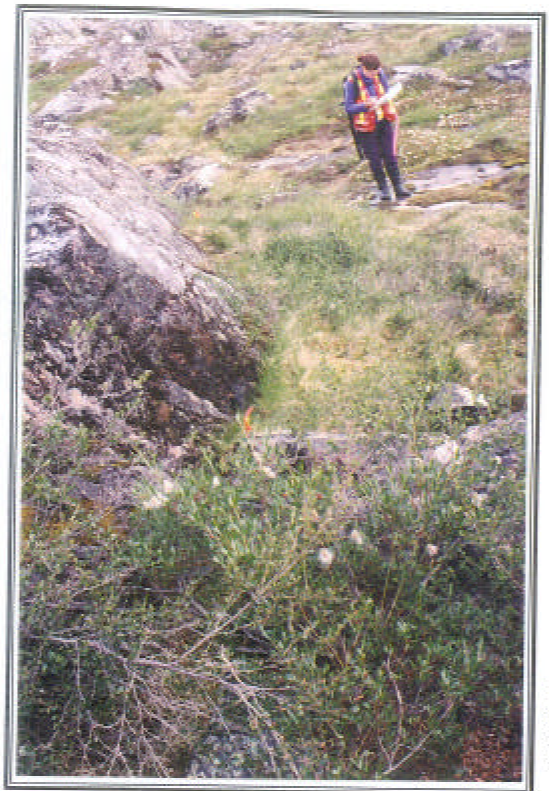

PHOTO 11. Plot 206
Willows at edge of heath tundra/sedge association at base of small cliff. (left)

PHOTO 12. Plot 206
Close-up of willow at base of small cliff. Red globes are moth galls. (below)

PHOTO 13. Plot 219
Birch Community, birch seep.

PHOTO 14. Plot 242
Heath Tundra Community on top of ridge with perched glacial erratic boulder.

PHOTO 15. Plot 225
Heath Tundra Community at base of small cliff near Long Lake. (above)

PHOTO 16. Plot 225
Close-up of alpine azalea in heath tundra. (left)

PHOTO 17. Plot 262
Heath Tundra Community with frost scars.
rock "dam" in stream valley above Lake C-1.

PHOTO 18. Plot 262
Close-up of frost scar.

PHOTO 19. Near Plot 228
Snowbank on north-facing slope, south side of Long Lake, photographed in late July.

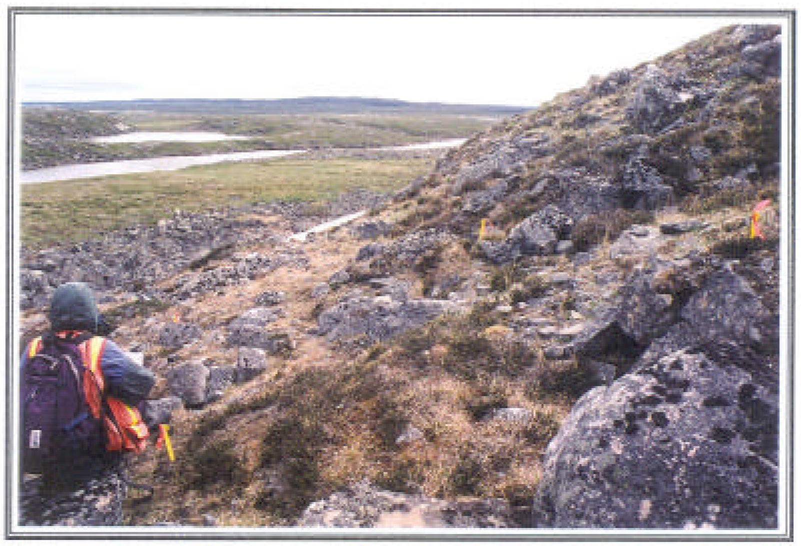

PHOTO 20. Plot 228
Snowbank Community adjacent to snowbank in Photo 19. North-facing slope above Long Lake.

PHOTO 21. Plot 229
Snowbank Community on south-facing slope, north side of Long Lake, base of cliff.

PHOTO 22. Plot 229
Close-up of mountain heather, typical snowbank community indicator species.

PHOTO 23. Plot 229
Close-up of Richardson's anemone, in snowbank community.

PHOTO 24. Near plot 229
Unusual fecal pellets of arctic hare, with apparent mud coating.
Each contains a small pebble.

PHOTO 25. Plot 239
Avens association on gravel saddle between ridges, northeast of the esst end of Long Lake.

PHOTO 26. Plot 233
Type of lichen-rock transition association, heath tundra with lichen-covered boulders.

PHOTO 27. Plot 223
Lichen-rock Community, lichens on boulders in boulder field.

PHOTO 28. Plot 223
Close-up of boulders with crustose lichens and foliose lichens webbing boulders together.

PHOTO 29. Plot 204
Lichen-rock Community, lichens on bedrock outcrop.

PHOTO 30. Plot 204
Close-up of lichens on glacially polished bedrock outcrop.

PHOTO 31. Plot 252
(Phenology Plot #4) Ridge Complex; esker crest association with mats of blueberry, avens, and crowberry.

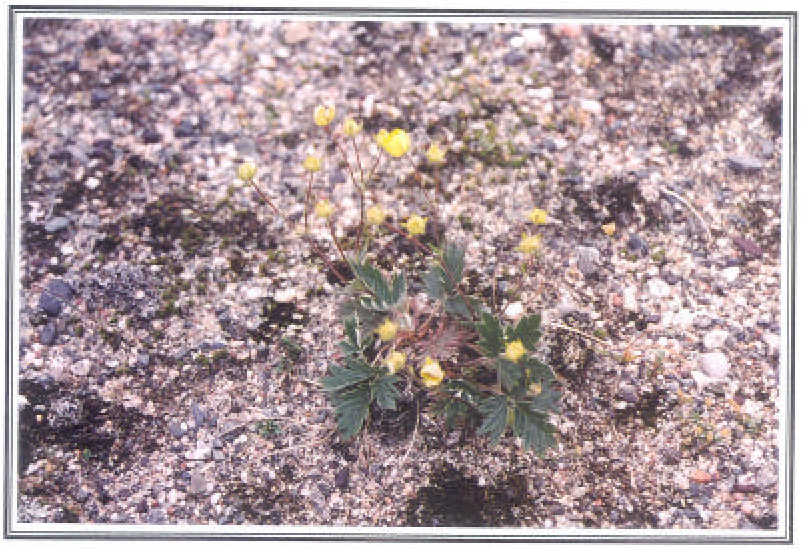

PHOTO 32. Plot 252
(Phenology Plot #4) Close-up of *Potentilla nivea* in esker crest association.

