area Under Leach =	100%	
Initial Ore Moisture =	4%		Maximum Solution Flow off Pad =	1,117	m^3/hr	Heap Evap. Coeff. for Heap and Overliner =	5%	
Leaching Ore Moisture =	25%		Maximum Area Under Leach =	46,598	m^2			
Residual Ore Moisture =	16%		Porosity of Heap =	40%				
Leachate Application Rate =	0.0244	$m^3/hr/m^2$	Annual Precipitation =	376	mm			

Catchment Areas : (Leach Pad Area Prepared, Events Pond Area) — **Runoff Coeff. :** 100%

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m^3)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m^3)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m^3)	6,191,944	6,352,706	6,513,468	6,669,045	6,829,807	6,829,807	6,829,807	6,829,807	6,829,807	6,829,807	6,907,595	7,068,358	
G	Area Available for Leach (m^2)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m^2)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m^2)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m^3)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	31,000	18,910	14,570	116,560
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	51,556	38,861	34,304	350,458
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	56	118,546
7	>>> Total Water In (m^3)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
	<WATER OUT OF SYSTEM> (m^3)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	15,006	(4,688)	(10,318)	0
14	>>> Total Water Out (m^3)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	15,006	10,318	0	15,006

TABLE 2.3 (cont'd)

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 8 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m²
Residual Ore Moisture =	16%	Porosity of Heap =	40%
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	376 mm

Catchment Areas : / Runoff Coeff. :

Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	7,223,934	7,384,696	7,545,459	7,701,035	7,861,798	7,861,798	7,861,798	7,861,798	7,861,798	7,861,798	7,939,586	8,100,348	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	31,000	18,910	14,570	116,560
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	51,556	38,861	34,304	350,458
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	56	118,546
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	15,006	(4,688)	(10,318)	0
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	51,556	38,861	34,361	469,004
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	15,006	10,318	0	15,006

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.3 (cont'd)

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 9 : AVERAGE YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days	Leach Pad Area Prepared =	310,000 m² (Runoff Coeff.: 100%)
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr	Events Pond Area =	15,500 m²
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr	Heap Evap. Coeff. for Area Under Leach =	100%
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr	Heap Evap. Coeff. for Heap and Overliner =	5%
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m²		
Residual Ore Moisture =	16%	Porosity of Heap =	40%		
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	376 mm		

Catchment Areas : / Runoff Coeff. :

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	DESCRIPTION		JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)		75	53	36	4	0	0	0	0	0	100	61	47	376
C	Mean Monthly Lake Evaporation (mm/month)		99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)														
D	Stacked Leach Ore Tonnage Previous Month (tonnes)		264,480	273,296	273,296	0	0	0	0	0	0	0	0	0	811,072
E	Stacked Leach Ore Volume Previous Month (m³)		155,576	160,762	160,762	0	0	0	0	0	0	0	0	0	477,101
F	>>> Total Storage on Pad (m³)		8,255,925	8,416,687	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	
G	Area Available for Leach (m²)		240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)		46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)		263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)														
1	Leach Pad :	As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	31,000	18,910	14,570	116,560
2		As Initial Ore Moisture	4,635	4,635	4,635	4,635	4,635	4,635	4,635	0	0	0	0	0	32,443
3		As Draindown	13,158	13,158	13,158	13,158	10,428	10,428	10,428	10,428	10,428	10,428	10,428	0	125,628
4	Event Pond :	As Precipitation	1,163	822	558	62	0	0	0	0	0	1,550	946	729	5,828
5	Sub-Total		42,205	35,044	29,511	19,095	15,063	15,063	15,063	10,428	10,428	42,978	30,284	15,299	280,459
6	Make-up Water from Freshwater Supply		0	0	0	0	0	0	0	2,512	6,604	0	0	0	9,116
7	>>> Total Water In (m³)		42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	42,978	30,284	15,299	289,575
	<WATER OUT OF SYSTEM> (m³)														
8	Leach Pad :	Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9		Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10		In Heap	21,667	21,667	21,667	21,667	21,667	21,667	21,667	17,033	17,033	17,033	0	0	202,768
11	Event Pond :	Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total		29,119	27,011	24,151	21,667	21,667	21,667	21,667	17,033	17,033	17,033	7,000	8,129	233,176
13	Change in Water Storage: Positive/(Negative)		13,086	8,033	5,360	(2,573)	(6,604)	(6,604)	(6,604)	(4,093)	0	25,946	23,284	7,170	56,399
14	>>> Total Water Out (m³)		42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	42,978	30,284	15,299	289,575
15	Solution Storage Requirement		13,086	21,119	26,479	23,906	17,302	10,697	4,093	0	0	25,946	49,229	56,399	56,399

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.4

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 4: 1 IN 100 WET YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days		
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr		
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr		
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr		
Residual Ore Moisture =	16%	Porosity of Heap =	40%		
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	550 mm		

Catchment Areas : / Runoff Coeff. :

Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	110	77	53	6	0	0	0	0	0	146	89	69	550
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	3,095,972	3,256,734	3,417,496	3,573,073	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,811,624	3,972,386	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	34,100	23,870	16,430	1,860	0	0	0	0	0	45,260	27,590	21,390	170,500
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,705	1,194	822	93	0	0	0	0	0	2,263	1,380	1,070	8,525
5	Sub-Total	54,811	44,069	36,257	20,959	19,006	19,006	19,006	19,006	19,006	66,529	47,975	41,465	407,095
6	Make-up Water from Freshwater Supply	0	0	0	5,382	17,544	17,544	17,544	17,544	17,544	0	0	0	93,101
7	>>> Total Water In (m³)	54,811	44,069	36,257	26,341	36,550	36,550	36,550	36,550	36,550	66,529	47,975	41,465	500,196
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	10,810	2,176	(2,776)	(10,209)	0	0	0	0	0	29,979	4,426	(3,213)	31,192
14	>>> Total Water Out (m³)	54,811	44,069	36,257	26,341	36,550	36,550	36,550	36,550	36,550	66,529	47,975	41,465	500,196
15	Solution Storage Requirement	10,810	12,985	10,209	0	0	0	0	0	0	29,979	34,405	31,192	34,405

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 4: 1 IN 100 WET APRIL PRECIPITATION

General Assumptions :

Daily Ore Production = 8,816 tonnes
Lift Height = 8 m
Bulk Density of Heap Ore = 1.7 t/m³
Initial Ore Moisture = 4%
Residual Ore Moisture = 16%
Leachate Application Rate = 0.0244 m³/hr/m²

Leach Cycle Time = 120 days
Maximum Solution Flow to Plant = 234 m³/hr
Maximum Solution Flow on Pad = 1,137 m³/hr
Maximum Solution Flow off Pad = 1,117 m³/hr
Porosity of Heap = 40%
Annual Precipitation = 562 mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared = 310,000 m² — 100%
Events Pond Area = 15,500 m²
Heap Evap. Coeff. for Area Under Leach = 100%
Heap Evap. Coeff. for Heap and Overliner = 5%

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	286	61	47	562
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	3,095,972	3,256,734	3,417,496	3,573,073	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,811,624	3,972,386	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	88,660	18,910	14,570	174,220
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	4,433	946	729	8,711
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	112,099	38,861	34,304	411,001
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	0	118,490
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	112,099	38,861	34,304	529,491
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	75,549	(4,688)	(10,374)	60,487
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	112,099	38,861	34,304	529,491
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	75,549	70,861	60,487	75,549

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 4: 1 IN 100 WET APRIL/MAY/JUNE PRECIPITATION - CASE A

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr
Residual Ore Moisture =	16%	Porosity of Heap =	40%
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	618 mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	286	100	64	618
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	3,095,972	3,256,734	3,417,496	3,573,073	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,811,624	3,972,386	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	88,660	31,000	19,840	191,580
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	4,433	1,550	992	9,579
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	112,099	51,556	39,838	429,229
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	0	118,490
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	112,099	51,556	39,838	547,719
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	75,549	8,006	(4,841)	78,715
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	112,099	51,556	39,838	547,719
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	75,549	83,555	78,715	83,555

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Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 4: 1 IN 100 WET APRIL/MAY/JUNE PRECIPITATION - CASE B

General Assumptions :

Daily Ore Production =	8,816 tonnes		Leach Cycle Time =	120 days
Lift Height =	8 m		Maximum Solution Flow to Plant =	234 m³/hr
Bulk Density of Heap Ore =	1.7 t/m³		Maximum Solution Flow on Pad =	1,137 m³/hr
Initial Ore Moisture =	4%		Maximum Solution Flow off Pad =	1,117 m³/hr
Residual Ore Moisture =	16%		Porosity of Heap =	40%
Leachate Application Rate =	0.0244 m³/hr/m²		Annual Precipitation =	618 mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	198	161	91	618
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	3,095,972	3,256,734	3,417,496	3,573,073	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,811,624	3,972,386	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	61,380	49,910	28,210	191,580
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	3,069	2,496	1,411	9,579
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	83,455	71,411	48,626	429,229
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	0	118,490
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	83,455	71,411	48,626	547,719
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	46,905	27,862	3,948	78,715
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	83,455	71,411	48,626	547,719
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	46,905	74,767	78,715	78,715

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Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 9 : 1 IN 100 WET YEAR PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes
Lift Height =	8 m
Bulk Density of Heap Ore =	1.7 t/m³
Initial Ore Moisture =	4%
Leaching Ore Moisture =	25%
Residual Ore Moisture =	16%
Leachate Application Rate =	0.0244 m³/hr/m²
Leach Cycle Time =	120 days
Maximum Solution Flow to Plant =	234 m³/hr
Maximum Solution Flow on Pad =	1,137 m³/hr
Maximum Solution Flow off Pad =	1,117 m³/hr
Maximum Area Under Leach =	46,598 m²
Porosity of Heap =	40%
Annual Precipitation =	550 mm

Catchment Areas :

		Runoff Coeff. :
Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	110	77	53	6	0	0	0	0	0	146	89	69	550
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	0	0	0	0	0	0	0	0	0	811,072
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	0	0	0	0	0	0	0	0	0	477,101
F	>>> Total Storage on Pad (m³)	8,255,925	8,416,687	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	34,100	23,870	16,430	1,860	0	0	0	0	0	45,260	27,590	21,390	170,500
2	As Initial Ore Moisture	4,635	4,635	4,635	4,635	4,635	4,635	4,635	0	0	0	0	0	32,443
3	As Draindown	13,158	13,158	13,158	13,158	10,428	10,428	10,428	10,428	10,428	10,428	10,428	0	125,628
4	Event Pond : As Precipitation	1,705	1,194	822	93	0	0	0	0	0	2,263	1,380	1,070	8,525
5	Sub-Total	53,598	42,856	35,044	19,746	15,063	15,063	15,063	10,428	10,428	57,951	39,398	22,460	337,096
6	Make-up Water from Freshwater Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
7	>>> Total Water In (m³)	53,598	42,856	35,044	19,746	15,063	15,063	15,063	10,428	10,428	57,951	39,398	22,460	337,096
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	21,667	21,667	21,667	21,667	21,667	21,667	21,667	17,033	17,033	17,033	0	0	202,768
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	29,119	27,011	24,151	21,667	21,667	21,667	21,667	17,033	17,033	17,033	7,000	8,129	233,176
13	Change in Water Storage: Positive/(Negative)	24,479	15,845	10,893	(1,922)	(6,604)	(6,604)	(6,604)	(6,604)	(6,604)	40,919	32,398	14,331	103,920
14	>>> Total Water Out (m³)	53,598	42,856	35,044	19,746	15,063	15,063	15,063	10,428	10,428	57,951	39,398	22,460	337,096
15	Solution Storage Requirement	24,479	40,324	51,217	49,295	42,691	36,086	29,482	22,877	16,273	57,191	89,589	103,920	103,920

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Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 9 : 1 IN 100 WET APRIL PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816	tonnes
Lift Height =	8	m
Bulk Density of Heap Ore =	1.7	t/m³
Initial Ore Moisture =	4%	
Leaching Ore Moisture =	25%	
Residual Ore Moisture =	16%	
Leachate Application Rate =	0.0244	m³/hr/m²

Leach Cycle Time =	120	days
Maximum Solution Flow to Plant =	234	m³/hr
Maximum Solution Flow on Pad =	1,137	m³/hr
Maximum Solution Flow off Pad =	1,117	m³/hr
Maximum Area Under Leach =	46,598	m²
Porosity of Heap =	40%	
Annual Precipitation =	562	mm

Catchment Areas : / Runoff Coeff. :

Leach Pad Area Prepared =	310,000	m²	100%
Events Pond Area =	15,500	m²	
Heap Evap. Coeff. for Area Under Leach =	100%		
Heap Evap. Coeff. for Heap and Overliner =	5%		

