Yukon Zinc
CORPORATION

Wolverine Project

Water Management and Treatment Plan

Advanced Exploration Phase

Type B Water Licence QZ01-051
Conditions 32, 37, 39, 50, 51, 53, 55, and 56.

Prepared by:

Pamela Ladyman, M.Sc., R.P.Bio.
Richard Goodwin, P.Eng.
Yukon Zinc Corporation

In conjunction with:

Canadian Environmental and Metallurgical Inc.

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1 Introduction

This report has been prepared to satisfy requirements contained within Type "B" Water Licence Approval QZ01-051. The structure and content of this report is based upon details provided in the Environmental Assessment Act Screening Report (Application No. LQ00026), by Yukon Government Energy, Mines and Resources and the Yukon Water Board. Specifically, this report provides information with respect to the following Water Licence Conditions: 32, 37, 39, 50, 51, 53, 55, and 56.

The purpose of this document is to describe plans for the Wolverine Project pertaining to the management and treatment of groundwater from underground development and seepage from the waste rock stockpile underground test mine. This document also provides a management plan for the disposal of fine sediments collected in the surface sumps and preliminary plan for sludge produced during water treatment.

A conceptual water treatment process was developed in May of 2004 for the treatment of mine water and waste rock dump seepage for the proposed underground test mine at Wolverine Mine. The conceptual water treatment system was submitted to the Yukon Water Board as part of Type B submission for Advanced Exploration Program at Wolverine. Type B Water license for the Advanced Exploration requires Yukon Zinc Corporation to undertake water treatability tests to firm up the sizing, reagent selection and optimization of the proposed water treatment system to meet discharge criteria.

2 Background Information

Regional climate data is available from three Environment Canada stations located within the Liard Basin. Watson Lake is located 175 km south-southeast of the project, at an elevation of 687 m a.s.l. Climate data is available for the period 1938-2005. Tuchitua is located 80 km southeast of the project, at an elevation of 724 m a.s.l. Climate data is available for the period 1971-2004. Hour Lake is located 60 km east-southeast of the project at an elevation of 890 m a.s.l. Climate data is available for the period 1982-2004.

These three stations are sited in valley bottoms and range from 500 m to 900 m lower in elevation than the project site. They are not fully representative of the climate at the project site, which is located in the upland region of the Pelly Mountains. Therefore, interpretation of regional climatic data to characterize conditions in the project area was tempered by the data collected on site. Wherever possible, regional data was corrected for the effects of location and elevation to generate expected conditions at the project.

2.1 Wolverine Project Site Precipitation

Baseline data collection began at the project site in 1996 and has continued intermittently to the present. In 1996 and 1997, and again for portions of 2000 and 2001, some automated data was collected at a location near the exploration camp site on Wolverine Lake.

Beginning in October 2004, continuous data has been collected by an automated weather station located adjacent to the project site airstrip (Photo 7.1-1; Figure 7.1-1). The weather station is located approximately 500 m northwest of the western corner of the airstrip and 2 km southeast of the underground mine portal at an elevation of 1325 m. The automated station consists of several instruments and a data logger. The station measures rainfall, air pressure, solar radiation, wind speed and wind direction, air temperature, and relative humidity. Data from the instruments is recorded by the data logger and is manually downloaded to a computer several times per year.

The climate at the project site is typical of its location and position. In general, summers are characterized by unstable air, thunderstorms, and frequent rainfall. Winters are cold and dry. Winter conditions begin in October and last through April. Late April and May are the driest months of the year and constitute spring. Summer lasts from June to August and is the wettest season of the year. The short fall period consists of late August through September.

2.1.1 Mean Annual Precipitation

The three regional climate stations have mean annual precipitation totals ranging from 418 mm at Watson Lake, to 514 mm at Hour Lake. Mean annual precipitation increases with elevation (the orographic effect); therefore, the mean annual precipitation at the project site should be higher than at any of the three regional stations.

Precipitation data collected at the project site is available for only the summer of 2005, and portions of the summer of 1996 and 1997. Although this is insufficient to directly determine the mean annual precipitation at the project site, it is possible to compare the recorded precipitation at the site for the periods of record, to the recorded precipitation at the regional stations for the same periods. Such a comparison indicates that monthly precipitation recorded at the site varies from 52% to 165% of precipitation recorded at regional stations. There is a weakly positive trend (higher precipitation at the project site than at regional stations) as might be expected because of the orographic effect; however, the data are too limited to provide definitive conclusions.

The Rainfall Atlas of Canada (Bruce 1968) and an Oregon State University reference for Yukon and Alaska[1] both indicate that mean annual precipitation at the project site is expected to be in the range of 500-600 mm. Mean annual precipitation at the project site has therefore been estimated at approximately 550 mm. As noted below, this estimated value is consistent with other observations.

2.1.2 Mean Monthly Precipitation

There are several scenarios whereby the precipitation at project site could be higher than at the regional stations. Precipitation could be higher evenly throughout the year, higher in winter but not in summer, higher in summer but not in winter, or higher at some times but not others in a manner that is more complex than a simple seasonal variation. Regional data indicate that the trend in increased precipitation with elevation is most

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[1] http://www.ocs.oregonstate.edu/pub/maps/Precipitation/Total/States/AK/ak_ppt.gif accessed August 15, 2005

pronounced in summer and is weak or nonexistent in winter. This supports the third scenario; that is, precipitation at the project site is higher than at the regional stations in summer, but similar to the regional stations during the winter.

When the regional data for summer precipitation is adjusted to account for increase elevation at the project site, the projected net summer precipitation at the site is roughly 25% higher than the regional summer mean, while the net winter precipitation remains similar to the regional winter mean. The results of this seasonal scaling are presented in Table 2.1. Additionally, the mean annual precipitation found by summing the mean monthly precipitation totals is 548 mm, essentially identical to the 550 mm estimate determined from regional precipitation mapping.