PHOTO 33. Plot 251
(Phenology Plot #5) Ridge Complex; esker slope association with dwarf birches, leeward slope.

PHOTO 34. Plot 216
Transitional association; turf hummocks invaded by heaths.

APPENDIX C
CHAPMAN REPORT ON IN-PIT TREATMENT

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Memorandum

To:	Project File	**Date:**	July 22, 2004
cc:	Kelly Sexsmith, SRK Cam Scott, SRK	**From:**	John Chapman
Subject:	Technical Memorandum R Jericho Post Closure Pit Lake Water Treatment	**Project #:**	1CT004.06

1 Introduction

1.1 Objectives

SRK Consulting has developed estimates of long-term post closure water quality in the Jericho Pit Lake (*Technical Memorandum Q: Post Closure Pit Lake Quality, SRK 2004, In: Abandonment and Restoration Plan, AMEC 2004)*. The current predictions suggest that concentrations of some contaminants may slightly exceed CCME guidelines for the protection of freshwater aquatic life. Given the proximity to the receiving environment, a contingency for post closure water quality management may be required to reduce contaminant concentrations in the pit lake to levels that are appropriate for discharge into Carat Lake.

The purpose of this memorandum is to provide "proof of concept" for use of an in-pit treatment system as a contingency to remove contaminants from the pit lake in the event water quality does not meet acceptable limits.

1.2 Background

Development of treatment strategies for water contained in pit lakes is dependant on site specific requirements. The evaluation and design of associated measures for treatment of the pit lakes should consider factors such as capacity, reliability, longevity, as well as monitoring and maintenance requirements.

Chemical treatment has a long track record. It is robust and reliable and is the technology of choice where the contaminant loads are high or there is no opportunity for experimentation. However, depending on the volume of water that has to be treated from a pit lake, the cost may be high. Biological treatment in some instances, where volumes are high and contaminant concentrations are low, have been shown to be cost effective and represent a viable alternative to conventional chemical treatment.

As discussed below, the current estimates of metal concentrations in the pit lake are within levels that may be treated with a biological treatment system. The intent would be to first revise the long-term estimates of pit water quality once actual seepage and runoff water quality data for the waste rock and pit wall runoff become available. If this data indicates that post-closure treatment may be required to meet discharge criteria, then verification would be completed during or shortly after operations cease, so that by the time the pit is flooded, the full scale system performance can be optimized. In the following sections, the likely performance of such a system is assessed and recommendations to verify the performance and develop specific design and implementation criteria are provided.

2 Biological Treatment Concept

A number of studies have been conducted on the use algae for the in-situ treatment of and pit lake water (Steinberg *et al.*, 2001; Pohler *et al.*, 2002; Poling *et al*., 2003). Typically, *in-situ* biological remediation involves the addition of nutrients to pit lakes to stimulate the growth of primary producers, mainly photosynthetic unicellular algae or phytoplankton. The algae remove metals from the top water layer through absorption and/or adsorption and eventual settling to the lake bottom where the decomposition of organic material creates biological oxygen demand that may in turn create suitable anoxic conditions for biological sulphate reduction (SRB). Under anoxic conditions, SRB can reduce sulphate to sulphide through a series of enzymatic reactions. The sulphide thus generated can form sulphide minerals with dissolved metals to reduce dissolved metal concentrations to very low levels. The cycling of iron from the sediment to the water column under anoxic conditions can also contribute to the co-precipitation of dissolved metals with Fe(III) oxy-hydroxide formed in the oxygenated zones of the pit lake.

Nutrient additions usually comprise phosphorous and nitrogen sources to stimulate phytoplankton growth. Nutrient additions to stimulate the growth of phytoplanktonic algae to promote dissolved metal removal have been successful at the Island Copper and at Landusky pit lakes (Adams, 2002). Successful results were also obtained from pilot-scale tests at Equity Silver mine (Martin *et al.*, 2003; Crusius *et al.*, 2003; McNee *et al.*, 2003). The growth of phytoplanktonic algae has also been stimulated by phosphorus addition at the Colomac Mine site within large contained areas exposed to ambient weather conditions (albeit that the primary purpose was ammonia removal), which demonstrated algae growth in a northern climate.

In a northern climate, heating by the sun causes the surface layer of water in a lake to warm up. The density of the warmer water in the surface layer is lower than the colder water at depth, resulting in a stratification of the lake during the summer months. It is this warmer surface layer of water that is productive. Phytoplanktonic growth would be supported to the depth of light penetration.

During fall, the surface water cools down to about 4 ^{o}C when it reaches its maximum density. This generally causes the now heavier water to sink to the bottom of the lake causing complete mixing of the lake. Typically lakes would also turn over in spring soon after ice-melt when the surface water temperature again approaches 4 ^{o}C.

In general, a similar sequence of events would be expected to occur in the pit lake. However, certain pit lakes may become permanently stratified if the water at depth is more saline, i.e. the water at depth consistently has a density that is higher than the surface water. The shape and depth of the pit lake, the thickness of the ice that forms during the winter and the energy of the flows into the pit lake are additional factors that will determine whether or not this condition, known as meromixis, would develop in the pit lake.