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18-Apr-97

	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	286	61	47	562
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	0	0	0	0	0	0	0	0	0	811,072
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	0	0	0	0	0	0	0	0	0	477,101
F	>>> Total Storage on Pad (m³)	8,255,925	8,416,687	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	88,660	18,910	14,570	174,220
2	As Initial Ore Moisture	4,635	4,635	4,635	4,635	4,635	4,635	4,635	0	0	0	0	0	32,443
3	As Draindown	13,158	13,158	13,158	13,158	10,428	10,428	10,428	10,428	10,428	10,428	10,428	0	125,628
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	4,433	946	729	8,711
5	Sub-Total	42,205	35,044	29,511	19,095	15,063	15,063	15,063	10,428	10,428	103,521	30,284	15,299	341,002
6	Make-up Water from Freshwater Supply	0	0	0	0	0	0	0	2,512	6,604	0	0	0	9,116
7	>>> Total Water In (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	103,521	30,284	15,299	350,118
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	21,667	21,667	21,667	21,667	21,667	21,667	21,667	17,033	17,033	17,033	0	0	202,768
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	29,119	27,011	24,151	21,667	21,667	21,667	21,667	17,033	17,033	17,033	7,000	8,129	233,176
13	Change in Water Storage: Positive/(Negative)	13,086	8,033	5,360	(2,573)	(6,604)	(6,604)	(6,604)	(4,093)	0	86,489	23,284	7,170	116,942
14	>>> Total Water Out (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	103,521	30,284	15,299	350,118
15	Solution Storage Requirement	13,086	21,119	26,479	23,906	17,302	10,697	4,093	0	0	86,489	109,772	116,942	116,942

...BLE 2.11

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 9 : 1 IN 100 WET APRIL/MAY PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816	tonnes
Lift Height =	8	m
Bulk Density of Heap Ore =	1.7	t/m³
Initial Ore Moisture =	4%	
Leaching Ore Moisture =	25%	
Residual Ore Moisture =	16%	
Leachate Application Rate =	0.0244	m³/hr/m²

Leach Cycle Time =	120	days
Maximum Solution Flow to Plant =	234	m³/hr
Maximum Solution Flow on Pad =	1,137	m³/hr
Maximum Solution Flow off Pad =	1,117	m³/hr
Maximum Area Under Leach =	46,598	m²
Porosity of Heap =	40%	
Annual Precipitation =	601	mm

Catchment Areas : / Runoff Coeff. :

Leach Pad Area Prepared =	310,000	m²	100%
Events Pond Area =	15,500	m²	
Heap Evap. Coeff. for Area Under Leach =	100%		
Heap Evap. Coeff. for Heap and Overliner =	5%		

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	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	286	100	47	601
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	0	0	0	0	0	0	0	0	0	811,072
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	0	0	0	0	0	0	0	0	0	477,101
F	>>> Total Storage on Pad (m³)	8,255,925	8,416,687	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	88,660	31,000	14,570	186,310
2	As Initial Ore Moisture	4,635	4,635	4,635	4,635	4,635	4,635	4,635	0	0	0	0	0	32,443
3	As Draindown	13,158	13,158	13,158	13,158	10,428	10,428	10,428	10,428	10,428	10,428	10,428	0	125,628
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	4,433	1,550	729	9,316
5	Sub-Total	42,205	35,044	29,511	19,095	15,063	15,063	15,063	10,428	10,428	103,521	42,978	15,299	353,696
6	Make-up Water from Freshwater Supply	0	0	0	0	0	0	0	2,512	6,604	0	0	0	9,116
7	>>> Total Water In (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	103,521	42,978	15,299	362,813
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	21,667	21,667	21,667	21,667	21,667	21,667	21,667	17,033	17,033	17,033	0	0	202,768
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	29,119	27,011	24,151	21,667	21,667	21,667	21,667	17,033	17,033	17,033	7,000	8,129	233,176
13	Change in Water Storage: Positive/(Negative)	13,086	8,033	5,360	(2,573)	(6,604)	(6,604)	(6,604)	(4,093)	0	86,489	35,978	7,170	129,636
14	>>> Total Water Out (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	103,521	42,978	15,299	362,813
15	Solution Storage Requirement	13,086	21,119	26,479	23,906	17,302	10,697	4,093	0	0	86,489	122,467	129,636	129,636

TABLE 2.12

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 9 : 1 IN 100 WET APRIL/MAY/JUNE PRECIPITATION - CASE A

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m²
Residual Ore Moisture =	16%	Porosity of Heap =	40%
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	618 mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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18-Apr-97

	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	286	100	64	618
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	0	0	0	0	0	0	0	0	0	811,072
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	0	0	0	0	0	0	0	0	0	477,101
F	>>> Total Storage on Pad (m³)	8,255,925	8,416,687	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	88,660	31,000	19,840	191,580
2	As Initial Ore Moisture	4,635	4,635	4,635	4,635	4,635	4,635	4,635	0	0	0	0	0	32,443
3	As Draindown	13,158	13,158	13,158	13,158	10,428	10,428	10,428	10,428	10,428	10,428	10,428	0	125,628
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	4,433	1,550	992	9,579
5	Sub-Total	42,205	35,044	29,511	19,095	15,063	15,063	15,063	10,428	10,428	103,521	42,978	20,832	359,230
6	Make-up Water from Freshwater Supply	0	0	0	0	0	0	0	2,512	6,604	0	0	0	9,116
7	>>> Total Water In (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	103,521	42,978	20,832	368,346
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	21,667	21,667	21,667	21,667	21,667	21,667	21,667	17,033	17,033	17,033	0	0	202,768
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	29,119	27,011	24,151	21,667	21,667	21,667	21,667	17,033	17,033	17,033	7,000	8,129	233,176
13	Change in Water Storage: Positive/(Negative)	13,086	8,033	5,360	(2,573)	(6,604)	(6,604)	(6,604)	(4,093)	0	86,489	35,978	12,703	135,170
14	>>> Total Water Out (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	103,521	42,978	20,832	368,346
15	Solution Storage Requirement	13,086	21,119	26,479	23,906	17,302	10,697	4,093	0	0	86,489	122,467	135,170	135,170

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.13

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 9 : 1 IN 100 WET APRIL/MAY/JUNE PRECIPITATION - CASE B

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr
Leaching Ore Moisture =	25%	Maximum Area Under Leach =	46,598 m²
Residual Ore Moisture =	16%	Porosity of Heap =	40%
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	618 mm

Catchment Areas : / **Runoff Coeff. :**

Leach Pad Area Prepared =	310,000 m²	100%
Events Pond Area =	15,500 m²	
Heap Evap. Coeff. for Area Under Leach =	100%	
Heap Evap. Coeff. for Heap and Overliner =	5%	

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18-Apr-97

	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	198	161	91	618
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	0	0	0	0	0	0	0	0	0	811,072
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	0	0	0	0	0	0	0	0	0	477,101
F	>>> Total Storage on Pad (m³)	8,255,925	8,416,687	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	8,577,449	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	61,380	49,910	28,210	191,580
2	As Initial Ore Moisture	4,635	4,635	4,635	4,635	4,635	4,635	4,635	0	0	0	0	0	32,443
3	As Draindown	13,158	13,158	13,158	13,158	10,428	10,428	10,428	10,428	10,428	10,428	10,428	0	125,628
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	3,069	2,496	1,411	9,579
5	Sub-Total	42,205	35,044	29,511	19,095	15,063	15,063	15,063	10,428	10,428	74,877	62,834	29,621	359,230
6	Make-up Water from Freshwater Supply	0	0	0	0	0	0	0	2,512	6,604	0	0	0	9,116
7	>>> Total Water In (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	74,877	62,834	29,621	368,346
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	21,667	21,667	21,667	21,667	21,667	21,667	21,667	17,033	17,033	17,033	0	0	202,768
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	29,119	27,011	24,151	21,667	21,667	21,667	21,667	17,033	17,033	17,033	7,000	8,129	233,176
13	Change in Water Storage: Positive/(Negative)	13,086	8,033	5,360	(2,573)	(6,604)	(6,604)	(6,604)	(4,093)	0	57,845	55,834	21,492	135,170
14	>>> Total Water Out (m³)	42,205	35,044	29,511	19,095	15,063	15,063	15,063	12,940	17,033	74,877	62,834	29,621	368,346
15	Solution Storage Requirement	13,086	21,119	26,479	23,906	17,302	10,697	4,093	0	0	57,845	113,678	135,170	135,170

Knight Piésold Ltd.
CONSULTING ENGINEERS

WESTERN COPPER HOLDINGS LIMITED.
CARMACKS COPPER PROJECT

HEAP LEACH PAD AND EVENTS POND
CALCULATION OF LEAKAGE THROUGH LINERS

18-Apr-97

J:\JOB\DATA\1785\LINESEEP.XLS C_B= 0.6 N_h = 0.000247097 holes per m^2

	Hole Area a (m^2)	Head h (m)	Permeability of overliner k_d (m/s)	Permeability of underliner k_s (m/s)	Liner Area per Cell A m^2	Q $C_B a(2gh_{ave})^{0.5} N_h A$ (per Cell) (m^3/s)	Q $3a^{0.75}h^{0.75}k_d^{0.5} N_h A$ (per Cell) (m^3/s)	Q $0.21a^{0.1}h^{0.9}k_s^{0.74} N_h A$ (per Cell) (m^3/s)
LEACH PAD Annual Average - Inner Liner	1.00E-05	1	1.00E-04	1.00E-07	10000	6.6E-05	1.3E-05	1.1E-06
LEACH PAD Annual Average - Outer Liner	1.00E-05	0.5	1.00E-04	1.00E-08	10000	4.6E-05	7.8E-06	1.1E-07

Seepage through inner liner	94	litres/day	24.7	USgpd
Seepage through outer liner	9	litres/day	2.4	USgpd
Expected leak detection flow	94	litres/day	24.7	USgpd

	Hole Area a (m^2)	Average Head h (m)	Permeability of overliner k_d (m/s)	Permeability of underliner k_s (m/s)	Liner Area A m^2	Q $C_B a(2gh_{ave})^{0.5}$ (m^3/s)	Q $3a^{0.75}h^{0.75}k_d^{0.5}$ (m^3/s)	Q $0.21a^{0.1}h^{0.9}k_s^{0.74}$ (m^3/s)
EVENTS POND Annual Average - Inner Liner	1.00E-05	3	N/A	1.00E-07	6000	6.8E-05	N/A	1.7E-06
Quarterly Average - Inner Liner	1.00E-05	8	N/A	1.00E-07	26000	4.8E-04	N/A	1.8E-05
Annual Average - Outer Liner	1.00E-05	0.5	5.00E-03	1.00E-08	6000	2.8E-05	3.3E-05	6.3E-08

Seepage through inner liner (annual)	151	litres/day	39.9	USgpd
Seepage through inner liner (quarterly)	1583	litres/day	418.1	USgpd
Seepage through outer liner	5	litres/day	1.4	USgpd
Expected leak detection flow 151 to	1583	litres/day		

TABLE 2.15
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

HEAP LEACH PAD
MATERIAL PARAMETERS USED FOR STABILITY ANALYSIS

J:\JOB\REPORT\1785\TAB3-15.XLS 18-Apr-97

Material Description	Unit Weight γ (kN/m^3)	Literature Survey Friction Angle ϕ' (Deg.)	Site Specific Testing Friction Angle ϕ' (Deg.)	Modelling Friction Angle ϕ' (Deg.)
Crushed Ore (Unsaturated)	16.7	30 to 45[Note 1]	Not tested	37
Crushed Ore (Saturated)	19.6	30 to 45[Note 1]	Not tested	37
Crushed Ore (Overliner)	16.7	30 to 45[Note 1]	Not tested	37
Smooth HDPE - Overliner Interface	16.7	26 to 29[Note 1]	Not tested	26
Smooth HDPE - GEONET Interface	16.7	6 to 25[Note 2]	13	13
Smooth HDPE - Soil Liner Interface	16.7	18 to 26[Note 3]	27	18
Foundation Overburden	22.3	Site Specific	36 to 41	36
Zoned Earthfill	22.4	Site Specific	36 to 44	40

Notes:

1. Reference: Harper, T.G., Leach, J.A., Tape, R.T. 1987, "Slope Stability in Heap Leach Design", in Geotechnical Aspects of Heap Leach Design, Ed. Dirk VanZyl Society Of Mining Engineers.
2. Reference: Lydick, L.D., and Zagorski, G.A., 1991, "Interface Friction of Geonets: A Literature Survey", Geotextiles and Geomembranes, Vol 10, pp 549-558.
3. Reference: Carroll, R.G., Chouery-Curtis, V., 1991, "Geogrid Reinforcement in Landfill Closures", Geotextiles and Geomembranes, Vol 10, pp 471-486.

TABLE 2.16
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

HYDROGEOLOGICAL IMPACT OF A SIMULATED UNCONTROLLED LEAK ON GROUNDWATER AND SURFACE WATER QUALITY

J:\JOB\DATA\1785\DILUTN.XLS 18-Apr-97

Leak Source***	Leakage Rate (m^3/day)	Pre-Development Groundwater Flux (m^3/day)	Post-Development Groundwater Flux (m^3/day)	Time to Reach Groundwater Table (Years)	Time to Reach Williams Creek (Years)	Mean Annual Flow in Williams Creek (0.0558 m^3/s) (m^3/day)	Available Dilution in Groundwater	Available Dilution in Williams Creek
At the deepest point in the leach pad area	0.4	87.5	40.7	0.42 years	36 years	4,821	111 fold	12,053 fold
In the leach pad area at the 780 m contour elevation	0.3	87.5	40.7	0.67 years	114 years	4,821	135 fold	16,070 fold
At the top limit of the leach pad	0.3	87.5	40.7	8.5 years	350 years	4,821	131 fold	16,070 fold
At the deepest point in the Events Pond	0.001	87.5	40.7	0.5 years	25 years	4,821	40,000 fold	4,821,000 fold

Note leakage rates given are leakage rates that are not intercepted and discharge to the deep groundwater system and thence to Williams Creek.
Note that the volume of leak from below the events pond would enter the shallow subsurface groundwater system and would be picked up by the foundation drainage system.