Table 2.1. Frequency Analysis of Monthly and Annual Precipitation at the Wolverine Project Site – Dry and Wet Years

Return period (years)	1 in 100 yr Dry	1 in 25 yr Dry	1 in 10 Yr Dry	Average Yr	1 in 10 Yr Wet	1 in 25 Yr Wet	1 in 100 Yr Wet	1 in 1000 Yr Wet	1 in 10000 Yr wet
Ratio of annual precipitation to mean annual[2]	0.509	0.639	0.74	1.00	1.255	1.344	1.451	1.595	1.75
Month									
Jan	18.3	23.0	26.6	36	45.2	48.4	52.2	57.4	63
Feb	14.3	17.9	20.7	28	35.1	37.6	40.6	44.6	49
Mar	10.7	13.4	15.5	21	26.4	28.2	30.5	33.5	36.8
April	10.2	12.8	14.8	20	25.1	26.9	29	31.9	35
May	24.4	30.7	35.5	48	60.2	64.5	69.6	76.6	84
Jun	35.1	44.1	51.1	69	86.6	92.7	100.1	110.0	120.8
July	41.7	52.4	60.7	82	102.9	110.2	119	130.8	143.5
Aug	31.6	39.6	45.9	62	77.8	83.3	90	98.9	108.5
Sept	29.0	36.4	42.2	57	71.5	76.6	82.7	90.9	99.8
Oct	22.9	28.8	33.3	45	56.5	60.5	65.3	71.8	78.8
Nov	20.4	25.6	29.6	40	50.2	53.8	58	63.8	70
Dec	20.4	25.6	29.6	40	50.2	53.8	58	63.8	70
Annual	278.9	350.1	405.5	548	687.7	736.5	795.1	874.1	959

2.1.3 Seasonal Precipitation Trends

As is shown in Table 2.1, mean monthly precipitation is greatest in July and lowest in April. Approximately 320 mm, or 58% of annual precipitation falls during the May-September period as rain or non-accumulating snow. Precipitation which falls between October and April forms the winter snow pack. When examining Table 2.1, note that a conversion factor of 10:1 (1 cm of snow = 1 mm of precipitation), as used by

[2] From Gartner Lee Ltd. (2004)

Atmospheric Environment Service, can be applied to estimate the snowfall in centimeters. For instance, the mean monthly precipitation at the project site for March is 21 mm. This is equivalent to 21 cm of snowfall.

The high summer precipitation and low winter precipitation characterize the continental climate of the southeastern Yukon. High pressure cells and cold temperatures dominate the winter months, leading to extended periods of low precipitation. In summer, thermal instabilities resulting from seasonal heating result in frequent convective storms (thunderstorms).

2.1.4 Annual and Monthly Precipitation

Gartner Lee Ltd. (2004) conducted a frequency analysis of the regional climate data in order to determine the variability of mean monthly and mean annual precipitation for a range of return periods. This frequency analysis determined the ratio of annual precipitation to mean annual precipitation that occurs for a given return period. For instance, precipitation in a 1-in-10 year wet year is approximately 25% greater than in a normal year. These ratios have been applied to the mean annual and monthly precipitation figures in Table 2.1 to provide estimates of monthly and annual precipitation for return periods ranging from a 1-in-100 dry year to a 1-in-10,000 year wet year.

2.1.5 Hourly and Daily Rainfall

Daily rainfall values over the period of record are available from the Watson Lake and Tuchitua regional stations. At Tuchitua, some periods of data are missing, but not enough to significantly affect the analysis. The Environment Canada program Consolidated Frequency Analysis (CFA) was used to conduct a frequency analysis by fitting the data to several statistical distributions. The daily rainfall records were determined by the program to be strongly bimodal[3]; therefore, the Wakeby and nonparametric distributions were chosen to fit to the data as they provide better fits to bimodal distributions than do distributions such as Generalized Extreme Value or triple-lognormal. Both Wakeby and nonparametric distributions gave similar goodness of fits for the two stations. The results from the two were therefore averaged to estimate maximum daily (24-hour) rainfall intensities for various return periods.

Regional one-hour rainfall intensities for a range of return periods were calculated using data from the maps in the Rainfall Atlas of Canada (Bruce, 1968) and the equations given in Alila (2000).

As neither one-hour nor 24-hour rainfall intensity vary significantly with elevation over the regional scale, these calculations should be representative of the expected maximum rainfall for the given durations and return periods at the project site and do not need to be corrected for the location of the project site relative to regional climate stations. Expected one-hour and 24-hour rainfall values are presented in Figure 2.1.

[3] The cause of the bimodality in the data was not determined and is not directly relevant in any case. It could result from El Nino vs. non-El Nino years, from a difference in precipitation between cyclonic storms and convective storms, or for other reasons.

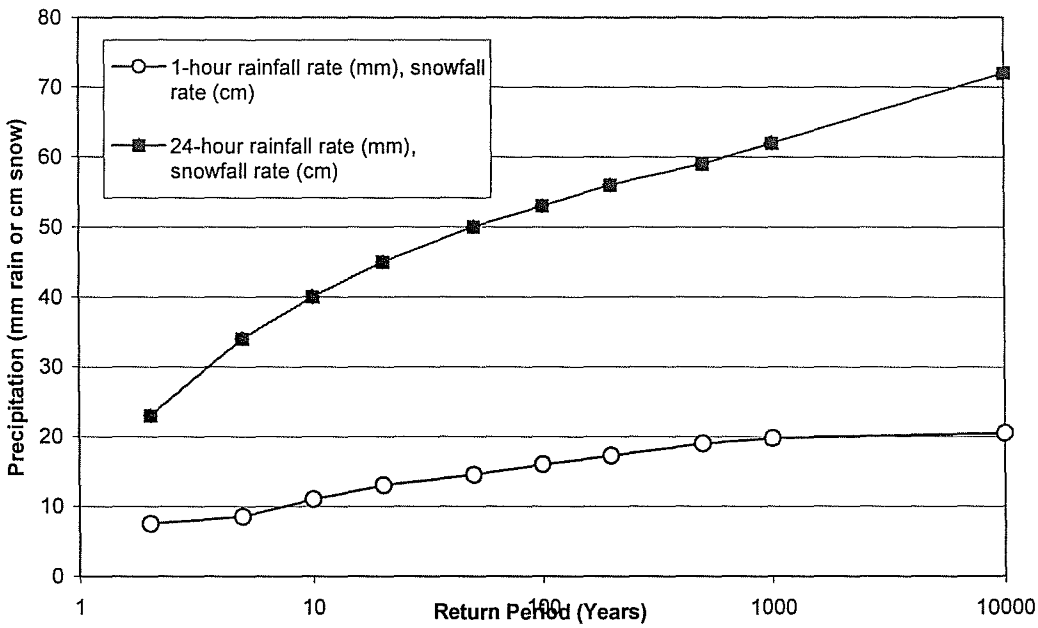


Figure 2.1. Hourly and Daily Extreme Precipitation - Wolverine Project Site

2.1.6 Hourly and Daily Snowfall

Because there are gaps in the daily data for winter precipitation at the regional stations, the 24-hour snowfall cannot be accurately determined using the frequency analysis method used for rainfall. No on-site data has been collected for daily or hourly snowfall values at the project site. Because net summer precipitation (rainfall) is greater than net winter precipitation, conversion of the 24-hour and daily rainfall values will provide a conservative estimate (overestimate) of extreme snowfall events. However, in the absence of other data, the values given for millimeters of rainfall in Figure 2.1 can be converted to centimeters to provide a conservative estimate of daily and hourly snowfall for various return periods.