In the case of the Jericho pit lake, the post closure continuous flow through of water and the low salinity conditions would prevent the build-up of salinity and it is therefore unlikely that meromixis would develop. The kinetic energy input from the inflows would also promote mixing. Therefore, the water in the pit lake is likely to be mixed on a regular basis.

In concept, implementation of a biological treatment system in the Jericho pit lake in a post-closure situation would require that nutrients be dispersed throughout the productive surface layer of the pit lake throughout summer. This is generally done by discharging a liquid containing dissolved nutrients into the propeller wash of a small boat as it traverses the surface of the pit lake. The timing and the frequency of the nutrient additions would depend on the productivity and the rate of nutrient consumption to ensure that elevated nutrient concentrations are not released to the receiving environment.

In the next section, a brief assessment of the likely performance of biological treatment system is completed.

3 Application to Jericho Site

3.1 Site Conditions

The rate of growth of phytoplankton will depend on the depth of light penetration, solar radiation, the temperature in the surface layer, and, the availability of nutrients.

The water flowing into the pit is not expected to contain elevated levels of suspended solids, therefore light penetration is not expected to represent a constraint on phytoplankton growth. In the following sections, the climatic conditions at the site are compared to those at the Colomac site, where phytoplankton growth has successfully been demonstrated through nutrient additions.

3.1.1 Sunlight

Table 3-1 below compares the average sunshine hours for nearby meteorological stations, and the exposure profiles are shown in Figure 3-1. The Jericho site is located at a latitude of about 66^{o}N, and is therefore expected to have sunshine exposures similar to that of Kugluktuk of about 1,629 hours of sunshine per annum. The sunshine exposure for Colomac, at a latitude of 64 ^{o}N is expected to similar to that of Baker Lake, i.e. 1,843 hours per annum. Both Kugluktuk and Baker Lake had approximately 300 hours of sunshine during July and 200 hours of sunshine during August. Based on these comparisons, the Jericho and Colomac sunshine profiles, and peak sunshine hours are expected to be similar. Therefore, during these peak exposure months (June and July) primary production of phytoplankton at Jericho is expected to similar to that observed at the Colomac Site. While the overall annual exposure is lower, this is of no consequence since the difference occurs primarily in the fall and winter when no growth would be expected anyway.

Table 3-1
Total Bright Sunshine (hours)

Station	Latitude	Longitude	Annual
Baker Lake	64 18 N	96 05 W	1843
Kugluktuk (Coppermine A)	67 50 N	115 7 W	1629
Norman Wells A	65 17 N	126 48 W	1854
Yellowknife A	62 28 N	114 27 W	2277

(Source: Environment Canada 1951-1980 Climate Normals)

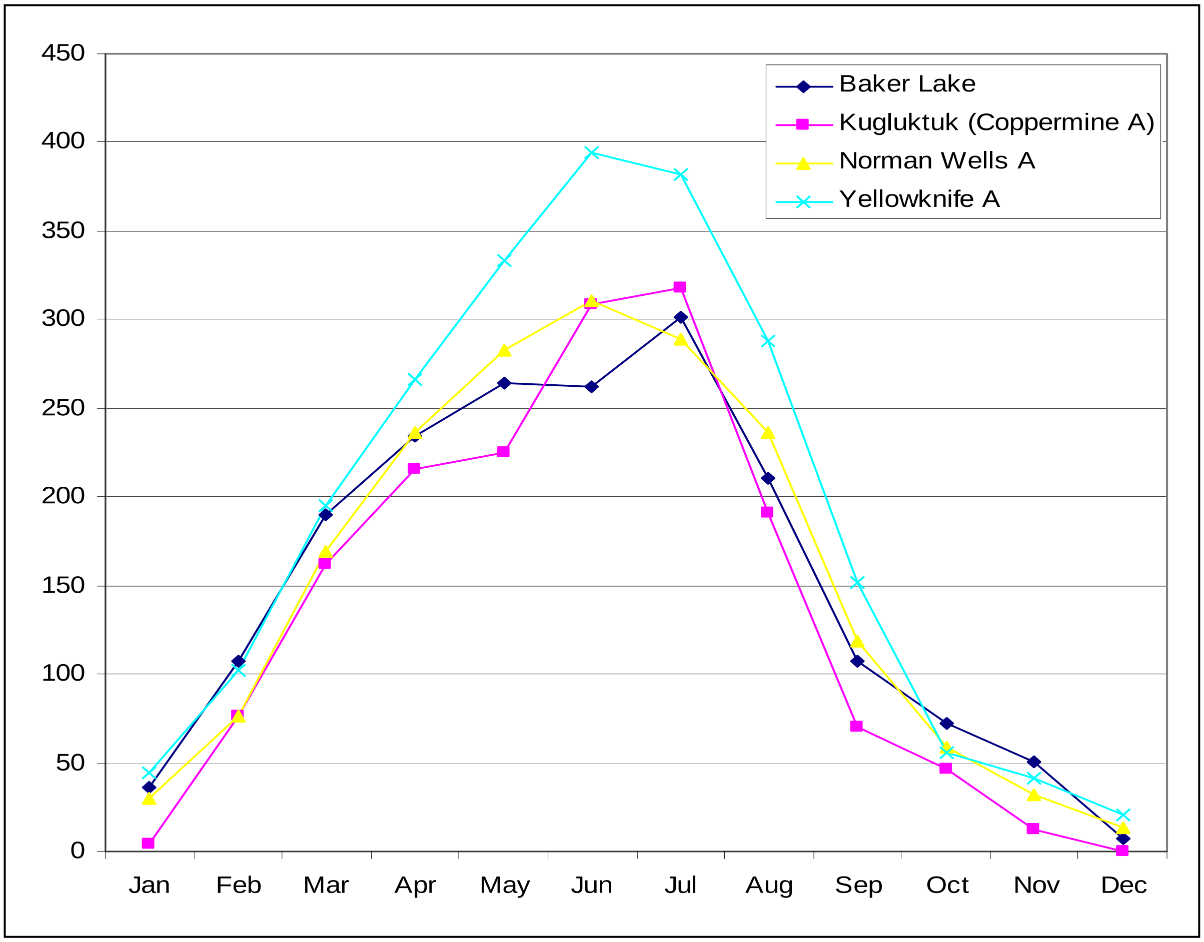

Figure 3-1 Average Annual Sunshine Profiles

3.1.2 Thermal Profile/Stratification

As discussed above, the solar radiation in the summer months is expected to be similar to that for the Colomac site. Therefore, the thermal stratification and peak temperatures are likely to be similar. At the Colomac Pit, thermal stratification occurs to a depth of about 5 meters, and the temperature increases to about 15 ^{o}C. (It should be noted that phytoplankton and metal removal occurs at temperatures as low as 4 ^{o}C at the Island Copper Pit Lake.)