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CARMACKS COPPER PROJECT

OVERALL MONTHLY PROJECT WATER BALANCE
YEAR 4: 1 IN 100 WET APRIL/MAY PRECIPITATION

General Assumptions :

Daily Ore Production =	8,816 tonnes	Leach Cycle Time =	120 days	Leach Pad Area Prepared =	310,000 m²		100%
Lift Height =	8 m	Maximum Solution Flow to Plant =	234 m³/hr	Events Pond Area =	15,500 m²		
Bulk Density of Heap Ore =	1.7 t/m³	Maximum Solution Flow on Pad =	1,137 m³/hr	Heap Evap. Coeff. for Area Under Leach =	100%		
Initial Ore Moisture =	4%	Maximum Solution Flow off Pad =	1,117 m³/hr	Heap Evap. Coeff. for Heap and Overliner =	5%		
Residual Ore Moisture =	16%	Porosity of Heap =	40%				
Leachate Application Rate =	0.0244 m³/hr/m²	Annual Precipitation =	601 mm				

(Catchment Areas : / Runoff Coeff. :)

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18-Apr-97

	DESCRIPTION	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	ANNUAL
A	Combined Rainfall and Snowmelt Distribution (mm/month)	75	53	36	4	0	0	0	0	0	286	100	47	601
C	Mean Monthly Lake Evaporation (mm/month)	99	71	33	0	0	0	0	0	0	0	93	108	404
	<STORAGE ON PAD AT BEGINNING OF MONTH> (m³)													
D	Stacked Leach Ore Tonnage Previous Month (tonnes)	264,480	273,296	273,296	264,480	273,296	0	0	0	0	0	132,240	273,296	1,754,384
E	Stacked Leach Ore Volume Previous Month (m³)	155,576	160,762	160,762	155,576	160,762	0	0	0	0	0	77,788	160,762	1,031,991
F	>>> Total Storage on Pad (m³)	3,095,972	3,256,734	3,417,496	3,573,073	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,733,835	3,811,624	3,972,386	
G	Area Available for Leach (m²)	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
H	Area Under Leach (m²)	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598	46,598
I	Heap and Overliner Area (m²)	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402	263,402
	<WATER INTO SYSTEM> (m³)													
1	Leach Pad : As Precipitation	23,250	16,430	11,160	1,240	0	0	0	0	0	88,660	31,000	14,570	186,310
2	As Initial Ore Moisture	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848	70,175
3	As Draindown	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	13,158	157,895
4	Event Pond : As Precipitation	1,163	822	558	62	0	0	0	0	0	4,433	1,550	729	9,316
5	Sub-Total	43,418	36,257	30,724	20,308	19,006	19,006	19,006	19,006	19,006	112,099	51,556	34,304	423,695
6	Make-up Water from Freshwater Supply	583	5,636	8,310	16,242	17,544	17,544	17,544	17,544	17,544	0	0	0	118,490
7	>>> Total Water In (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	112,099	51,556	34,304	542,185
	<WATER OUT OF SYSTEM> (m³)													
8	Leach Pad : Evaporation from Area Under Leach	4,613	3,308	1,538	0	0	0	0	0	0	0	4,334	5,033	18,826
9	Evaporation from Heap and Overliner	1,304	935	435	0	0	0	0	0	0	0	1,225	1,422	5,321
10	In Heap	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	36,550	438,596
11	Event Pond : Evaporation from Pond	1,535	1,101	512	0	0	0	0	0	0	0	1,442	1,674	6,262
12	Sub-Total	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	36,550	43,550	44,679	469,004
13	Change in Water Storage: Positive/(Negative)	0	0	0	0	0	0	0	0	0	75,549	8,006	(10,374)	73,181
14	>>> Total Water Out (m³)	44,001	41,894	39,034	36,550	36,550	36,550	36,550	36,550	36,550	112,099	51,556	34,304	542,185
15	Solution Storage Requirement	0	0	0	0	0	0	0	0	0	75,549	83,555	73,181	83,555

CAD FILE: \1785\FIG\~ Plot 1=1

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
SCHEMATIC SOLUTION MANAGEMENT FLOW SHEET

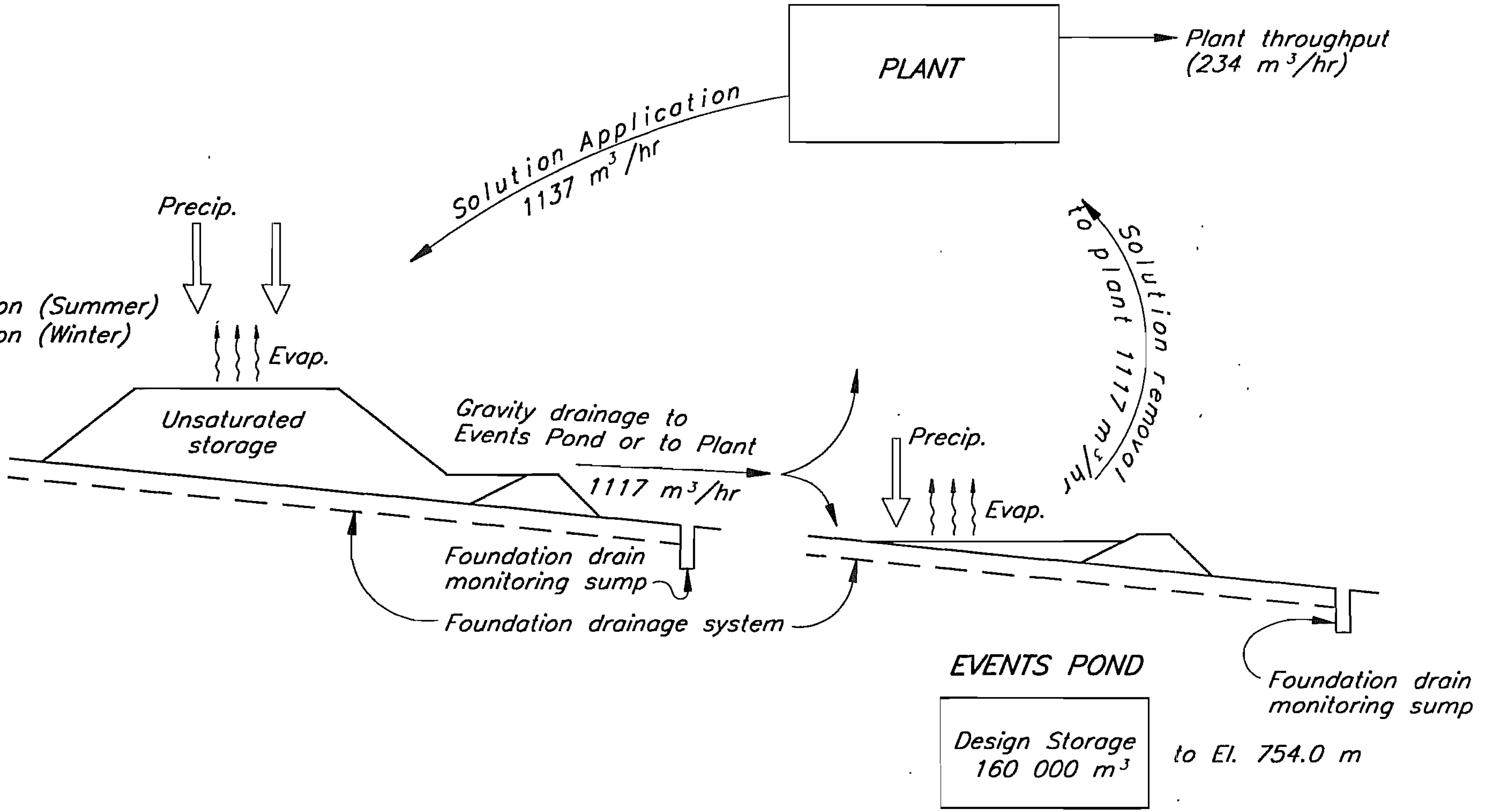

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FIGURE 2.1

1785.A8

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WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