Snowpack accumulates from October through March at the project site. Snow may fall in other months of the year but mean temperatures are high enough to ensure that snowfall will melt rather than accumulate.

Fresh snow in cold climates is dry and light. If melted, one centimeter of fresh snow produces only one millimeter of water – a 10:1 snow water equivalent. Snow on the ground undergoes changes as it ages. It is compacted by wind and by further snowfall on top of it. Warming and cooling cycles promote changes in snow crystal form, changing the snow from flakes to granules that pack more tightly. The snow water equivalent of old snow is approximately 5:1 (McClung and Schaerer, 1993).

Few measurements of snow water equivalent have been made at the project site. Anecdotal reports from workers overwintering at the site report a maximum snow depth of approximately 1 m at undrifted locations. One onsite measurement, in early March

1997, found a snow water equivalent of 128 mm but did not record an associated snowpack depth. The peak snowpack in the average year will occur in late March or early April, immediately before spring warming begins.

Yukon Government snow surveys for the Liard Basin[4] indicate that mean annual snowpack in the Liard Basin is in the range of 150 to 175 mm snow water equivalent. Using the 5:1 conversion factor for old snow, this would be equivalent to a snowpack depth of 0.75 m to 0.88 m. However, because little total precipitation occurs in late March and April, the snowpack may continue to age and consolidate through this period with few inputs. In this case, the peak snowpack depth would not necessarily occur at the same time as the peak snow water equivalent, but rather earlier in the winter, when the snow water equivalent would have a value between the 10:1 value for new snow and the 5:1 value for old snow. This suggests that the mean annual peak snowpack depth at the project site is probably 1.0 m or greater.

Some snow on the ground melts as a result of heating from below, even in cold climates. Additionally, some snow in the upper snowpack sublimates (evaporates) and returns to the atmosphere as water vapour. For these reasons, the net snow water equivalent of the snowpack throughout the season is lower than the sum of the snowfalls that have occurred. Mean winter precipitation (October-April) from Table 7.1-3 totals 230 mm. This indicates that approximately two-thirds to three-quarters of the winter precipitation accumulates, while approximately one-third to one-quarter is lost to melt or sublimation during the winter.

To estimate the expected snow water equivalent under conditions from a 1-in-1,000 year dry year to a 1-in-10,000 year wet year, the regional frequency analysis of annual precipitation (Gartner Lee Ltd. 2004) was applied to snowpack depth and snow water equivalent. The results are given in Table 2.2. It should be noted that the maximum snow water equivalent would occur later in the year in the case of a wet year, and earlier in the year in the case of a dry year. Cold temperatures and heavy snowfall both contribute to increased snowpack and snow water equivalent. Therefore, it should be expected that the extreme dry year snowpacks are a result of both light precipitation and warm temperatures. In dry years the snowpack will reach maximum snow water equivalent early in the year (e.g., early March) and could melt away as soon as early May. Extreme wet year snowpacks are the result of heavy winter precipitation and cold spring temperatures which delay melt. These deep snowpacks could peak in late May and continue to melt through July and even into August.

[4] http://www.environmentyukon.gov.yk.ca/pdf/water_forcast(1).pdf accessed August 25, 2005

Table 2.2. Frequency Analysis of Winter Snowpack

Return Period	Mean Precipitation Ratio[5]	Maximum snowpack water equivalent (low)	Maximum snowpack water equivalent (high)
(year)		(mm)	(mm)
1000 year dry	0.327	49.1	57.2
100 year dry	0.509	76.4	89.1
25 year dry	0.639	95.9	111.8
10 year dry	0.74	111	129.5
Average year	1.00	150	175
10 year wet	1.255	188.3	219.6
25 year wet	1.344	201.6	235.2
100 year wet	1.451	217.7	253.9
1000 year wet	1.595	239.3	279.1
10000 year wet	1.75	262.5	306.3

3 Water Management Infrastructure Details

Water management activities for the test mining program consist of two components:

1) water use and collection of groundwater in the underground workings
2) collection of surface runoff from the temporary waste rock facility

As outlined in Water Licence QZ01-051, no waste discharge shall exceed the following limits summarized in Table 3.1.

Table 3.1. B Licence Maximum Authorized Concentration Grab Sample Discharge Quality Criteria

Parameter	Limit
Arsenic	0.10 mg/l
Cadmium	0.02 mg/l
Copper	0.20 mg/l
Lead	0.20 mg/l
Nickel	0.50 mg/l
Zinc	0.50 mg/l
TSS	15 mg/l
Ammonia	2.5 mg/l
Selenium	0.015 mg/l

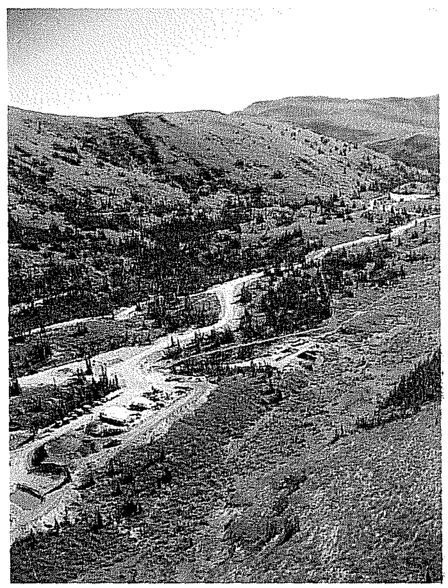
[5] Gartner Lee Ltd. (2004)

A discharge must also meet a fish bioassay standard. The methodology for conducting fish bioassays will follow Environment Canada Method EPS 1/RM/13 for a 96 hour LC_{50}.

3.1 Portal Sumps

The location of infrastructure required to manage water from the portal area is shown in Picture 3.1 and drawings provided in Appendix A (based on surveys conducted at the end of the test mine program). The clean and dirty water surface sumps as-built drawing is included in Appendix B. The clean and dirty sump volumes are 285 m^3 and 308 m^3, respectively.

Picture 3.1. Portal Infrastructure (Sept. 19, 2005).