It is therefore concluded that the climatic conditions at the site will be suitable for phytoplankton growth.

3.1.3 Nutrients

The treatment strategy requires that nutrients be added to the pit lake at concentrations that would stimulate phytoplankton growth. Baseline characterization of the receiving surface water quality indicated oligotrophic conditions (i.e. low nutrient conditions), which suggest that nutrient management within the pit lake will be key to the success of an in-situ treatment system.

3.2 Predicted Water Quality

Table 3-2 provides a summary of the initial estimates of key parameters for each source of water that will be directed to the pit lake. These comprise discharges from Ponds A, B, and C and runoff from the pit walls. The table includes the initial estimates of the pit water quality, as presented in Technical Memorandum F (SRK 2003), and revised estimates of pit water quality which consider the effects of partial freezing of the waste rock dumps (SRK 2004). The pit lake water quality, as shown in the second part of the table, represents estimated long-term steady state conditions. The long-term steady state concentrations are shown to indicate the effect of the net loadings to the pit lake, since it will be possible to remove most of the accumulated contaminants before discharge occurs.

Table 3-2
Assessment of Pit Water Quality for Different Assumptions of Source Concentrations

Flows and Concentrations of Water Sources to the Open Pit									
Source Concentrations	**Source**	**Annual Flow**	**T-Al mg/L**	**T-Cd mg/L**	**T-Cu mg/L**	**T-Fe mg/L**	**T-Pb mg/L**	**T-U mg/L**	**T-Zn mg/L**
Estimated Water Quality during Operations Period (from Revised Water and Load Balance)	Pond A	126,668	0.19	0.0005	0.050	0.28	0.0042	0.24	0.021
	Pond B	48,839	0.18	0.0004	0.045	0.27	0.0050	0.23	0.020
	Pond C	118,173	0.04	0.0025	0.0039	0.20	0.0065	0.11	0.022
	Pit Runoff	34,120	0.34	0.0001	0.0078	1.1	0.0033	0.066	0.013
Estimated Water Quality Post-Closure Period	Pond A	126,668	0.06	0.0002	0.017	0.09	0.0014	0.079	0.0072
	Pond B	48,839	0.06	0.0001	0.015	0.09	0.0017	0.076	0.0066
	Pond C	118,173	0.30	0.0006	0.0014	0.30	0.0032	0.052	0.0063
	Pit Runoff	34,120	0.112	0.00004	0.0026	0.37	0.0011	0.022	0.004
Baseline Data (avg. of 2003 Seeps)	Stream C1	224,045	0.093	0.00005	0.0034	0.31	0.00014	0.0010	0.0015
Predicted Water Quality in the Pit Lake									
Contributing Sources			**T-Al mg/L**	**T-Cd mg/L**	**T-Cu mg/L**	**T-Fe mg/L**	**T-Pb mg/L**	**T-U mg/L**	**T-Zn mg/L**
A+B+C+Pit+Ice+Stream C1 (at steady state)			0.13	0.0002	0.007	0.24	0.0013	0.038	0.004
CCME Aquatic Life Guidelines			*0.1*	*1.7E-05*	*0.002*	*0.3*	*0.001*	*na*	*0.03*
Health Canada Guidelines			*0.1*	*0.005*	*1.0*	*0.3*	*0.01*	*0.02*	*5*
Carat Lake Baseline Data			*0.052*	*0.00005*	*0.0020*	*0.025*	*0.00005*	*0.00020*	*0.0020*
Ratio of Pit Lake to CCME Aquatic Guidelines			*1.3*	*12*	*3.5*	*0.8*	*1.3*	*-*	*0.1*

Table 3-2 also provides a ratio of the estimated pit lake water quality to the CCME Guidelines for the protection of freshwater aquatic life. As shown, cadmium and copper are the primary contaminants of concern, whereas aluminium and lead may marginally exceed the guidelines. Iron and zinc would meet the CCME guidelines for the protection of freshwater aquatic life.

At neutral pH conditions, it is anticipated that the total aluminium is likely to be present as a suspended precipitate, which would in part be removed within the lake due to gravitational settlement. It is not expected to represent a concern in the downstream receiving environment. In the next section, the performance of a biological treatment system is estimated.

3.3 Biological Treatment Performance Assessment

In this section the Island Copper experience will be used to assess the potential performance that could be expected at the Jericho Pit Lake. The Island Copper in-situ pit lake treatment system for metals removal is a full scale system with several years of operational data that has been well documented. Although the Island Copper project is located at a latitude of only 51.7^{o}N, in the winter the site experiences significantly lower solar radiation and lower water temperatures than will be expected at the Jericho Pit Lake. Therefore, the Island Copper winter performance data can be used to provide a conservative indication of the potential performance at Jericho.

3.3.1 Contaminant Loading and Removal Rates

The metal concentrations and flows presented in Table 3-2 can be used to calculate specific loadings to the pit lake. The estimated contaminant loadings to the Jericho pit, calculated as grams per hectare of pit lake surface area per year, are shown in the first row in Table 3-3.