EVENTS POND CAPACITY

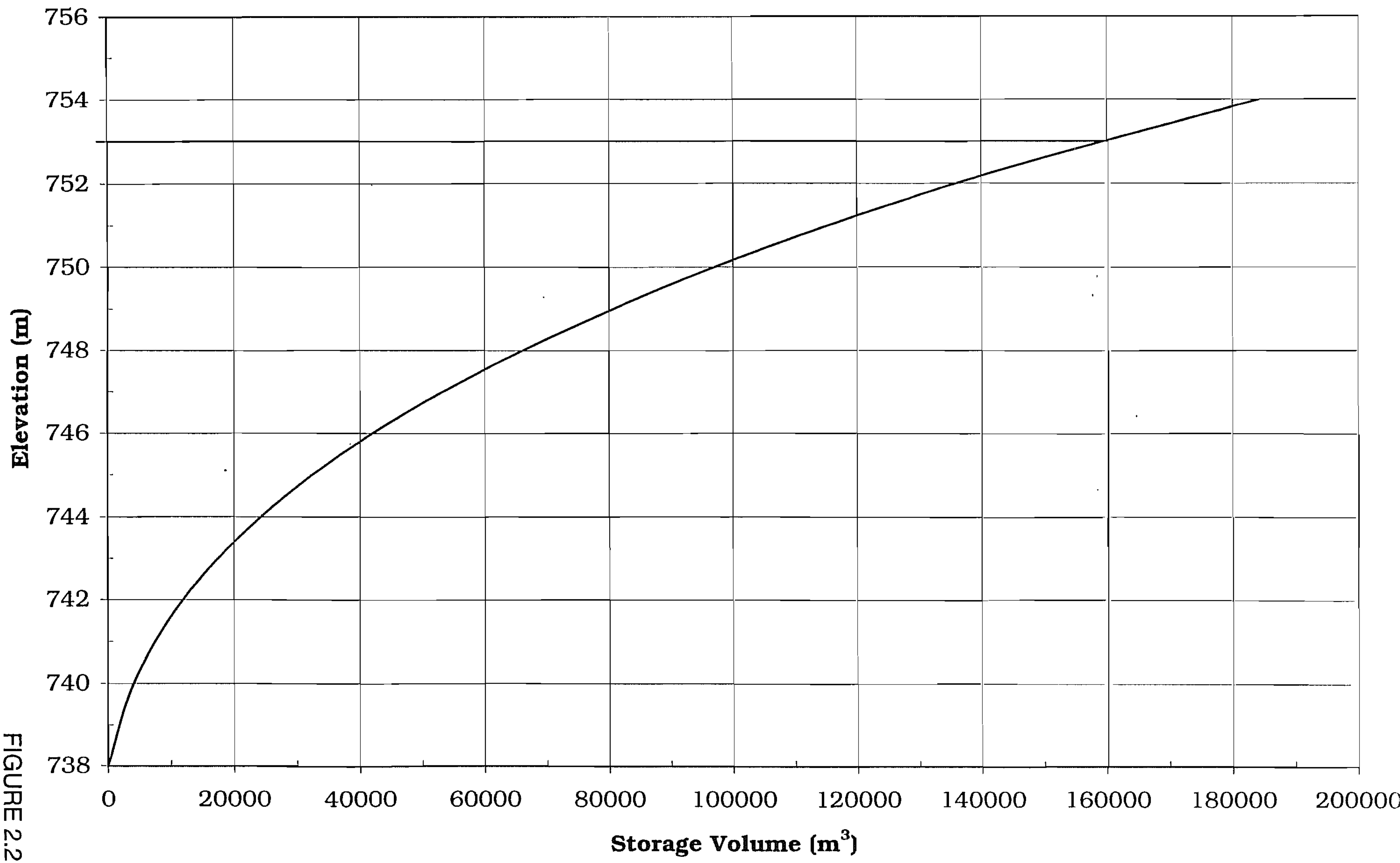


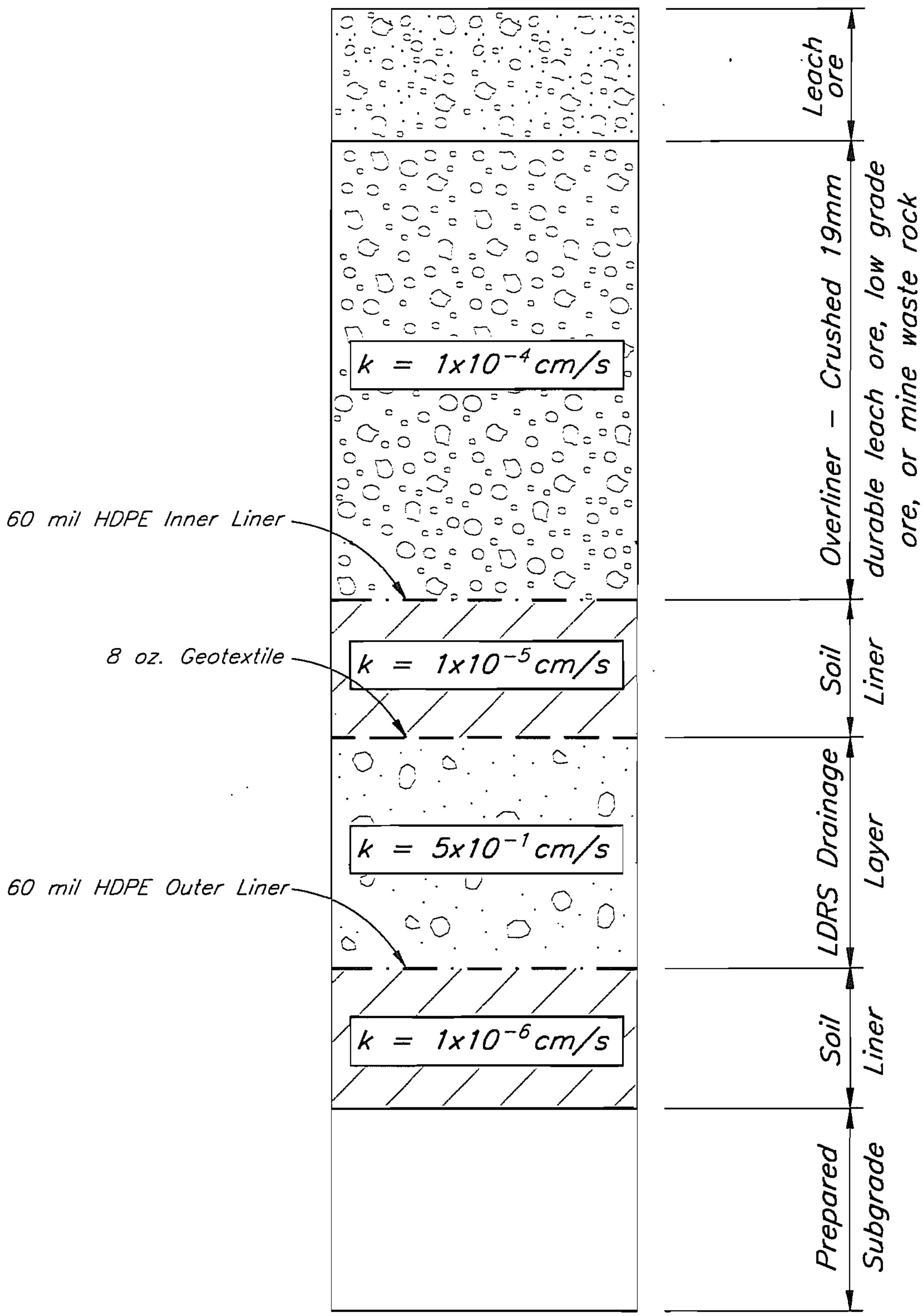
FIGURE 2.2

WESTERN COPPER HOLDINGS LIMITED

CARMACKS COPPER PROJECT

HEAP LEACH PAD

ENGINEERED COMPOSITE LINER SYSTEM



APR. 18, 1997

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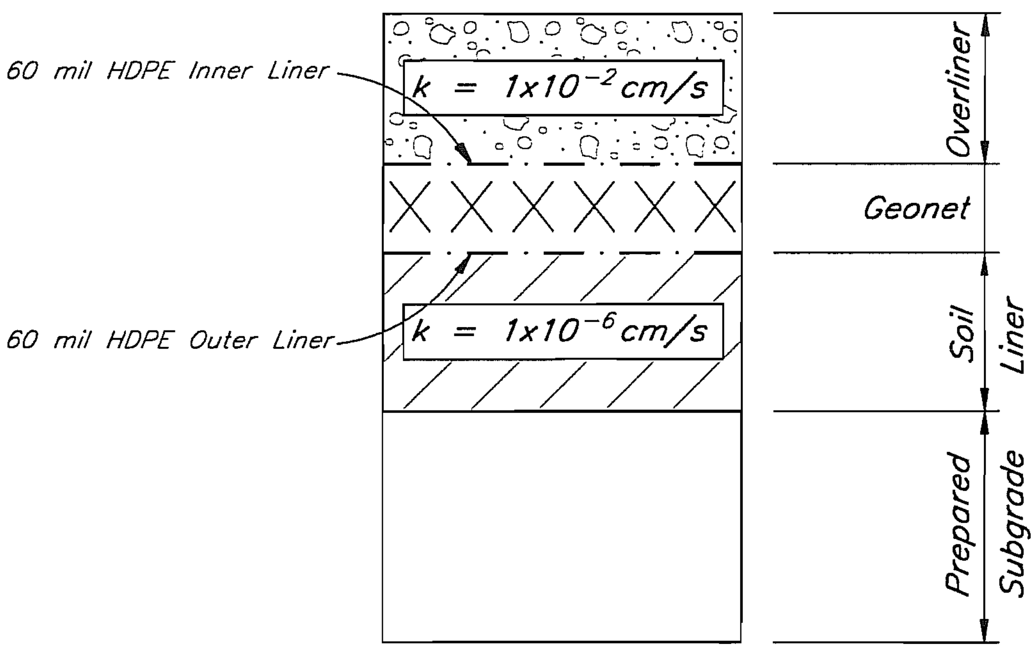
FIGURE 2.3

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
ENGINEERED LINER SYSTEM
UPSTREAM SLOPE OF HEAP LEACH PAD CONFINING EMBANKMENT



CAD FILE: \1785\FIG\A3 Plot scale 1=1

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FIGURE 2.4

WESTERN COPPER HOLDINGS LIMITED

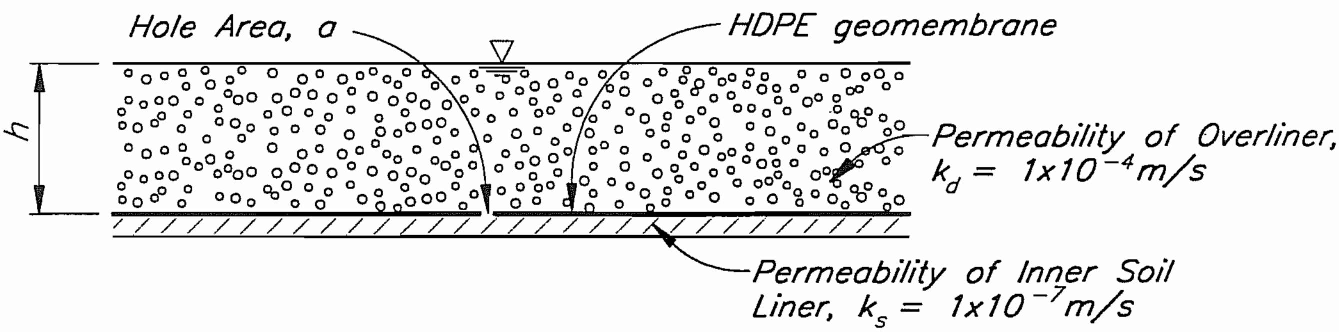
CARMACKS COPPER PROJECT

LEACH PAD LINER SYSTEM LEAKAGE RATES

INNER LINER:

Formula $Q = 0.21a^{0.1}\ h^{0.9}\ k_s^{0.74}$

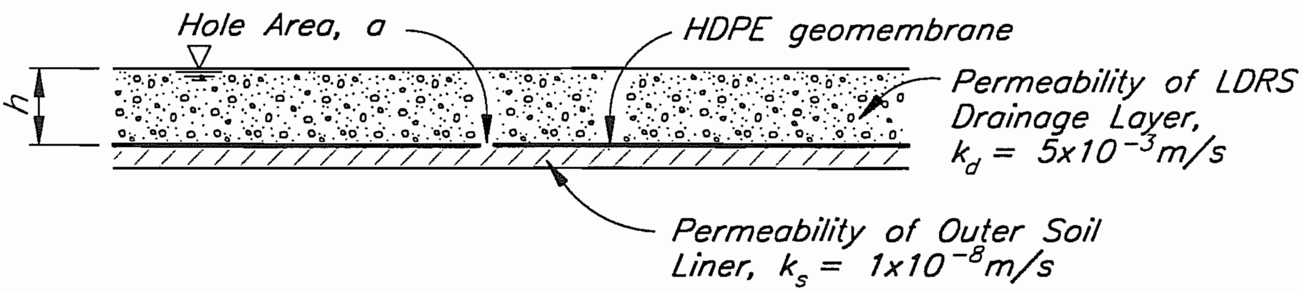
$Q = 3a^{0.75}\ h^{0.75}\ k_d^{0.5}$



OUTER LINER:

Formula $Q = 0.21a^{0.1}\ h^{0.9}\ k_s^{0.74}$

$Q = 3a^{0.75}\ h^{0.75}\ k_d^{0.5}$

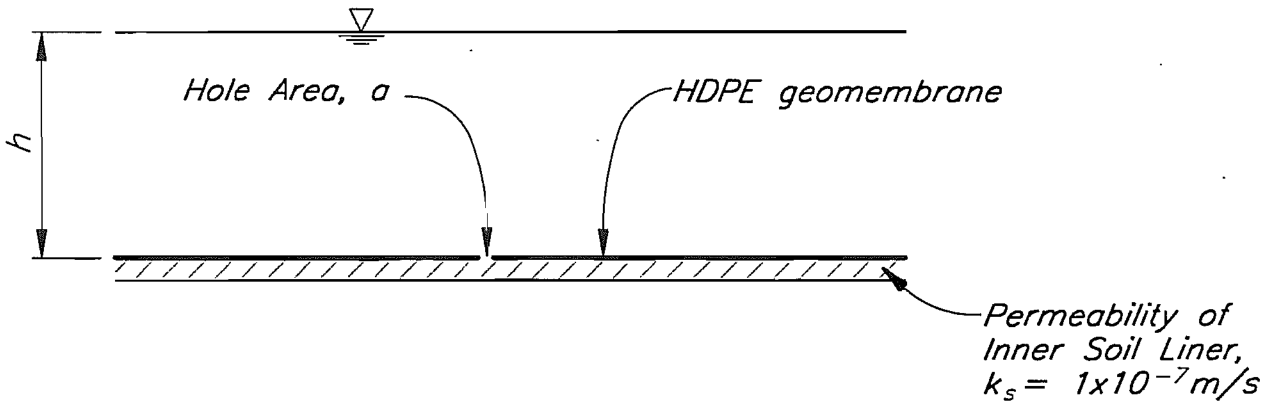


WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
EVENTS POND LINER SYSTEM LEAKAGE RATES

INNER LINER:

Formula $Q = 0.21a^{0.1} h^{0.9} k_s^{0.74}$

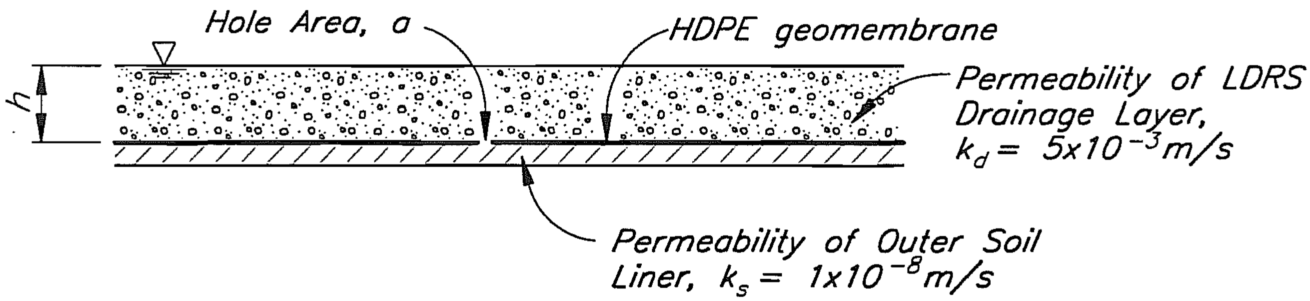
$Q = 3a^{0.75} h^{0.75} k_s^{0.5}$



OUTER LINER:

Formula $Q = 0.21a^{0.1} h^{0.9} k_s^{0.74}$

$Q = 3a^{0.75} h^{0.75} k_s^{0.5}$



CAD FILE: \1785\FIG\A4 Plot scale 1=1

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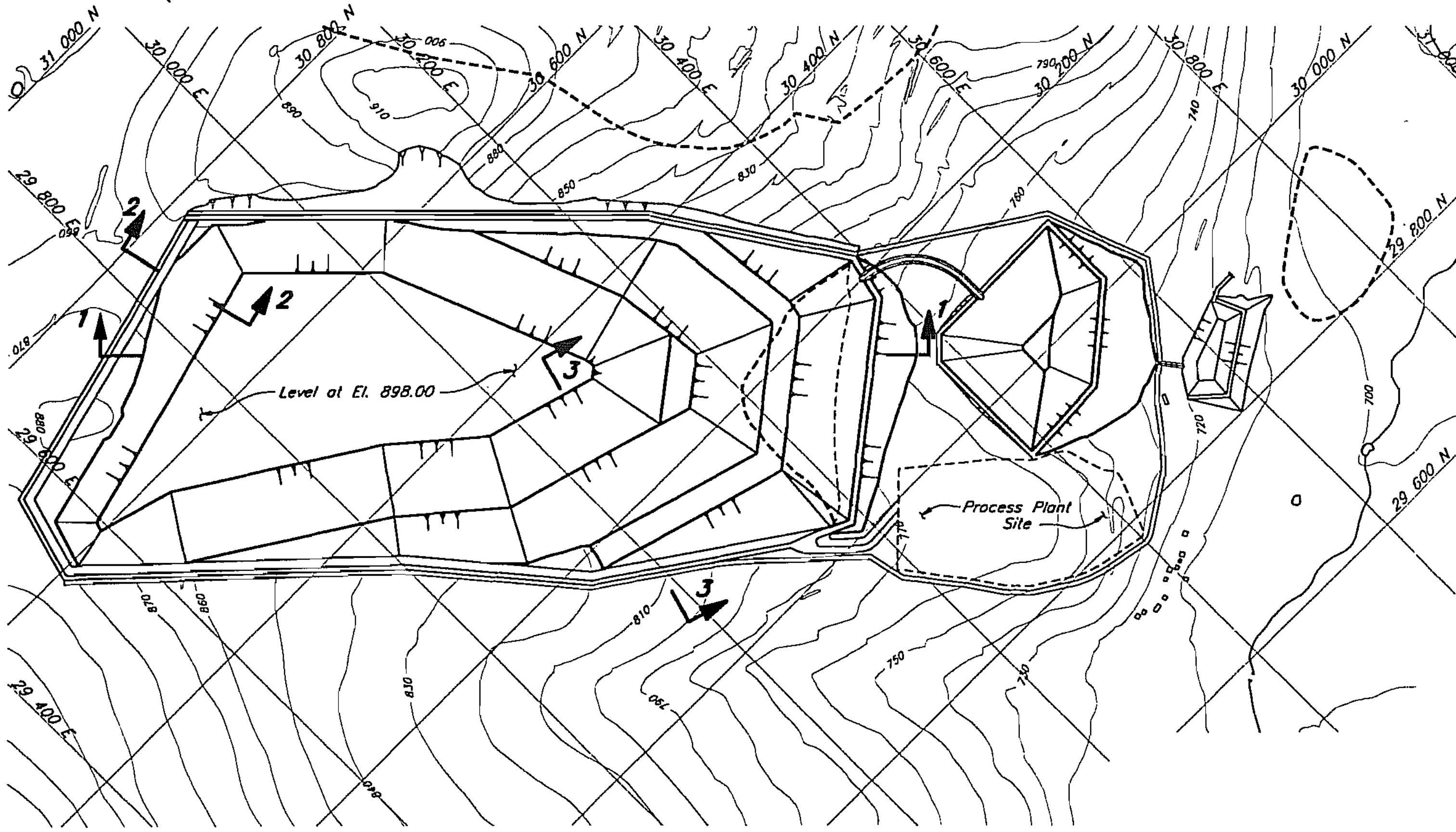
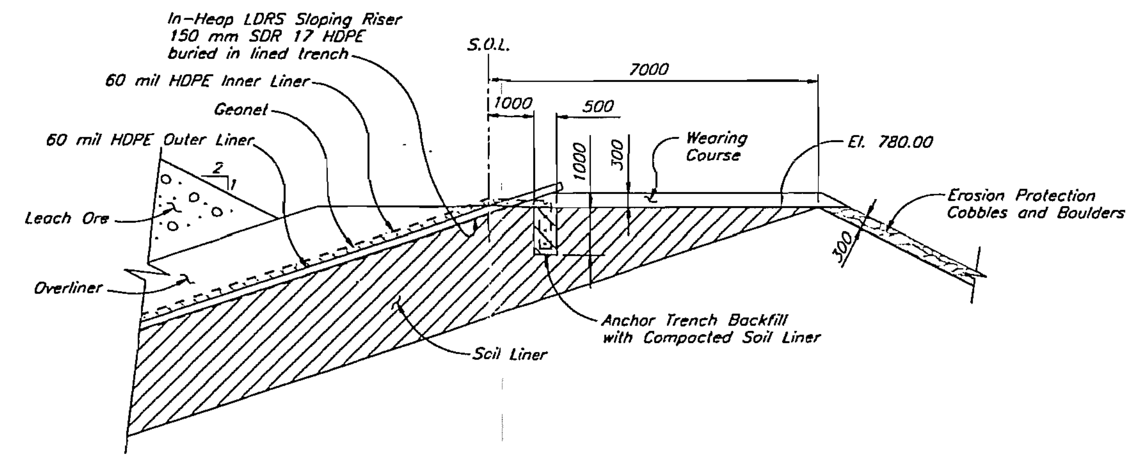
FIGURE 2.6

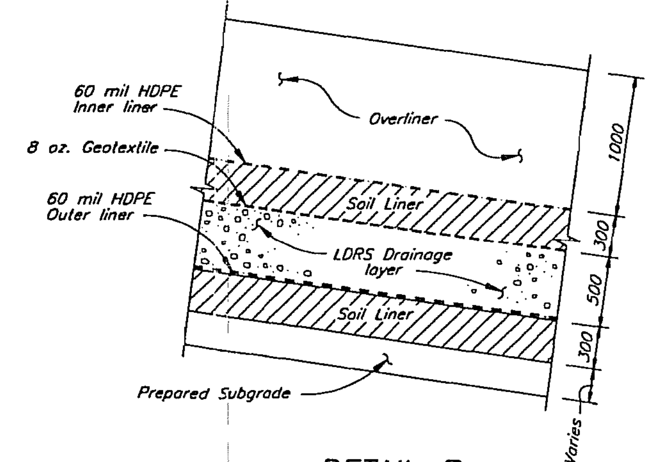
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
STABILITY ANALYSIS GEOMETRY- AND SLOPE CONFIGURATION MODELS



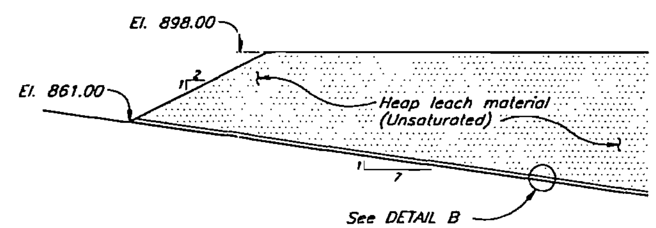
HEAP LEACH PAD LAYOUT
Scale A



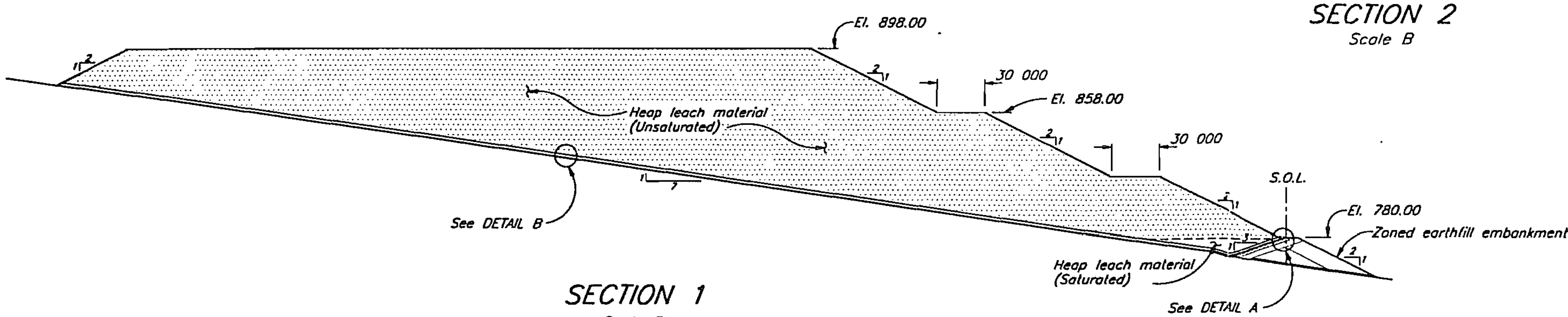
DOUBLE LINER SYSTEM
DETAIL A
NTS



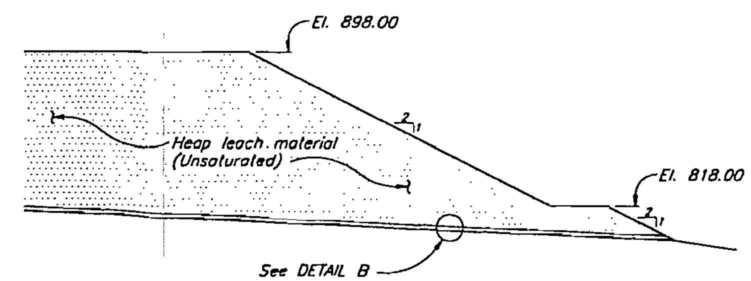
DETAIL B
NTS



SECTION 2
Scale B



SECTION 1
Scale B



SECTION 3
Scale B

NOTE

1. All elevations are in metres, and dimensions are in millimetres, unless otherwise noted.

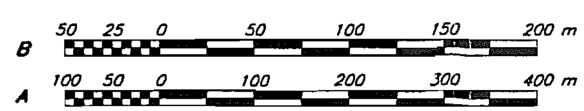


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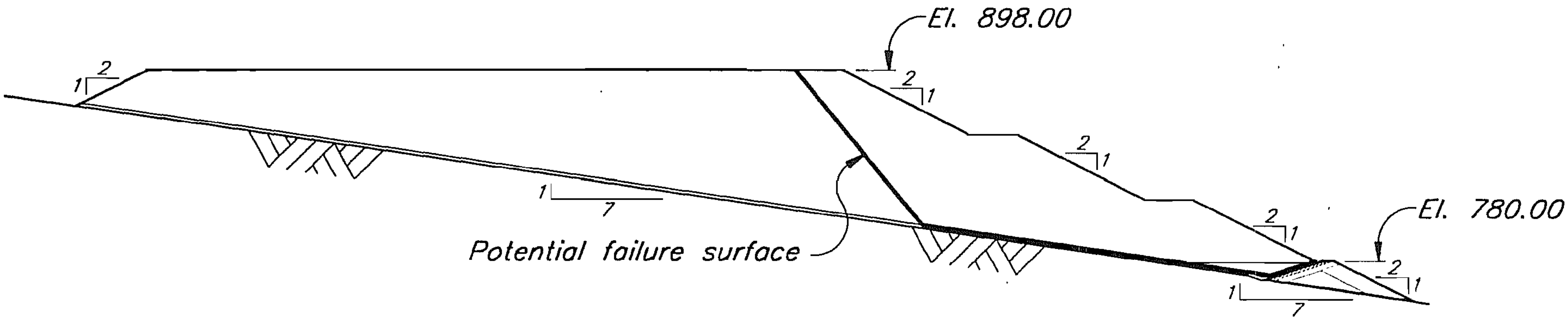
FIGURE 2.7

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
STABILITY ANALYSIS – RESULTS FOR SECTION 1



MINIMUM FACTORS OF SAFETY	
CASE	FACTOR OF SAFETY
Static conditions	1.4
Seismic conditions	1.0

Scale 80 40 0 80 160 m

Feb. 20, 1997

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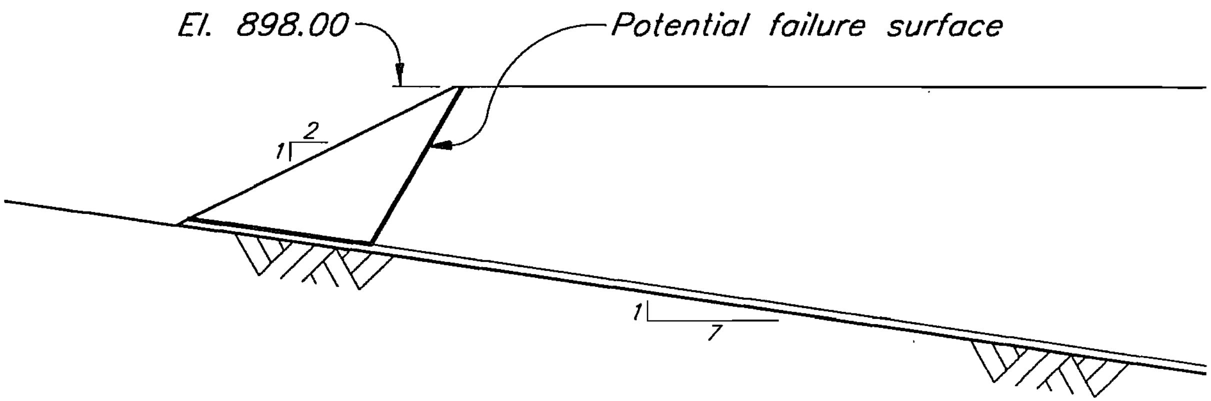
FIGURE 2.8

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
STABILITY ANALYSIS – RESULTS FOR SECTION 2



MINIMUM FACTORS OF SAFETY	
CASE	FACTOR OF SAFETY
Static conditions	1.7
Seismic conditions	1.4