Picture 3.2. Sump water pipeline and discharge route (green line) to bladder (green square) and receiving end point at Wedge Pond (red circle)

The 2005 portal development activities commenced in the spring and continued until mid November. The underground discharge is pumped into the Dirty Sump (DWS) and the overflow from the DWS flows to the Clean Sump (CWS). Drainage from the temporary stockpile outside the portal is also directed to the dirty sump. The two sumps are constructed to allow for the settling and treatment of the test mine discharge. The dual sump arrangement allows for the control of water movement between sumps and for sump cleaning. Drill water was pumped from the well at Wolverine Creek, or from the CWS, depending on sump water volume and quality.

A third sump, the treatment sump, was constructed in late summer to provide additional retention time for settling and storage capacity (123 m^3).

3.2 Waste Rock Storage Facility

Infrastructure at the temporary waste rock pad is shown in Picture 3.3 and drawings provided in Appendix A. The waste rock pad as-built drawing is included in Appendix B.

Picture 3.3. Waste Rock Pad and Collection Sump (Sept. 19, 2005)

A collection sump located at the southern end of the pad collects drainage from the pad. Based on the average daily flow, the collection sump was originally designed with a capacity of 24 m^3, but was enlarged during construction to accommodate 195.6 m^3. Ditches and berms have been constructed to collect surface runoff and/or direct it away from the pad. The sump was constructed from local compacted till and lined with Enviro Liner®.

4 Water Treatment

A conceptual water treatment process was developed in 2004 for the treatment of mine water and waste rock dump seepage. Chemistry data from the "Humidity cell waste water characterization test work" was used to develop a process flow sheet and mass balance. The water treatment process was designed using theoretical values obtained from the chemistry model, mainly based on data from the humidity cells, and it was highly recommended that a pilot plant test or at least a bench scale test be conducted to obtain reliable data. Water samples were collected throughout the summer to provide actual chemical characterization of the water in both the sumps and the underground (groundwater).

4.1 Groundwater Inflow Rate and Quality

The permeability (*i.e.* hydraulic conductivity) of the rock at the mine site was measured in two deep exploration boreholes by Gartner Lee Ltd. The hydraulic conductivity values measured in the test intervals ranged from 1.7 x 10^{-7} cm/s to 1.8 x 10^{-4} cm/s. The rate of groundwater flow into the mine was estimated using several analytical methods. An analytical equation developed by Goodman et al. (1965) estimated inflow rates of at least 10 L/s (36.0 m^3/hr) following development of 300 m of mine drift. Development of conceptual hydrogeologic flow nets and assessment of dewatering data collected during initial advancement of a test mining decline confirmed that a groundwater inflow rate of at least 10 L/s should be expected during mine development and operation with a resultant radius of a groundwater cone of depression extending up to 1 km from the perimeter of the mine.

Inflow rates may be higher immediately following excavation and should decrease with time as the saturated rock above the mine is drained. After the rock above the mine is drained and a cone of depression (i.e., lowered groundwater table) will develop around the dewatered mine area and infiltration from precipitation and lateral ground water flow will continue to provide inflow to the mine workings. The minimum rate of mine water inflow from precipitation infiltration is estimated to be about 7 L/s (25.2 m^3/hr) based on an infiltration rate of 40% over the dewatered catchment area using an average annual precipitation of 479 mm. Inflows encountered during ongoing test mining can be used to calibrate these initial inflow calculations.

During any closure phase of the mine and cessation of mine dewatering, the mine will flood and groundwater levels are expected to return to near pre-mining conditions. It is unlikely that the mine will decant as the portal entrance is the highest point of the mine.

Groundwater samples were collected from two exploration boreholes at depths up to 150 m below ground surface during the in-situ bedrock permeability-testing program (discussed in Section 7.6.2). In addition, groundwater samples were collected during advancement of the decline to establish background groundwater quality. The results indicate that baseline groundwater quality is relatively dilute with conductivity values of 145 to 389 μS/cm and neutral pH values of 7.7 to 8.2. Dissolved trace metals with elevated baseline concentrations in groundwater include selenium, lead, zinc, cadmium and copper.

During test mining samples of mine dewatering water (*i.e.* groundwater mixed with drill water, explosives residue, drill waste *etc.*) have been collected in a 'dirty' sump. Its average chemical composition is shown in Table 4.1. Although the initial pH was very high, it is expected to drop to pH ~8 once the water is in equilibrium with the atmosphere. Apart from high nitrate and ammonia concentrations, the mine water (as observed in the 'dirty' sump in July and August 2005) is also characterized by high dissolved selenium and antimony concentrations.

Table 4.1. Average Chemical Composition of Mine Water (July and August).

Dissolved Metals (mg/L)		Physical Parameters		
Ag	**0.00005**			
Al	0.415	pH	11.40	units
As	0.001	Conductivity	626	uS/cm
Ba	0.08			
Be	**0.0001**	Alkalinity	102	mg/L as $CaCO_3$
B	0.1	Hardness	151	mg/L as $CaCO_3$
Bi	**0.025**			
Ca	59.2	NO_3	8.74	mg/L as N
Cd	**0.00005**	SO_4	106	mg/L
Co	**0.00025**	NH_3+NH_4	3.66	mg/L as N
Cr	0.013			
Cu	**0.0025**	Thiosalts	**1**	mg/L as S_2O_3
Fe	0.82	CN(T)	0	mg/L
Hg	**0.000025**	CNO	0	mg/L
K	11.6	CNS	0	mg/L
Li	**0.005**			
Mg	0.51			
Mn	**0.0005**			
Mo	0.013			
Na	53.1			
Ni	**0.004**			
P	**0.05**			
Pb	**0.00025**			
Sb	0.0322			
Se	0.006			
Si	15.3			
Sn	**0.01**			
Sr	0.253			
Ti	**0.0015**			
Tl	**0.00005**			
U	**0.00005**			
V	0.016			
Zn	**0.0025**			

4.2 *Revised Water Quality Model*

Following the commencement of the test mining program, discharges from all pertinent sources were collected and subjected to analytical tests to determine the contaminants of concern. Based on the initial interpretation by consultants retained by YZC, the underground water being discharged to the surface sumps was considered to be 'too clean' to be representative the water quality anticipated from underground dewatering. Part of the reason was that the underground development had not yet encountered the ore. Initial contaminants of concern were total suspended solids (TSS) and ammonia. Based on the initial results, Canadian Environmental and Metallurgical Inc. in conjunction with Zamtan Management Inc, conducted several pilot tests to determine the necessary steps to deal with TSS as described below.