Table 3-3 also summarises the removal rates achieved at the Island Copper Mine (Poling et al. 2003). Note that the removal rates are given in units of g/ha/**day**, as opposed to the units of g/ha/**year** in which the loadings are reported. The annual average, winter (December to February) and summer (June to August) removal rates are shown. (Removal rates in test cells or limno corrals at the Equity Silver mine yielded similar rates of metal removal.) Typically the rate of removal at the Island Copper Mine decreases in the winter due to reduced sunshine and colder weather. In the winter, the surface water temperature in the Island Copper Pit Lake may decrease to below 5 ^{o}C. Apart from the latitude of the Island Copper site, the predominantly rainy winter (overcast) also limits solar radiation so that the winter conditions are significantly less conducive to phytoplankton growth than would be the case during the summer at the Jericho site. Therefore, estimating contaminant removals that may be achieved at Jericho using the winter rates observed at the Island Copper site will provide a conservative indication of the pit lake treatment performance.

The last row in Table 3-3 provides an estimate of the time that would be required to remove the annual metal loading from the Jericho Pit Lake, estimated from the Island Copper winter removal rates. As shown by the results, the cadmium removal would require the longest treatment time (at about 22 days). This would mean that 3 to 4 fertilizer applications spaced 10 days apart should be sufficient to achieve metal removals equivalent to the annual loadings.

Table 3-3
Estimated Contaminant Loadings and Removal Rates

Description	Units	T-Cd	T-Cu	T-Pb	T-Zn
Jericho Pit Lake Loadings	g/ha/year	6.6	227	41	145
Island Copper Removal rates					
Annual Average	g/ha/day	0.91	25	n/a	66
Low (Winter)	g/ha/day	0.30	18	n/a	40
High (Summer)	g/ha/day	1.6	37	n/a	160
Time to achieve removal (using winter rates from Island Copper)	Days	22	13	n/a	4

3.3.2 Retention Time

In the previous section it was shown that within a treatment period of less than 1 month it is possible to remove the equivalent of an entire years loading to the pit lake. The potential for contaminant release from the pit lake would depend on the retention time within the pit lake. Effectively, if the retention time exceeds the time required to treat the equivalent loading, the net release of contaminants would effectively be limited. On the other hand, if the retention time is much shorter than the treatment time, the risk for contaminant release will be significant.

The pit lake will have a total flooded volume of about 6.5 million m^3. For completely mixed conditions it can be shown that the retention time of the annual flow into the pit lake will be about 20 years. In the event that meromixis develops, the retention time in the surface layer would be approximately 1.5 years. In either event, the retention time significantly exceeds the treatment time indicating an insignificant risk for contaminant release.

3.3.3 Water Quality

The Island Copper Pit Lake metal loadings are significantly greater than those indicated for the Jericho Pit Lake (as can be inferred from the metal removal rates). The retention time of the surface layer in the Island Copper Pit Lake is approximately 1 year, compared to a more favourable minimum retention time of about 1.5 years at Jericho. Therefore metal concentrations at Jericho are expected to similar or lower than at Island Copper. At the Island Copper Pit Lake, copper concentrations are typically lowered from about 0.02 to 0.03 mg/L to less than 0.004 mg/L; lead from about 0.009 mg/L to less than 0.00005 mg/L; zinc from in excess of 5 mg/L to less than 0.002 mg/L; and cadmium from 0.03 mg/L to less than 0.001 to 0.002 mg/L. It should be noted that the surface water of the Island Copper Pit Lake is brackish, with a salinity of about 3 parts per thousand, because it is partially mixed with seawater. The resultant elevated chloride content, which strongly complexes cadmium and to a lesser extent copper and zinc, is limiting the extent of metal removal. In the case of the Jericho Pit Lake, chloride concentrations will be lower, and complexing reactions are not expected to affect metal removal. It is therefore likely that metal concentrations will be reduced below those observed for the Island Copper site.

Results from limno-corral tests conducted at the Equity Silver mine (McNee et al, 2003) indicated that copper decreased from about 0.005 mg/L to <0.001 mg/L and cadmium decreased from about 0.005 mg/L to < 0.0002 mg/L. Similar reductions in metal concentrations would be expected for the Jericho Pit Lake, which suggests that water quality approaching CCME guidelines may be achieved by in-situ biological treatment.

3.3.4 Fertilization and Nutrients

At the Island Copper Site, liquid fertilizer is applied at a frequency of about 10 days throughout the entire year. The program is designed to coincide with the phytoplankton growth cycle. Typically, dissolved otho-phosphate is maintained at less than 0.005 mg/L (as P) at the time of fertilization which decreases to less than 0.001 mg/L by the end of the 10 day fertilization cycle. Total nitrogen is maintained at less than 0.5 mg/L (as N).

It is anticipated that at Jericho, fertilization would be undertaken only during the ice free period and only for about 2 months of the year. The fertilization would be undertaken every 10 days during July and August, once the majority of the spring runoff has discharged from the pit, and the thermocline has established in the pit lake. A liquid fertilizer mix would be prepared, and dispensed from a small boat that would traverse the surface of the pit lake. The liquid fertilizer would be released to the propeller wash of the boat, which would disperse the fertilizer. Studies elsewhere have shown this to be an effective method of fertilizing. The volume of liquid fertilizer that would be added would be determined from the residual nutrient concentration in the surface layer, the composition of the fertilizer and the volume of the surface layer.

Discharges from the pit lake during the fertilization period would be minimal and could be controlled with an appropriate spillway design. Treated water would be released by gravity the following spring. Assuming nutrients levels would be maintained at level similar to those for the Island Copper Lake, nutrient levels are not expected to impact on the receiving environment, even though it is oligotrophic.

3.3.5 Conclusions

As discussed in the previous sections, biological in-situ treatment represents a feasible contingency in the event that unacceptable water quality results in the Jericho Pit Lake.

The technology and understanding of the metal removal processes is rapidly evolving and finding application elsewhere. However, at present, laboratory and field scale demonstration of the technology would be required to verify its application to the Jericho Pit. Considering the estimated time-scale to complete flooding of the pit lake (25 to 30 years), sufficient time is available to complete such a demonstration during or after operations. In the next section, recommendations for the demonstration in-situ biological treatment of the Jericho Pit Lake are provided.