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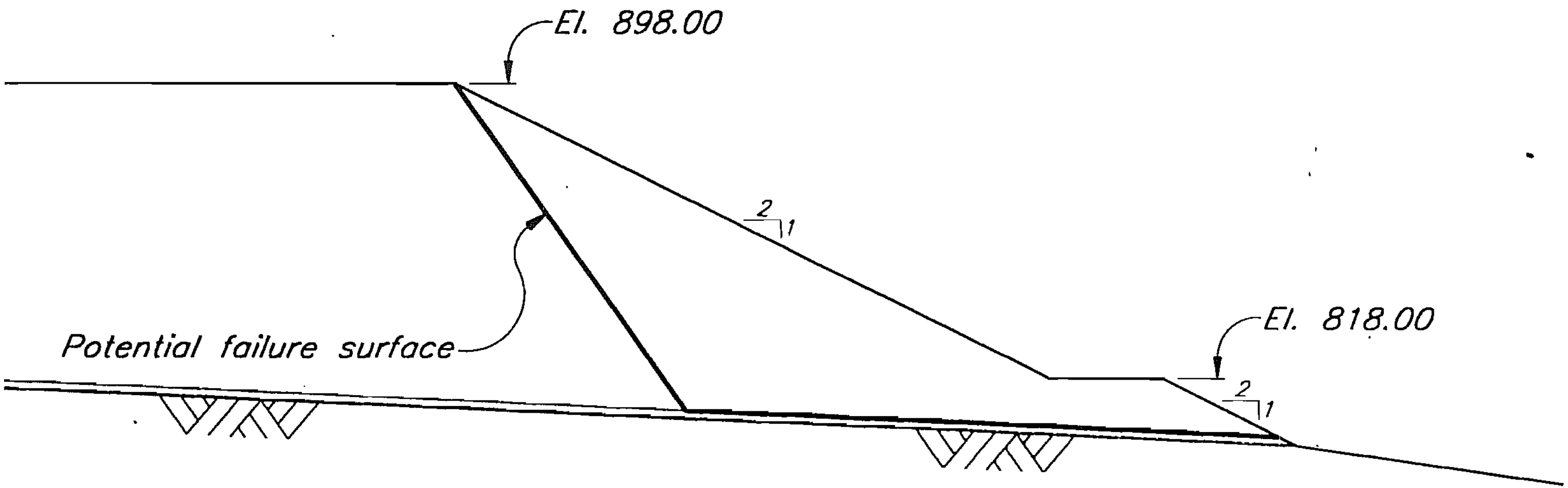
FIGURE 2.9

CAD FILE: \1785\FIG\A7 Plot 1=1

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
STABILITY ANALYSIS - RESULTS FOR SECTION 3



MINIMUM FACTORS OF SAFETY	
CASE	FACTOR OF SAFETY
Static conditions	1.4
Seismic condition	1.0

Scale 40 20 0 40 80 m

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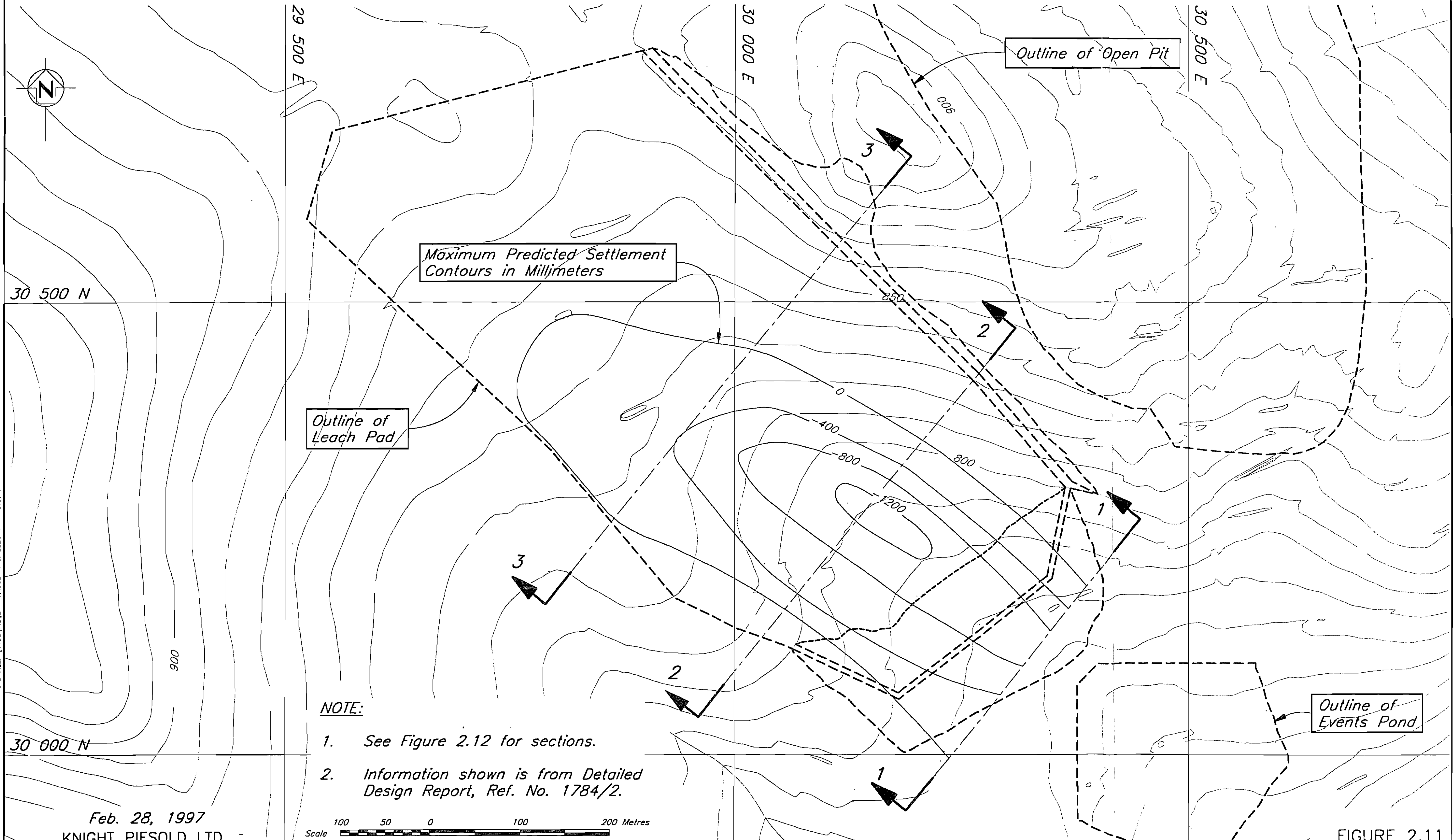
FIGURE 2.10

1785.A7

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
MAXIMUM PREDICTED SETTLEMENT CONTOURS WITHIN HEAP LEACH PAD FOUNDATION



NOTE:

1. See Figure 2.12 for sections.
2. Information shown is from Detailed Design Report, Ref. No. 1784/2.

Feb. 28, 1997

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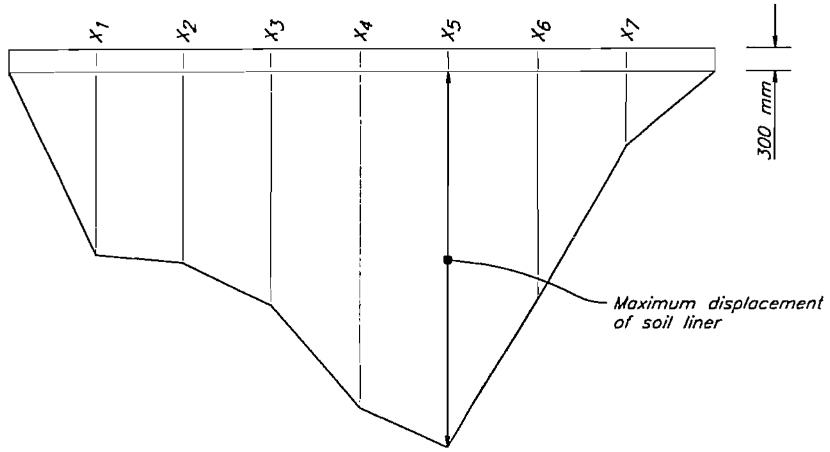
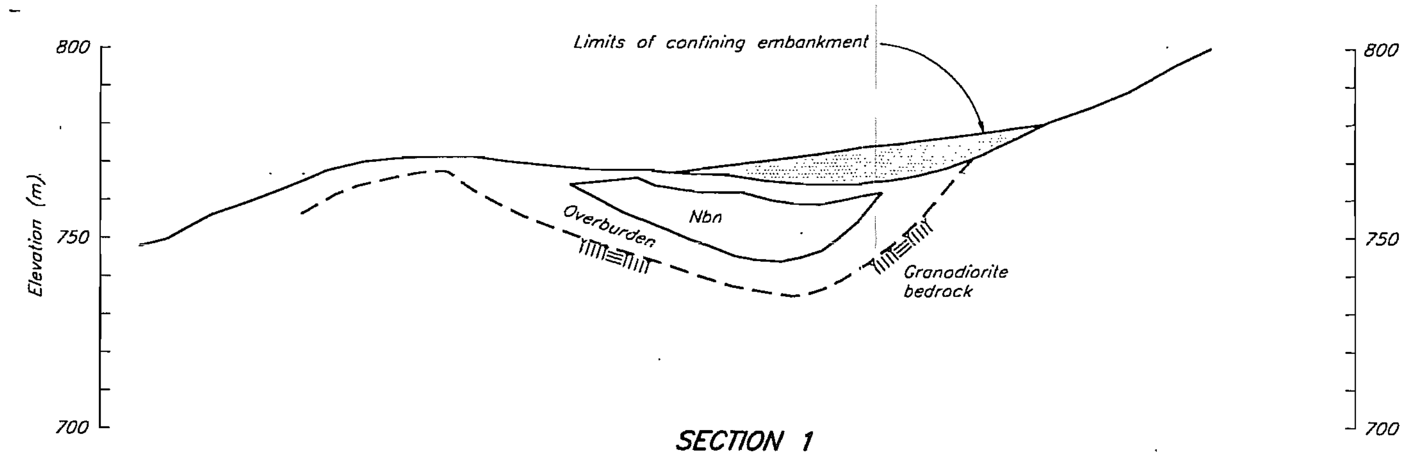
FIGURE 2.11

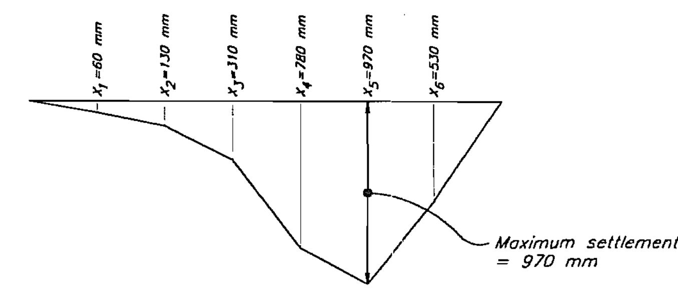
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
SETTLEMENT CONDITIONS FOR HEAP LEACH PAD



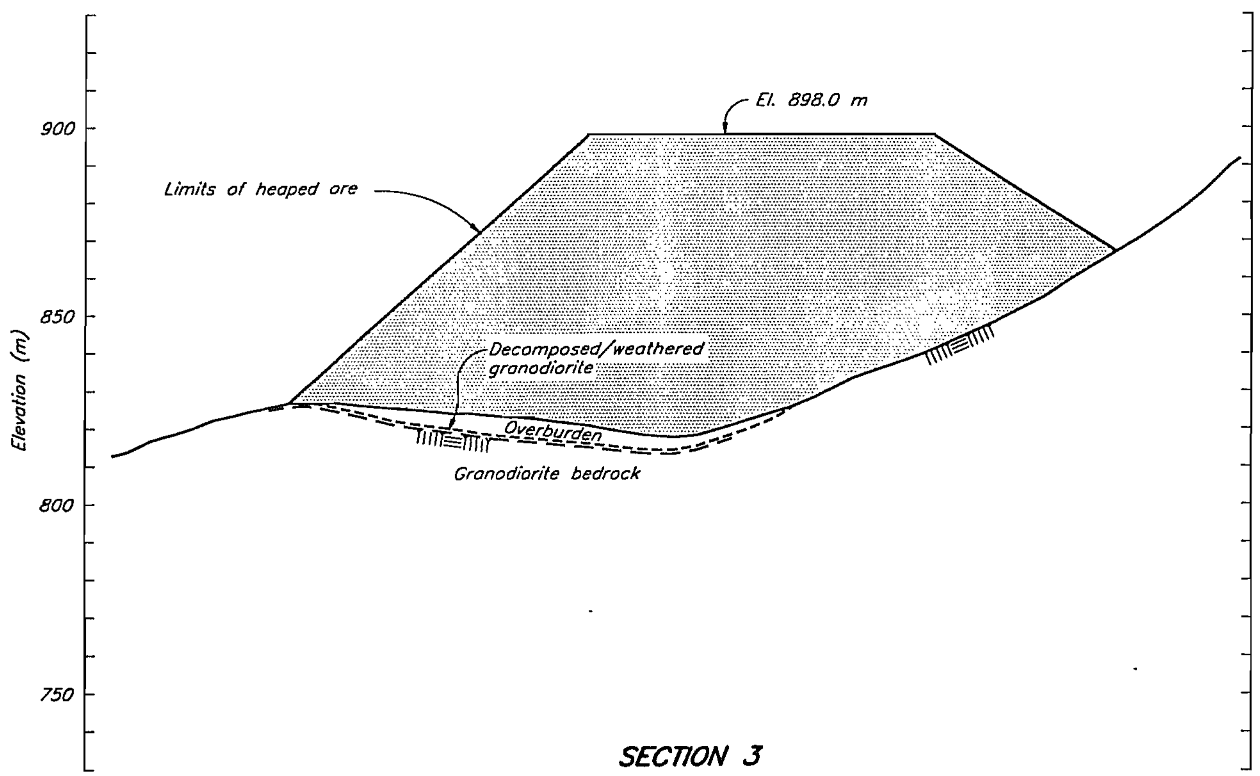
TYPICAL SETTLEMENT PROFILE
N.T.S.