4.2.1 Coagulant and Flocculant Addition

To meet Section 41 of the Type B Water License requirements for discharge, Yukon Zinc Corporation (YZC) sampled the DWS to determine the supernatant water quality. The water samples taken at the dirty pump were analyzed for metals, anions, nitrogen species, total dissolved solids (TDS), and TSS. Field monitoring includes TDS, water temperature, conductivity and field pH on a regular basis. The field pH fluctuates between 7.8 and 11.8 and 10 out of 14 measurements are above pH 9. The source of the buffer was shotcrete, used as part of the ground control program. Shotcrete adds high alkalinity to the water being pumped to the dirty pond. The water quality data indicated that while the metals concentration is within the discharge criteria for the water sample analyzed, the ammonia and TSS concentrations are above the allowable discharge limits.

Series of bench scale tests were conducted to determine the reagents that may lower the TSS using the water samples delivered to CEMI on July 25, 2005 (samples taken on July 21, 2005). The water sample was from the DWS near the discharge valve, and at the time was deemed to be representative of the water coming from underground at the current time (test mine not within the ore). The initial testing did indicate that it is possible to drop the TSS within 10 minutes to approximately 10 mg/L using a combination of coagulant and flocculent and the concentration should be significantly less with a longer retention time of more than 10 minutes. The coagulant application rate – dosage may change with a change in the water chemistry as expected in the future.

The bench scale tests indicated that coagulant Ipafloc 16 will be required along with flocculant Powerfloc 163; both reagents are carried by Power Chemicals Ltd. The treatment system is designed for TSS removal only for the present scope with meeting a target concentration of 15 mg/L or less. The coagulant side of the process requires the following components: mixing tank and a metering pump to control dose rate.

The coagulant was added directly to the mix tank using a metering pump to control the dose rate. The dosing rate of the coagulant was determined to be approximately 20 mg/L for the sample tested and this can vary widely depending on the influent quality. The floc solution is highly concentrated and will have to be diluted onsite in a 45gallon drum at

0.20% solution (approximately 0.41 litres for every 205 litres). The floc will be added with a 2 to 2.5 minute retention time to allow the fine TSS to settle.

Once the underground development was in ore (mid September), the water quality decreased and additional contaminants of concern included zinc and selenium. The treatment method will be a function of the source water quality, as well as the best practical and economical effluent process technology available.

4.2.2 Ongoing Testwork and Water Treatment Plant Design

It is assumed that the most recent water samples collected in October and November are the most representative, as the underground development was within the ore for approximately one month prior to sampling. It should be noted that all subsequent development will follow the ore. Therefore, this data and subsequent water quality model will account for metal release from the ore.

To determine the water treatment process effectiveness, CEMI is conducting bench scale tests on water samples collected from the underground sump at the end of the test mining program (within the ore body), and will construct a humidity cell in order to collect leachate solution to carry out exp

Outlined below is the experimental framework needed to get the level of process certainty to design a water treatment plant. To develop a representative WTP flow sheet, bench scale testing is key to producing a low risk water treatment system. The bench scale testing would provide initial effluent water quality and preliminary data for conceptual engineering design of the WTP. Two HDS bench scale test will be conducted to cover the range of expected drainage from neutral to worst case.

4.3 Water Treatment Plant

For the water treatment a number of alternative methods were considered including High Density Sludge (HDS), lime neutralization, reverse osmosis, activated silica gel, biological treatment and activated carbon. The HDS method was selected because it is robust, it is reasonably affordable, has minimal sludge production with near stable sludge quality and is easy to fine tune once constructed.

The effective removal of base metals in a chemically stable form in the HDS process is primarily the result of the formation of co-precipitates with iron on the surfaces of the recycled sludge particles. A high iron to total metals ratio in the treatment plant feed is sought to provide for chemical stability of the precipitates. In all cases, the oxidation of ferrous iron to ferric iron is the principal oxygen-consuming reaction; oxygen transfer into solution is controlling the reaction rate and hence the reactor tank sizing. The rate of oxygen transfer is often the dominant factor in agitator design.

The products of the neutralization reactions are metal hydroxide precipitates ($M(OH)_2$ or $(M(OH)_3)$) and gypsum ($CaSO_4$ $2H_2O$). The primary equipment and processes steps required for HDS water treatment facility can be summarized as follows. Lime and recycled sludge are added to the lime-sludge mix tank at the head of the process, providing the main neutralization agent. This mixture is discharged to the lime/sludge tank where it is mixed with influent, thereby achieving neutralization. Iron salts are typically added to the influent to achieve the required iron to metals ratio. The lime/sludge mixture is fed to the main Lime Reactor 1 and Lime Reactor 2 where a combination of aggressive aeration and high shear agitation ensures optimum process chemistry and subsequent clarifier performance. The discharge from the lime reactors is treated with flocculent. In the final step, the clarifier separates the treated effluent from the sludge; a portion of the sludge is recycled to the head of the process. The HDS process is operated most effectively at a pH between 9.0 and 9.5; the operating pH for Wolverine Project will be set at pH 9.5, as most metals encountered will precipitate at or below this concentration of hydroxide ions. Oxidation of ferrous to ferric takes place rapidly at this pH, with air being the most common oxidizing agent.

The WTP will treat waste rock stockpile seepage and underground mine water to meet the B Licence discharge criteria. It is proposed to mount the WTP on skids so that it can be moved to either location.

A number of proven technologies exist to treat ammonia and these include the following: (1) natural degradation; (2) air stripping; (3) steam Stripping; (4) biological nitrification – denitrification; (5) break-point chlorination; (6) ion Exchange; and, (7) reverse osmosis.

Natural degradation is one of the most widely used methods in the mining industry and it is proposed for the Wolverine Project. Natural degradation of ammonia involves the transpiration of dissolved ammonia gas from wastewaters by retaining wastewaters in holding ponds. Ammonia removal by natural degradation is influenced a number of factors including:

- pond conditions (surface area, depth, turbidity, turbulence, ice cover, and retention time;
- effluent pH >8,
- concentration and temperature; and
- aeration.

Selenium can also be removed successfully in a lime treatment system as experienced at number of sites in British Columbia. However, in cases where a high degree of oxidation is expected a secondary process may be installed to meet the discharge criteria. The higher oxidation state of selenium prevents the precipitation and typically requires a reduction step in order to precipitate the selenium. There are other techniques such as biological treatment, chemical reducing using reagents, ion absorption resins, and most recently the development of Activated Silica Gel. The Silica Gel technology is capable of removing selenium to concentration of less than 1 ppb.

4.4 Sediment and Sludge Management

To date, in the absence of a water treatment plant, there has been no sludge generated during the test mining program. The portal sumps have been used to collect the fine fraction of the waste development rock that gets transported from the underground to the surface during dewatering. In order to maintain capacity, the dirty sump water was drained into the clean sump in early August, and the sediment was removed and placed on the waste rock pad with the coarse fraction.