4 Requirements for Demonstration

Water quality and flow monitoring during the first three to five years of operation will be required to refine the current estimates of long-term water quality in the pit lake, and therefore determine the need for the in-situ treatment. The demonstration program would be implemented if the refined predictions indicate that treatment is required.

As noted before, the technology is evolving rapidly and it will be necessary to stay abreast of developments through continued literature reviews. The following presents a program that would demonstrate the applicability of the technology to the Jericho site. However, adjustments may be required to accommodate future developments.

A program for the demonstration of the effectiveness of biological treatment as a contingency measure would comprise three phases as follows.

4.1 Phase I – Bench Scale Assessment

The objectives of the bench scale investigation address the following questions:

- Can phytoplankton blooms be established in water from the site (that would represent the estimated long term pit lake water quality)?
- What are the minimum nutrient requirements to initiate a phytoplankton bloom, and how frequently should fertilization occur to maintain phytoplankton growth?
- Will metal removal rates exceed metal loadings and will sufficiently low metal concentrations be achieved?

To address these objectives, it is recommended that a laboratory program be undertaken on site in large containers (20 to 200 L vessels) that are exposed to ambient solar radiation and that are maintained at a temperature equivalent to that which develops in the surface layer of the local lakes.

The vessels would be filled with seepage from the waste rock piles or simulated pit lake water, and fertilized with different concentrations of nutrients. The rate of phytoplankton growth, dissolved nutrient concentrations and contaminant concentrations would be monitored on a regular basis. Typically the tests would be completed over a 6 to 8 week period.

Typically this scale of testing provides good information on the nutrient demand and the rate of phytoplankton growth. However, metal removal rates and achievable water quality are more onerous to demonstrate at this scale due to the short duration of the tests.

Results from the phase of the program would be used to design a larger scale field test that would be undertaken in Phase II of the program.

4.2 Phase II – Field Scale Demonstration

The purpose of the field scale tests would be to provide large scale demonstration of metal removal rates and nutrient requirements. The larger scale would enable easy scale-up to a full-scale system. This phase of testing would follow the initial bench scale program.

Larger scale tests would then be undertaken to more accurately evaluate metal removal. The larger scale tests would comprise limno-corrals that would be established in the PKCA, water management pond or a local lake as soon as thermal stratification occurs. (Limno-corrals are simple open ended enclosures that comprise a circular vertical curtain suspended from a floatation ring to isolate a column of water from the surrounding water body. While the enclosure is open-ended at the base, isolation is achieved due to thermal stratification in the water body.) If the water quality in the waterbody does not reflect the pit lake water quality, the surface water layer within the limno-corral would be replaced with water at an appropriate quality. The surface layer would then be fertilized at a rate and schedule determined from the laboratory program. The water quality would be monitored to establish metal removal rates and terminal concentrations. The limno-corrals would also be equipped with sediment traps to verify the fate of the metals. Further testing would also be undertaken on the sediments to assess the potential for nutrient recycling.

4.3 Phase III – Full Scale Verification

The objectives of this phase of investigation would be to verify the results from the field scale demonstration and to treat the pit lake water so that it meets discharge criteria before reaching the spill point. This phase of the investigation would be undertaken during the flooding of the pit.

Once a sizeable water body has been established in the pit, it is recommended that the water quality profiling be undertaken on a regular basis to monitor the water quality and mixing regime of the pit lake. Since numerous seasons will be available before the water level reaches the spill elevation, it is recommended that intermittent fertilization programs be undertaken to verify metal removal and treated water quality. At this time, nutrient recycle rates can also be established to ensure that over-fertilization does not occur once full scale flow-through operations commence.

5 Conclusions and Recommendations

The evaluation of in-situ biological treatment as a contingency treatment process for the Jericho Pit Lake after closure presented herein suggests that in-situ biological pit lake treatment may achieve water quality approaching CCME guidelines. In addition, nutrient concentrations are not expected to significantly impact the receiving environment. As such, it is appropriate to consider biological treatment as a post closure treatment strategy to remove contaminants from the pit lake.

Water quality monitoring during the first three to five years of operations will be required to refine the current estimates of water quality in the pit lakes. If the refined estimates indicate there is a need for water treatment after closure, staged demonstration of the treatment process will be required to verify residual metal and nutrient concentrations.

6 References

AMEC Earth & Environmental, 2004. Abandonment and Restoration Plan, Jericho Diamond Project Submitted to: Tahera Corporation, May 2004.

Adams J., 2002. Biological treatment of metals and in-organics in mining waters. Price B. and Bellefontaine K. (editors), presentation at the 9th Annual British Columbia Ministry of Energy and Mines – MEND, Vancouver, B.C.

Crusius J., Pieters R., Leung A., Whittle T., Pendersen G. and McNee J.J., 2003. Tale of two pit lakes: Initial results of a three year study of the Main Zone and Waterline pit lakes near Houston, British Columbia, Canada. Mining Engineering, 43(2) 43-48.

Martin A.J., Crusius J., McNee J.J., Whittle P., Pieters R. and Pedersen T.F., 2003. Field-scale assessment of bioremediation strategies for two pit lakes using limnocorrals. Sixth International Conference on Acid Mine Drainage – Application and Sustainability of technologies, pp. 529-39.

McNee J.J, Crusius J., Martin A.J., Whittle P., Pieters R., Pendersen T.F., 2003. The physical, chemical and biological dynamics of two contrasting pit lakes: Implication for pit lake bio-remediation. Sudbury 2003- Mining and the Environment, available on CD and at http://www.ott.wrcc.osmre.gov/library/proceed/sudbury2003/sudbury03/135.pdf)

Pohler I., Wenderoth D.F., Wendt-Potthoff K. and Hoffle M.G., 2002. Bacterioplankton community structure and dynamics in enclosures during bioremediation experiments in an acidic mining lake. Water, Air, and Soils Pollution: Focus 2:111-121.