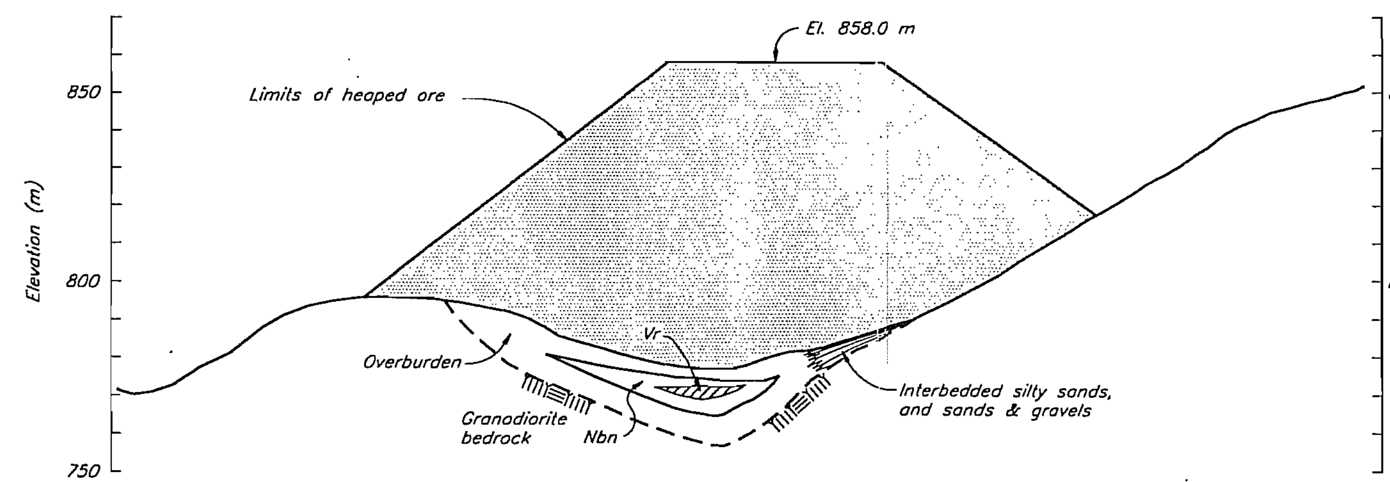
SECTION 1
Horiz. Scale A, Vert. Scale B



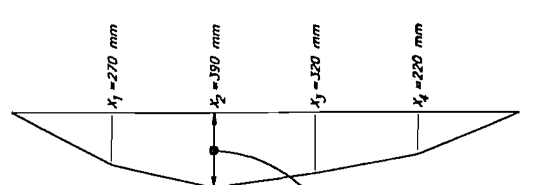
SETTLEMENT PROFILE
Horiz. Scale A, Vert. Scale C



SECTION 3
Horiz. Scale A, Vert. Scale B



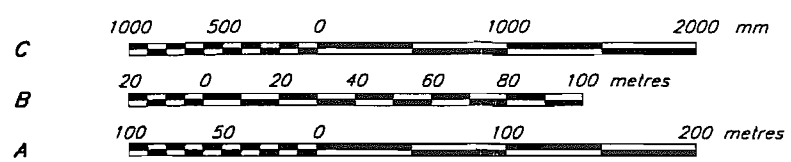
SECTION 2
Horiz. Scale A, Vert. Scale B

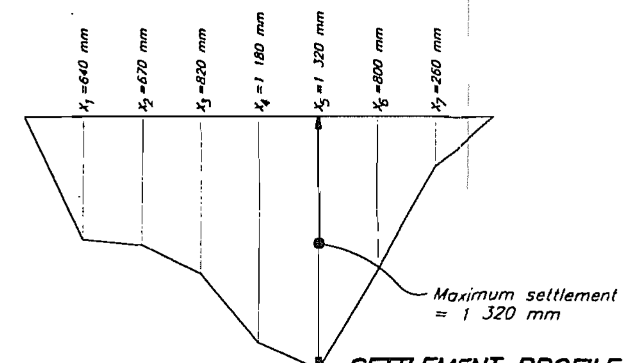


SETTLEMENT PROFILE
Horiz. Scale A, Vert. Scale C

LEGEND

Nbn	No excess ice, well bonded frozen soil
Vr	Random or irregular oriented ice formations in frozen soil





SETTLEMENT PROFILE
Horiz. Scale A, Vert. Scale C

NOTES

1. All elevations are in metres, and dimensions are in millimetres, unless otherwise noted.
2. See Figure 2.11 for locations of sections on plan view.
3. Information shown is from Detailed Design Report, Ref. No. 1784/2.

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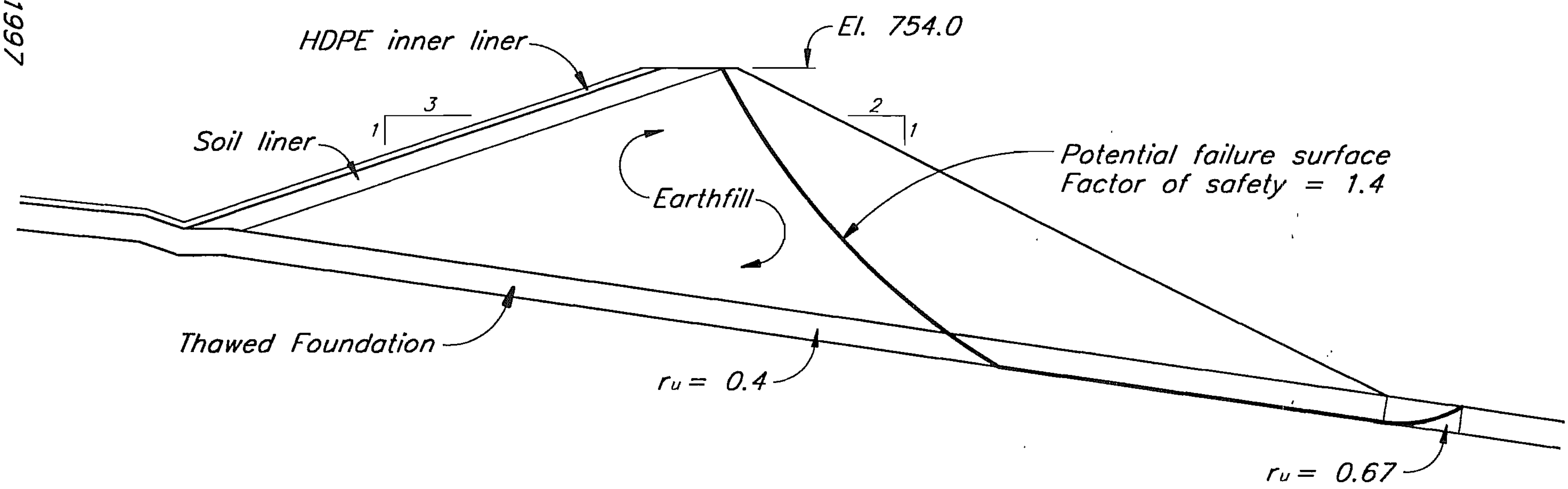
FIGURE 2.12

CAD FILE: 1785\FIG\A9 Plot 1=1

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
EVENTS POND
STATIC STABILITY ANALYSIS



Zone	γ kN/m³	φ' degrees
Earthfill	22.4	36°
Soil Liner	16.7	18°
HDPE Inner Liner	16.7	12°
Thawed Foundation	22.3	36°

April 23, 1997

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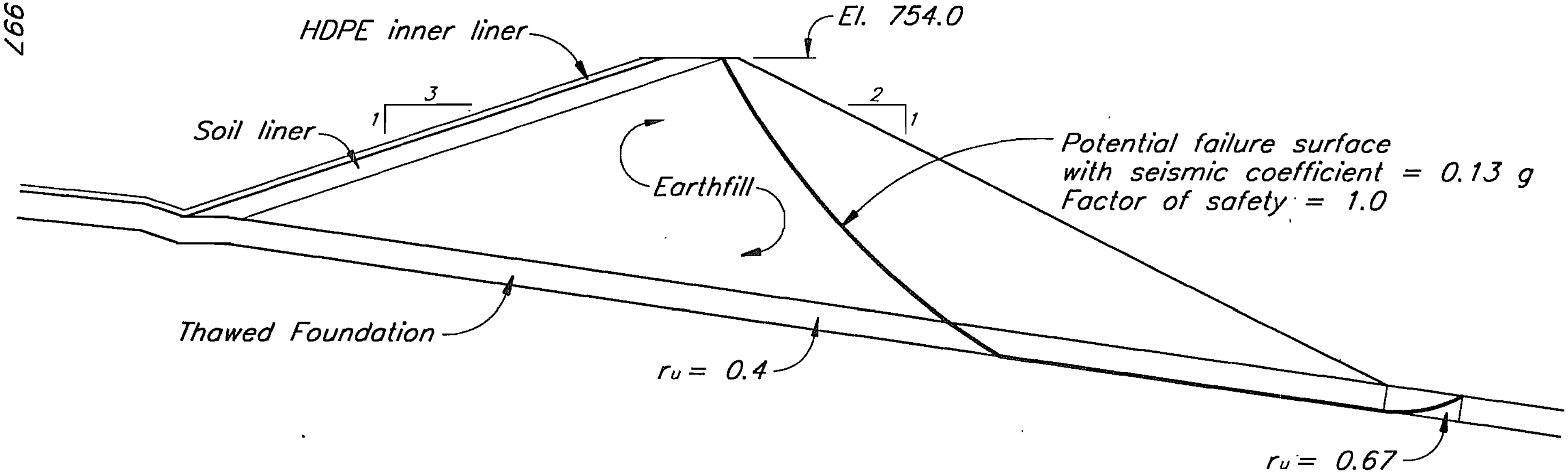
FIGURE 2.13

1785.A9

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

EVENTS POND
PSEUDOSTATIC STABILITY ANALYSIS



Zone	γ kN/m^3	ϕ' degrees
Earthfill	22.4	36°
Soil Liner	16.7	18°
HDPE Inner Liner	16.7	12°
Thawed Foundation	22.3	36°

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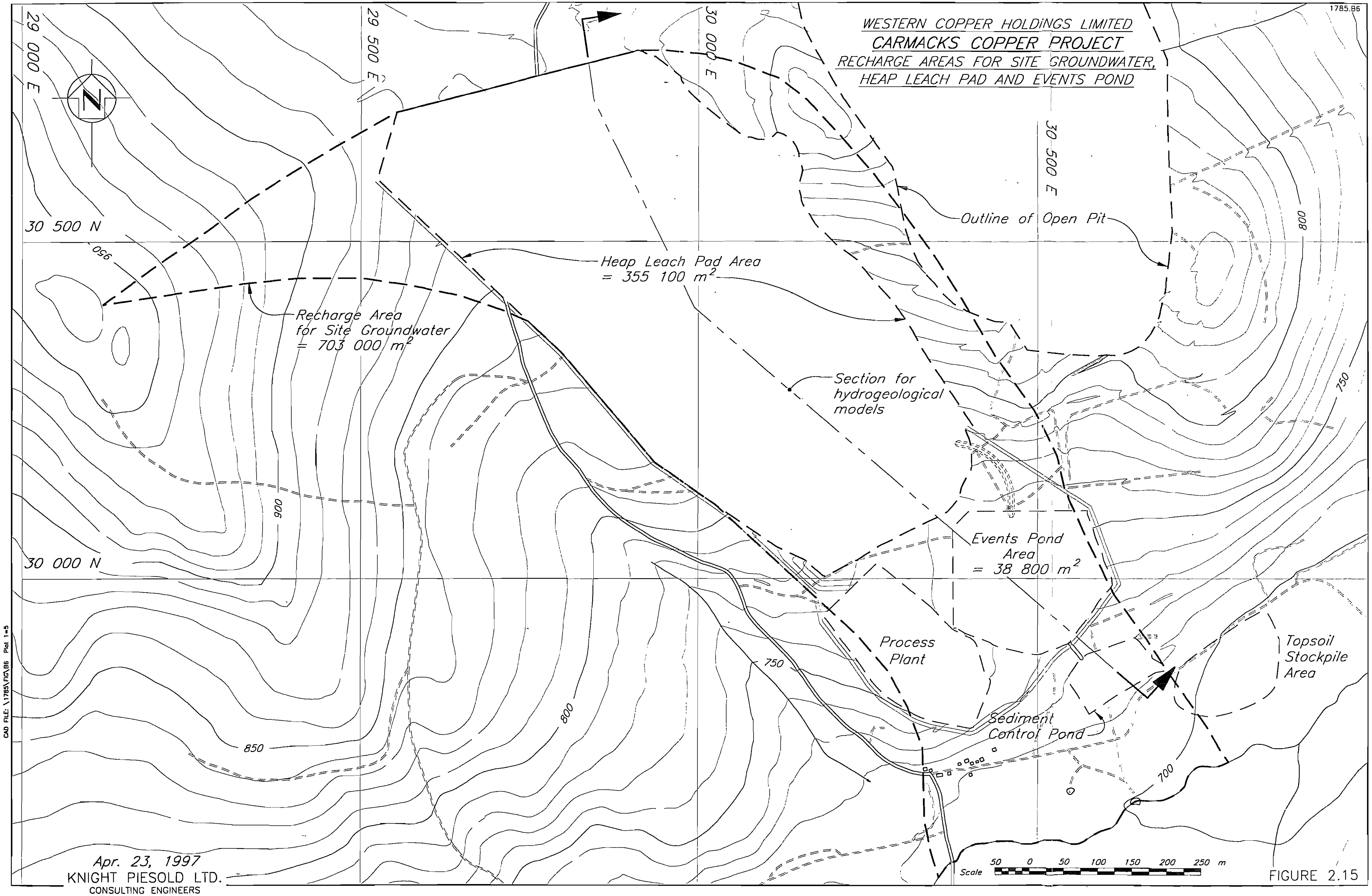
FIGURE 2.14