Based on the conceptual water treatment plant input parameters detailed in Application submission the sludge will constitute 91.04% TSS and less than 8.96% of metal hydroxides. Therefore, it will be essential to remove the TSS before the effluent is treated through the WTP. The TSS (sediment) can then be disposed of separately from the waste products (sludge) from the WTP.

Sludge management will be part of the waste treatment system. The simple neutralization process currently being tested will likely produce low density metal hydroxide precipitate.

The amount of sludge anticipated to be generated during pilot testing of the water treatment plant is unlikely to be an adequate volume to allow for the determination of sludge quality and the testing of sludge stability. Recognizing that several thousand liters of sump water would be required to adequately conduct the stability tests, YZC proposes to continually characterize and monitor inputs to the water treatment plant for future sludge management. The settled sludge will be filtered, dried and weighed to determine sludge generation. The sludge will be subjected to TCLP procedure to determine whether it is hazardous or not. Based on the TCLP results, a sludge management plan will be developed. As the volume of sludge from the water treatment is likely to be a small volume, YZC proposes to stabilize the sludge through the addition of cement (likely 5-10% by volume) and place it underground during backfilling.

4.5 Winter operation

During advanced exploration, water quality will be monitored from all point sources to determine the need to treat the discharges. The water quality data together with mine rock geochemistry and hydrological and hydrogeological data will be used to predict the long-term water chemistry. Further details are provided in the Temporary Closure Plan.

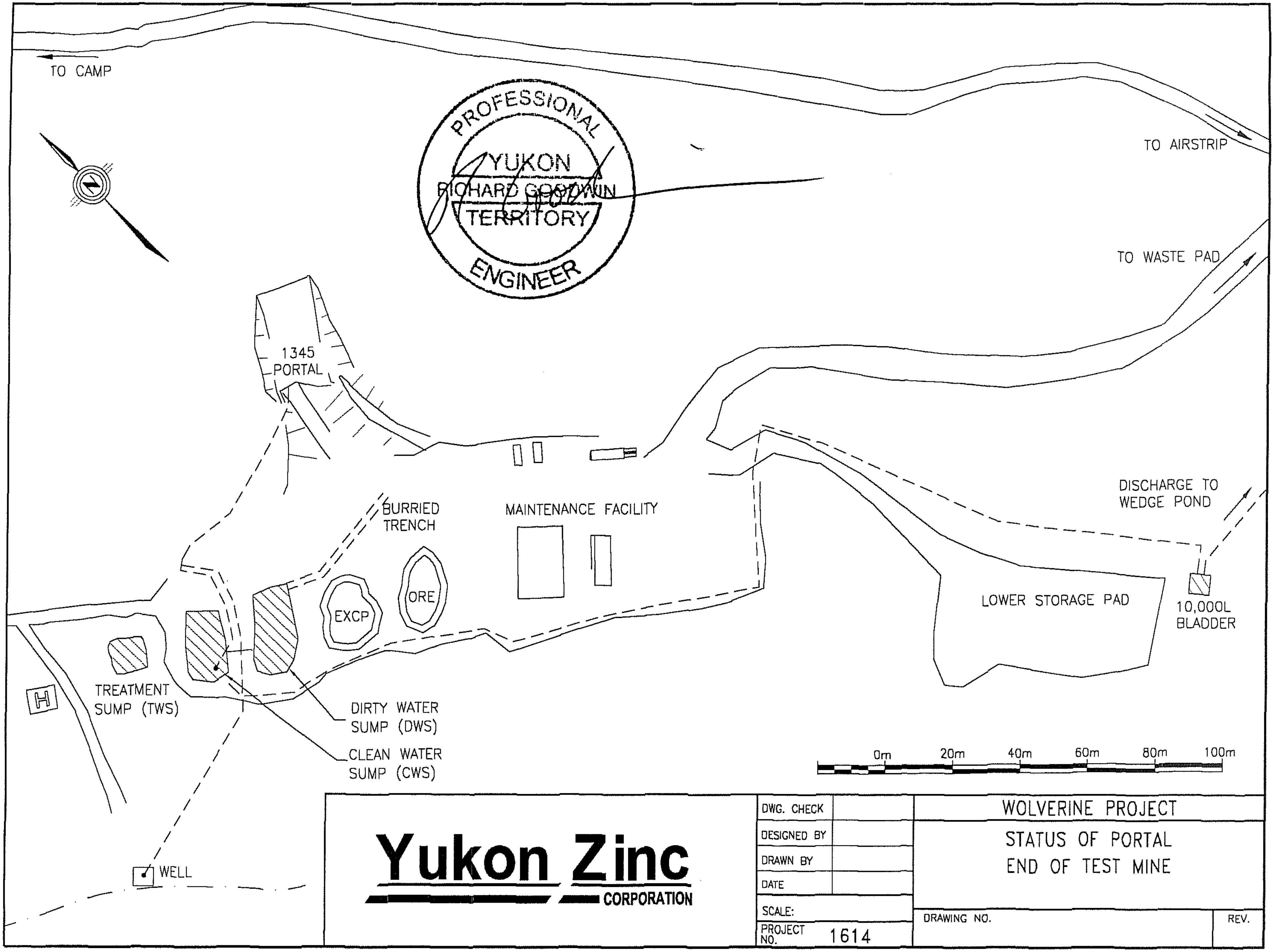
5 Further Requirements

Following the completion of the bench scale and pilot testing and the generation of the revised water quality model, a report will be submitted that includes all testwork analytical results and final WTP design. Testing and design work is anticipated to be completed in February 2006. As per Condition 55, a water treatment plant operating manual will be developed upon finalization of the water treatment plant design. The water treatment plant will be operational prior to spring freshet and the commencement of onsite activities. As per Condition 56, a final plan for treatment sludge stabilization and disposal plan will be prepared once there is an adequate amount of sludge to test.