Poling G. W., Pelletier C. A., Muggli D., Wen M., Gerits J., Hanks C. and Black K., 2003. Field studies of semi-passive biogeochemical treatment of acid rock drainage at the Island Copper Mine pit lake. Sixth International Conference on Acid Rock Drainage (ICARD): Developing an Operation, Maintenance, pp.549-558.

SRK Consulting, 2003. Technical Memorandum F: Site Water Balance and Load Concentration Model, Jericho Project, Nunavut. Prepared for Tahera Corporation, September 2003.

SRK Consulting, 2004. Technical Memorandum Q: Post Closure Pit Lake Quality. Memorandum prepared for Tahera Corporation, July 2004, *In*: AMEC 2004.

Steinberg C.E.W. and Totsche O., 2001. De-acidification of flooded lignite mining lakes by controlled eutrophication: microcosms experiments. 40th Annual Conference of Metallurgists of CIM, Toronto, Canada, pp. 357-369.

APPENDIX D
CLOSURE COST ESTIMATE TO 31 DEC 2006

Memo

To	**Nunavut Water Board**	File No.	**2AM-JER0401**
From	**Bruce Ott**	cc	**G. Missal** **C. Wray** **R. Jones**
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Date	**30 March 2007**		
Subject	**Closure and Reclamation Cost Update**		

The RECLAIM model was used to update reclamation cost estimates to December 2006. The cost breakdown is similar to that used for the 2005 estimate submitted to NWB February 2006 (AMEC 2006). The 2005 estimate was based on the reclamation and closure cost estimate submitted with the Jericho Water Licence application (AMEC July 2004).

This memorandum lists the changes in disturbance and cost estimates from the 2005 Closure cost estimate. Changes were due to on going mine facilities construction as indicated. The memorandum references costs estimate produced with the RECLAIM model; the 2006 estimate is attached.

Item	2005 Estimate	2006 Estimate
Waste Rock Dump 2 Contour Area	99,240 m^2	147,660 m^2
Waste Rock Dump 2 Reclamation Cost	$141,923	$174,739
Contouring		
PK Dam Contouring	60,000 m^2	1,052,940 m^2
Road Contouring	86,275 m^2	94,753 m^2
Pad Contouring	16,640 m^2	166,240 m^2
Borrow Area A Contouring	3,480 m^2	6,475 m^2
Coarse PK Contouring	0 m^2	3,774 m^2
Total Contouring	232,611 m^2	1,388,002 m^2
Airstrip Scarify	36,000 m^2	68,700 m^2
Pad Cover	44,400 m^3	69,799 m^3
Fine PK Cover	0 m^3	2814 m^3
Scarify/Cover Total Cost	$400,620	$872,119
Closure Monitoring Cost	$531,500	$631,500
Total Reclamation Cost to 31 December	**$6,955,627**	**$7,620,373**

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WASTE ROCK DUMP RECLAMATION COSTS

Load and Haul Overburden

Cycle time: 992 loader (min/load)	4	min/load	
Cycle time: 992 loader (load/hr)	12	load/hr	
Cycle time 777 Off-Highway Truck (min/load)	15	min/load	
Cycle time 777 Off-Highway Truck (load/hr)	4	load/hr	
Number of 992 Loaders Used	1		
Number of 777 Off-Highway Trucks Used	3		
Total Cycles Available - 992 Loader	12	(load/hr)	
Total Cycles Avaialble - 777 Off-Highway Truck	12	(load/hr)	
Capacity (m^3/hr)	50	m^3/hr	
Capacity (LCMs/hr)	600	LCMs/hr	
Cacacity (ECMs/hr)	480	ECMs/hr	
Quantity Waste Dump 2 (1 not built)	29,790	m^3	
Area of Waste Dump 2 to contour @ 60m^2/m	147,660	m^2	
Total 992 Loader Hours Required	29,790 / 480 x 1 machine		62
Total 777 Off-Highway Truck Hours Required	29,790 / 480 x 3 machines		186

Equipment	Fuel/hr (Litres)	Total Hrs	Machine $ Cost/hr	Operator $ Cost/hr	Machine Cost $	Operator Cost $	Fuel Cost $	Total Cost $
D10	84	177	216	56.99	38,382	10,114	11,179	59,675
992	78	62	319	60.60	19,810	3,761	3,631	27,202
777	70	186	206	51.58	38,317	9,603	9,775	57,695
16G (allocation)	44	141	125	55.87	17,636	7,878	4,653	30,167
Cost to Reclaim Waste Rock Dumps					114,146	31,355	29,238	174,739

Note: Footprint perimeter of WRD#2 x 60m^2/m

Note: 2005 costs inflated 5%

CONTOURING COSTS

Reclaim Remaining Areas

Contour

Assume D10 can contour at a rate of		1000	m^2/hr
Open Pit			
	Distance to Contour Crest	6000	m
	Area to Contour	10	m^2/m
	Total Area to Contour	60,000	m^2
PK Dams			
	Distance to Contour	17549	m
	Area to Contour	60	m^2/m
	Total Area to Contour	1,052,940	m^2
Roads			
	Distance to Contour	18951	m
	Area to Contour	5	m^2/m
	Total Area to Contour	94,753	m^2
Pads			
	Distance to Contour	33248	m
	Area to Contour	5	m^2/m
	Total Area to Contour	166,240	m^2
Borrow Area A			
	Distance to Contour	1,295	m
	Area to Contour	5	m^2/m
	Total Area to Contour	6,475	m^2
Coarse PK Stockpiles		3774	m^2
Causeway grade down		9000	m^2
Total Area to Contour		1,388,002	m^2
Total D10 Hours Required		1,388	hrs