1785.A10



1785.B6
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
RECHARGE AREAS FOR SITE GROUNDWATER, HEAP LEACH PAD AND EVENTS POND
29 000 E
29 500 E
30 000 E
30 500 E
30 500 N
30 000 N
Outline of Open Pit
Heap Leach Pad Area = 355 100 m²
Recharge Area for Site Groundwater = 703 000 m²
Section for hydrogeological models
Events Pond Area = 38 800 m²
Process Plant
Topsoil Stockpile Area
Sediment Control Pond
950
900
850
800
750
700
Scale 50 0 50 100 150 200 250 m
Apr. 23, 1997
KNIGHT PIESOLD LTD.
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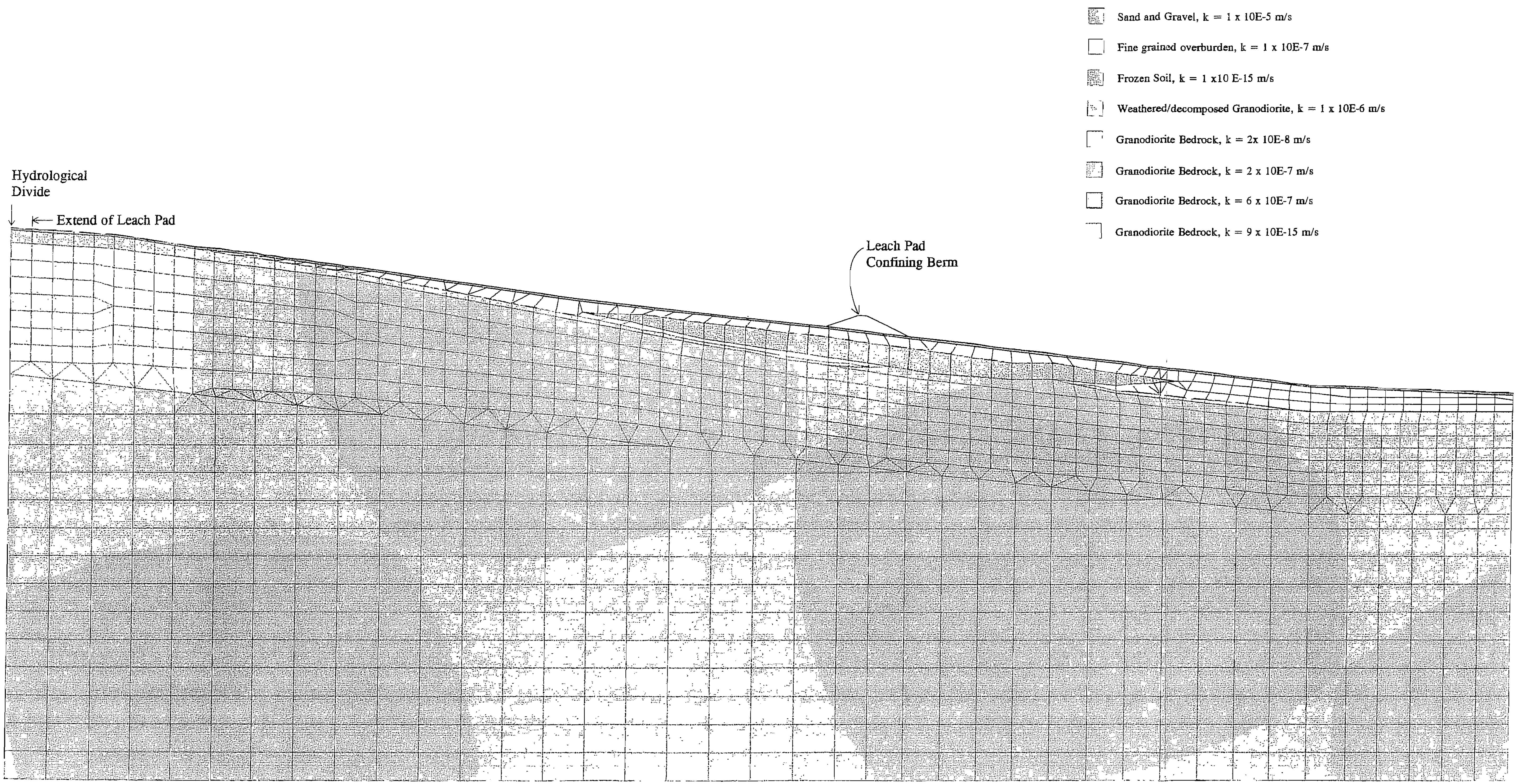
FIGURE 2.15
CAD FILE: \1785\FIG\B6 Plot 1=5

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
HYDROGEOLOGICAL MODEL OF FINITE ELEMENT PARAMETERS



J:\JOB\DATA\1784\SEEP\HLP-2.SEP

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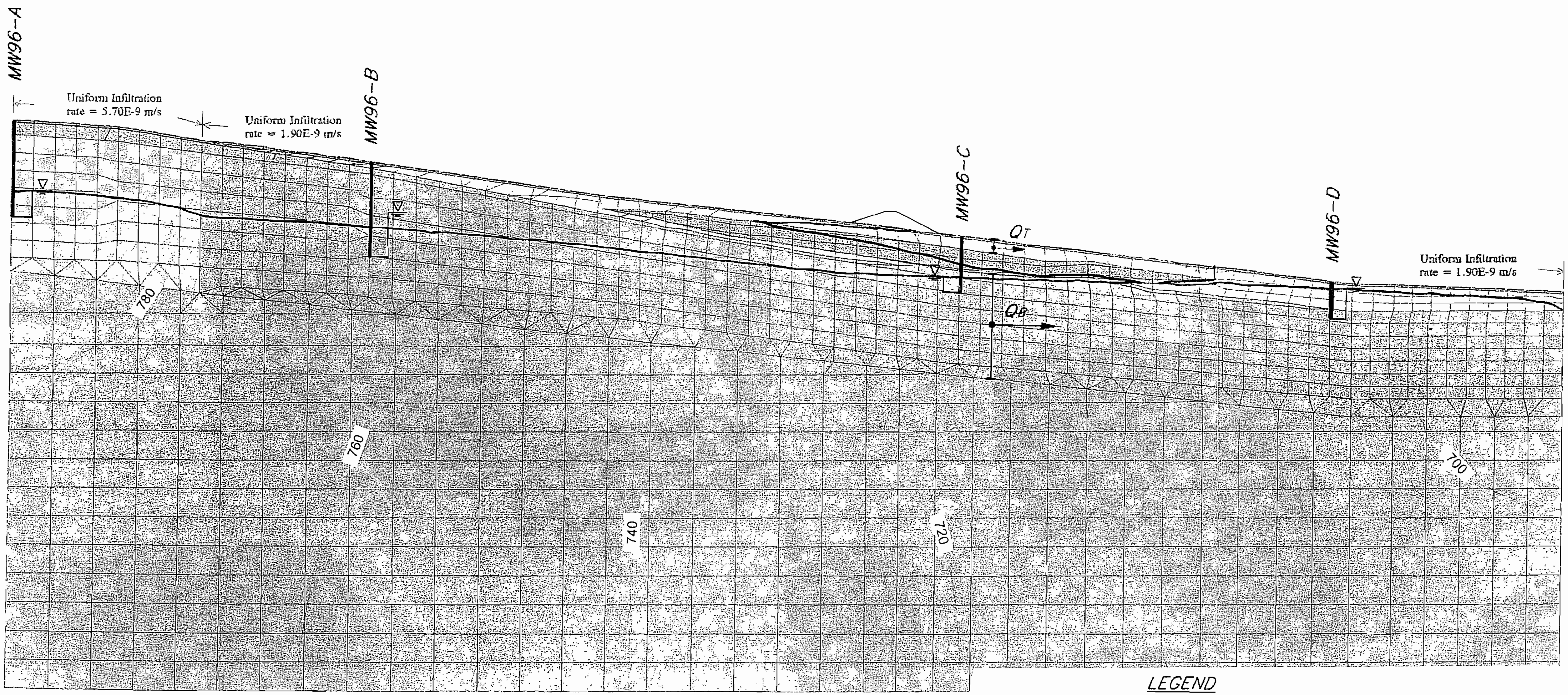
FIGURE 2.16

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
HEAP LEACH PAD
HYDROGEOLOGICAL MODEL OF EXISTING CONDITIONS



LEGEND

—— 760 —— Equipotentials

Perched Aquifer, Q_T = 0.017 m^3/day/m width (9% of seepage)

Main Aquifer, Q_B = 0.175 m^3/day/m width (91% of seepage)

Total flow in Main Aquifer = 87.5 m^3/day

⟶ Seepage flow vectors

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FIGURE 2.17

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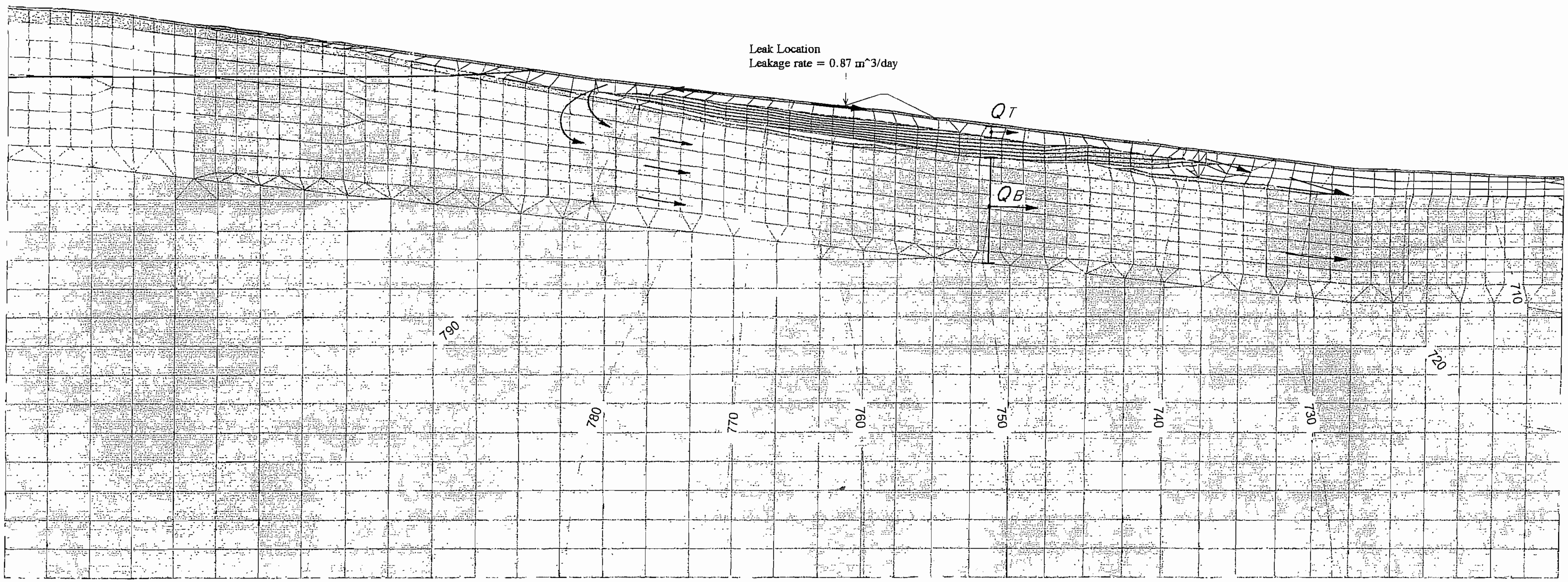
CARMACKS COPPER PROJECT

HEAP LEACH PAD

HYDROGEOLOGICAL MODEL OF LEAK AT DEEPEST POINT

IN LEACH PAD AREA



LEGEND

—— 740 —— Equipotentials

Leak to Perched Aquifer, Q_T = 0.539 m^3/day (60% of seepage)

Leak to Main Aquifer, Q_B = 0.367 m^3/day (40% of seepage)

——▶ Seepage flow vectors

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FIGURE 2.18