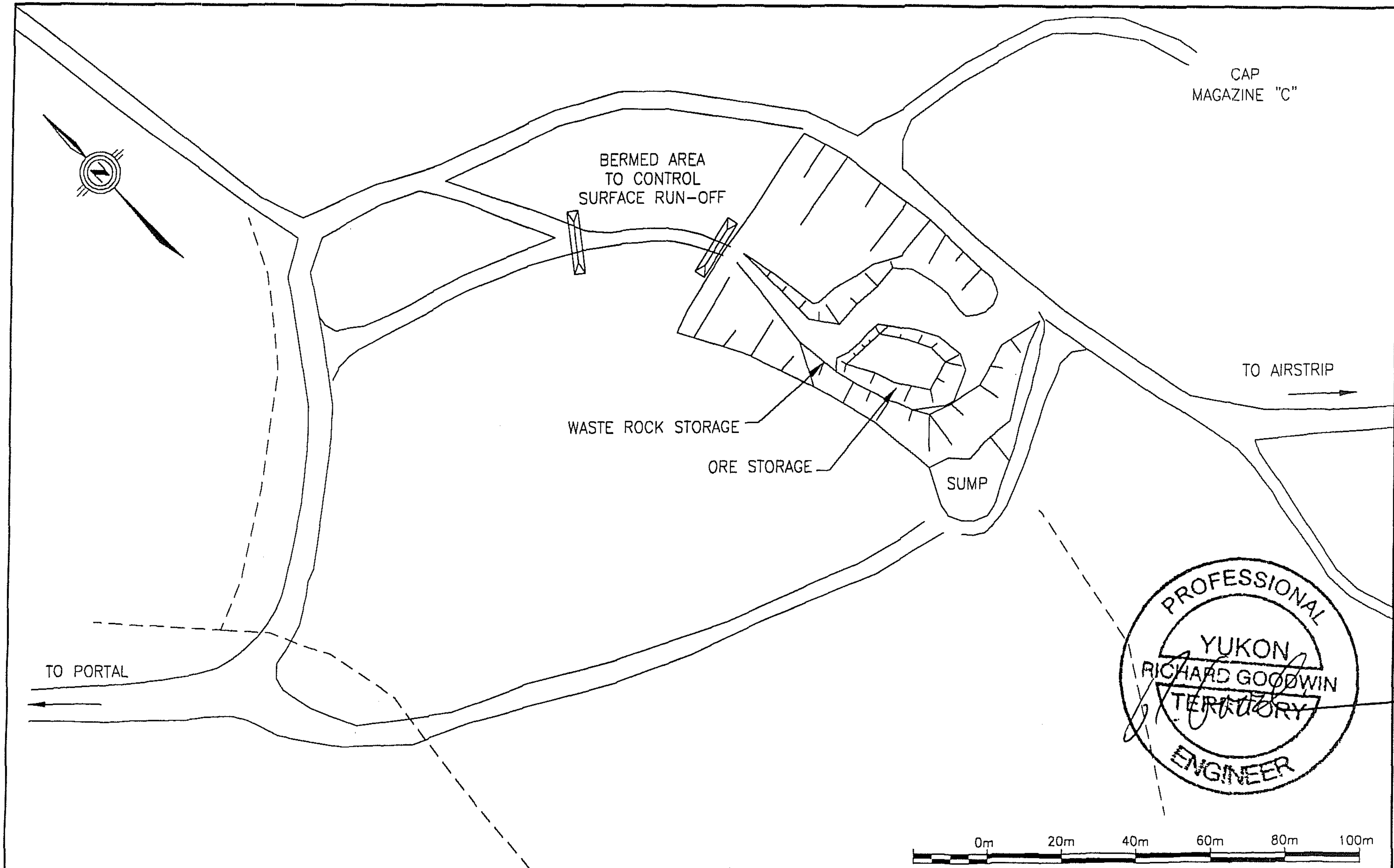
Appendix A

Portal Infrastructure and Waste Rock Pad Drawings

(based on surveys conducted at end of the test mine program)



TO CAMP
TO AIRSTRIP
TO WASTE PAD
PROFESSIONAL
YUKON
RICHARD GOODWIN
TERRITORY
ENGINEER
1345
PORTAL
BURRIED
TRENCH
MAINTENANCE FACILITY
DISCHARGE TO
WEDGE POND
LOWER STORAGE PAD
10,000L
BLADDER
EXCP
ORE
TREATMENT
SUMP (TWS)
DIRTY WATER
SUMP (DWS)
CLEAN WATER
SUMP (CWS)
H
WELL
0m
20m
40m
60m
80m
100m
Yukon Zinc
CORPORATION
DWG. CHECK
DESIGNED BY
DRAWN BY
DATE
SCALE:
PROJECT NO. 1614
WOLVERINE PROJECT
STATUS OF PORTAL
END OF TEST MINE
DRAWING NO.
REV.



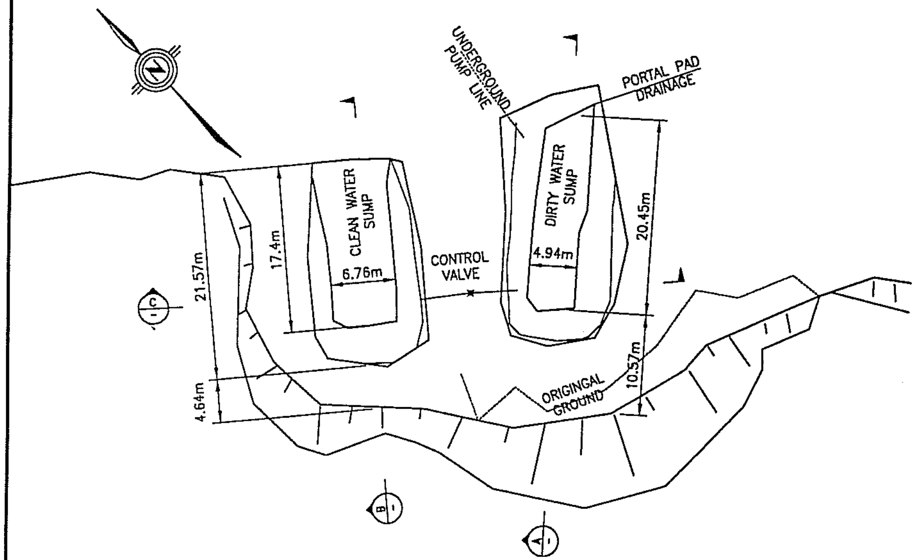
Yukon Zinc
CORPORATION

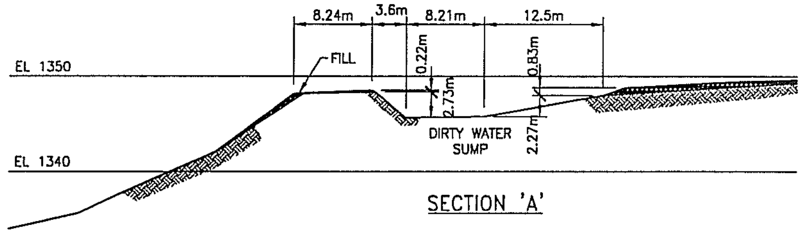
DWG. CHECK		WOLVERINE MINE PROJECT
DESIGNED BY		STATUS OF WASTE ROCK PAD END OF TEST MINE
DRAWN BY		
DATE		
SCALE:		DRAWING NO. / REV.
PROJECT NO.	1614	