OTHER RECLAMATION COSTS

Reclaim Remaining Area

Disturbance Area to Cover

PK Dam Overburden

Area to Cover	0	m^2		
Volume of Overburden @ 0.3 m			0	m^3

PK Dam Coarse Rejects

Area to Cover	0	m^2		
Volume of Overburden @ 0.5 m			0	m^3

Roads/Airstrip - Scarify Only

Distance 6 m roads	3,500	m	
Area to Scarify/Meter	6	m^2	
Areato Scarify	21,000	m^2	
Distance 10 m roads	16,160	m	
Area to Cover / Meter	10	m^2	
Area to Cover	161,600	m^2	
Distance 18 m roads	5,800	m	
Area to Cover / Meter	18	m^2	
Area to Cover	104,400	m^2	
Distance Airstrip	1,374	m	
Area to Cover / Meter	50	m^2	**Running surface only**
Area to Cover	68,700	m^2	

Pads (including accommodations, fuel farm, crusher site, waste transfer, explosives facilities and laydowns)

Area to Cover	232,664	m^2		
Volume of Overburden @ 0.3 m			69,799	m^3

Coarse PK Stockpiles (#4 only. #1 & 3 not constructed; #2 included with E dam)

Area to Cover	8,979	m^2		
Volume of Overburden @ 0.3 m			2,694	m^3

Fine PK in PKCA

Area to Cover	9,379	m^2		
Volume of Overburden @ 0.3 m			2,814	m^3

Total Volume to Cover

75,307 m^3

Capacity (ECMs/hr)

480 ECMs/hr

Total D10 Hours Required	(66,376 + 98,200) / 1000	431
Total 992 Loader Hours Required	66,376 / 480 x 1 machine	157
Total 777 Off-Highway Truck Hours Required	66,376 / 480 x 3 machines	471

Equipment	Fuel/hr (Litres)	Total Hrs	Machine $ Cost/hr	Operator $ Cost/hr	Machine Cost $	Operator Cost $	Fuel Cost $	Total Cost $
	84							
D10	78	1,819	216	56.99	393,452	103,673	114,598	611,722
992	70	157	319	60.60	50,079	9,507	9,178	68,764
777	44	471	206	51.58	96,863	24,275	24,710	145,848
16G (allocation)		214	125	55.87	26,767	11,956	7,062	45,785
Cost to Reclaim Remaining Areas					567,161	149,411	155,547	872,119

Note: 2005 costs inflated 5%

SITE EQUIPMENT COSTS

Disassembly, Freight to Site, Assembly

	Cost/Load	# of Units	Pcs/Load	# of Loads	Total Cost $
D10	6,000	2	1.5	3	18,000
992	6,000	2	3.5	7	42,000
777	6,000	3	3.0	9	54,000
16G	6,000	1	2.0	2	12,000
Cat 345	6,000	1	1.0	1	6,000
Crane	12,000	1	1.0	1	12,000
Disassembly (allocation)					15,000
Assembly (allocation)					15,000
		10		23	174,000

Transport South is included under Transport Southbound at End of Reclamation

Disassembly of Facilities	Fuel/hr (litres)	Total Hrs	Machine $ Cost/hr	Operator $ Cost/hr	Machine Cost $	Operator Cost $	Fuel Cost $	Total Cost $
Crane	75	2,189	220	61.98	481,580	135,674	123,131	740,385
Cat 345	40	2,189	250	58.33	547,250	127,684	65,670	740,604
Welders/Riggers				64.73	n/a	566,724		566,724
Labourers				49.19	n/a	861,337		861,337
					1,028,830	1,691,420	188,801	2,909,051

	# Operators	Months	Days/Month	Hrs/Day
Cane Op	1	6	30.4	16
Excavator Op	1	6	30.4	12
Welders and Riggers	4	6	30.4	12
Labourers	8	6	30.4	12

Cat 345 excavator is fitted out with Hydraulic Hammer and Shears

Nuna Overheads	# Operators	Months	Days/Month	Hrs/Day	Operator $ Cost/Hr	Total Cost $
Site Supervisors	1	6	30.4	12	89.4	195,679
Foreman	2	6	30.4	12	73.34	321,053
Safety	1	6	30.4	12	63.72	139,470
Administrator	1	6	30.4	12	52.84	115,656
Operator	1	6	30.4	12	58.33	127,673
						899,531

	Months	Cost / Month	Total $ Cost
Support Equipment (Bobcat, Tractor Lowboy, IT 28)	6	30,000	180,000

	Months	Cost / Month	Total $ Cost
Facilities Support	8	90,000	720,000

DEMOBILIZATION COSTS

Transport South Bound at End of Reclamation		# of Loads	Cost / Load	Total Cost	
	Building	0			**Bury on site**
	Plant facilities	0			**Bury on site**
	Gen Sets	6			
	Fuel Tanks	0			**Decontaminate and bury on site**
	Mobile Equipment	23			
	Misc.	20			
		49	5,200	254,800	

Transportation	# of Trips	Cost / Trip	Total Cost
	94	800	75,200

Catering	# of People	Months	Days / Mon	Cost / Day	Total Cost $
Earthworks	5	6	30.4	45	41,040
Plant Decommissioning	12	6	30.4	45	98,496
Decontaminate fuel tanks	4	2	30.4	45	10,944
Decontaminate explosives buildings	4	2	30.4	45	10,944
Administration	6	6	30.4	45	49,248
					210,672

Monitoring		Cost / Year	# of Years	Total	
	Water quality (to Yr 10)	40,000	10	400,000	**Annual**
	Water quality (to Yr 20)	40,000	2	80,000	**Yr 15 & 20**
	Geotech	4,500	7	31,500	
	Airfare	2,500	40	100,000	
	Post Closure Inpit treat.	10,000	2	20,000	**Passive treatment**
				631,500	

Subtotal	6,927,612
Contingency - 10%	692,761
Total Cost Including Contingency	7,620,373

Note: Site monitoring per INAC Guidelines every 5 years after post closure Year 10.

APPENDIX E
PRE-CONSTRUCTION SITE PHOTOS

Photo 1: Airstrip Access Road and Airstrip Looking North

Photo 2: Airstrip Looking South. Carat Lake is at the Top of the Picture

Photo 3: Exploration Portal Area. Carat Lake is in the Background

Photo 4: Long Lake (PKCA site) Looking Southwest