Appendix B

Clean and Dirty Water Sump As-built Drawing

Waste Rock Pad As-built Drawing





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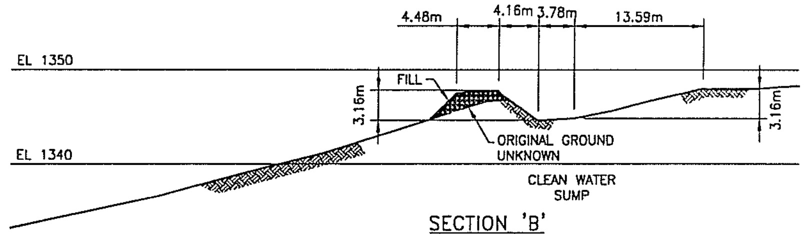

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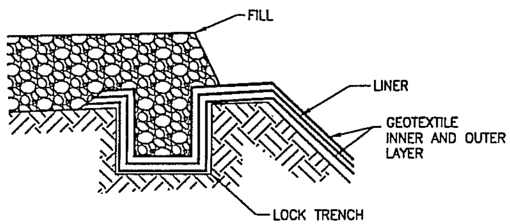
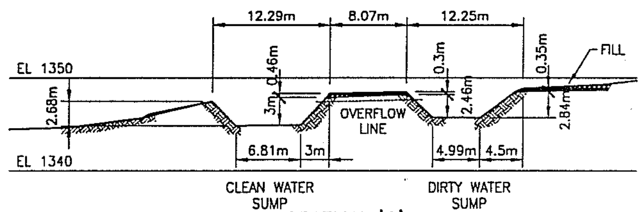


TYPICAL LINER ANCHOR DETAIL



SECTION 'C'

PROFESSIONAL ENGINEER
YUKON TERRITORY
RICHARD GOODWIN

Aug 05/05

REV.	REVISION DESCRIPTION	DATE	BY	APP'D

Yukon Zinc CORPORATION

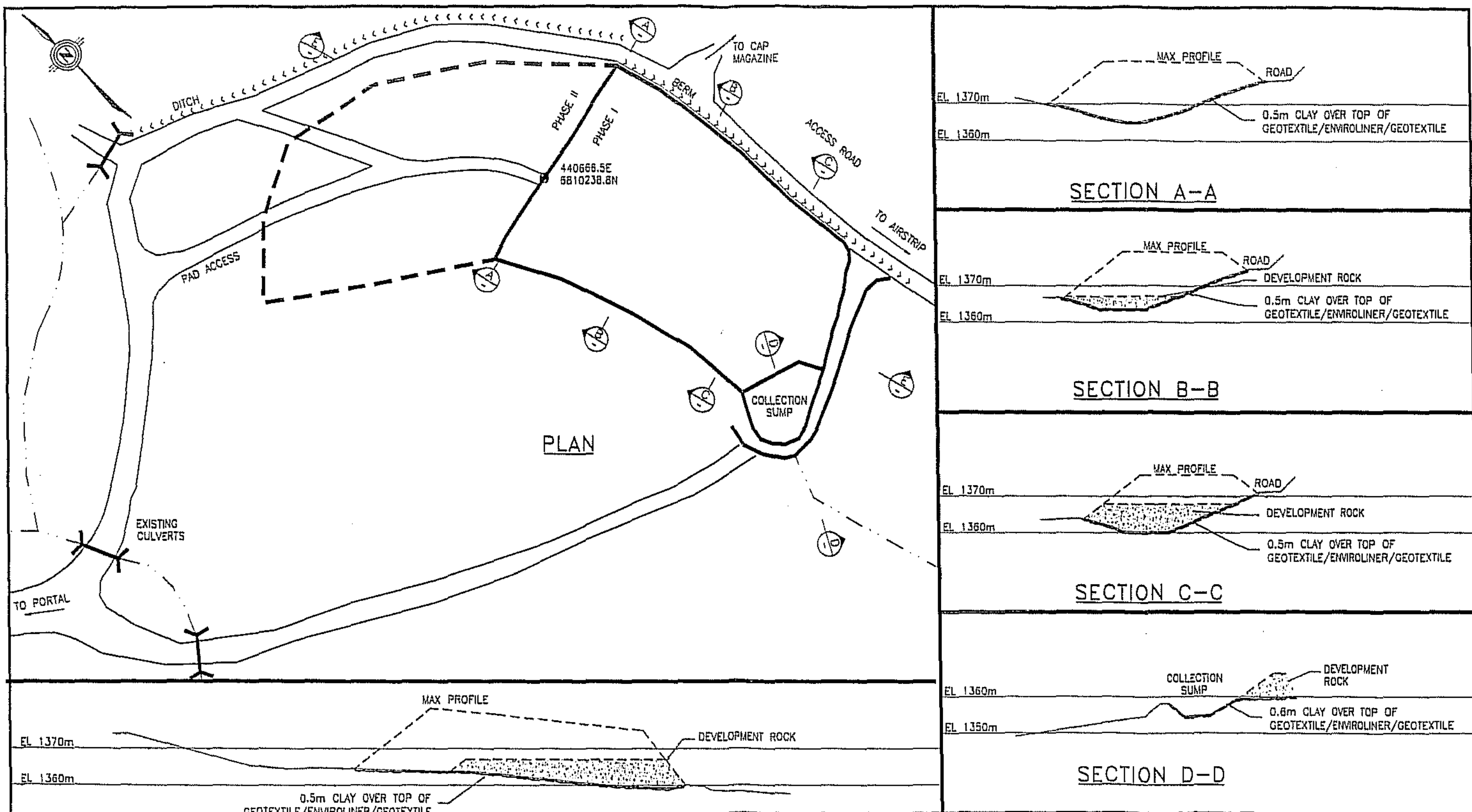
DESIGNED BY	RMO	
DWG. CHECK		
DRAWN BY	RMO	05/08/04
SCALE: 1:500		
PROJECT NO. 1614		

WOLVERINE PROJECT

CLEAN AND DIRTY WATER SURFACE SUMPS ASBUILTS

DRAWING NO. 1614-C-018

REV. A



LONG SECTION E–E

File Name: 1614	
Projection: UTM Zone 9, NAD 27	Date: Oct 13, 2005
Scale: NTS	Prepared By:
Data Sources: Yukon Zinc Corporation	

Yukon Zinc Corporation

Wolverine Project

Figure 2.7-1 WASTE ROCK PAD PLAN AND CROSS-SECTION