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Memorandum

To: Elsa Reclamation and Development Company Ltd.

From: Karl Reimer

Date: November 15, 2013

Re: Summary of existing hydrogeological information in the Keno District 2013 site investigation.

1 Overview of Existing Hydrogeological Investigations

There have been several groundwater investigations conducted in the Keno District. These investigations are summarized in the following documents consisting of reports, maps, and borehole logs:

- Interralogic Inc. Technical Memorandum Update: Keno City Groundwater Evaluation, (March 2012)
- SRK Consulting 2010 Bellekeno Groundwater Program (SRK, 2010)
- SRK Consulting 2008 Technical Memorandum Assessment of Groundwater Regime at the Valley Tailings Facility (SRK, 2009)
- Map of Keno Basin Groundwater Monitoring Station Locations (Figure 1 in Appendix D)
- Water Quality Results (September/October results)

The following information is being developed and will be available for the recently installed groundwater wells:

- Site plans for each discharging mine site, showing wells, surface water sample locations, mine workings.
- 2013 Borehole Logs from 2013 installed wells.
- Slug Testing Results from 2013 installed wells.

1.1 KENO CITY AREA INVESTIGATION (INTERRALOGIC, 2012)

Interralogic (March 2012) was commissioned to investigate the Keno City area groundwater to determine where flow from Onek adit, which was known to infiltrate into the subsurface, may have contaminated groundwater. The following bullets summarize the study design and results.

- Geographic area of study:
  - Keno City, Onek Mine
- Number of wells:
  - 5 private wells (4 private, 1 municipal)
    - VanSut;
    - Café;
    - Hotel Well
    - Fire hall
  - 5 monitoring wells installed in Keno City 2011
    - MW-1A;
    - MW-1B;
    - MW-2;
    - MW-3; and
    - MW-4
  - Onek Monitoring Well
    - ONEK monitoring well
- Surface water Sampling Locations
  - 2 locations
    - KV-41 (Lightning Creek)
    - KV-45 (Onek Adit)
    - Backhoe trenches downgradient of Onek adit
- Findings/Conclusions:
  - Groundwater flow (determined from 8 wells) - Table 3 and Figures 4 and 5
    - Convergence of southwest and northward flow below central Keno City
    - High permeable feature in groundwater below Keno City maybe a buried glacial valley/fracture bedrock zone
    - Groundwater reports to surface at Lightning Creek east of Keno City
  - From the perspective of the Onek 400 portal, groundwater flow is generally southwest towards high permeability feature but not towards Keno City water domestic/municipal supply wells
  - Groundwater impacts from sampling are shown in Table 5
    - Cadmium and zinc in groundwater are considered to be from historic mining activities, specifically the Onek 400 adit and may be other in place vein materials or waste materials in the adit area.

   - Groundwater/Surface water interaction at Onek 400 - appears that Onek 400 discharge is infiltrating to groundwater close to Onek adit. Evidence of this is high zinc (Zn) and cadmium (Cd) concentrations in MW-3 (overburden well located immediately west of adit portal), and lack of flow in the channel downgradient of this adit within 200 meters of the adit discharge location.
   - Onek 400 adit does not appear to be impacting Firehall well, the current Keno City water supply. In the current flow regime, it appears unlikely that the Firehall well is threatened by the discharge from the Onek 400 adit.

This technical memo is included in Appendix A.

1.2 KENO CITY AND BELLEKENO MILL AREA GROUNDWATER INVESTIGATION (SRK CONSULTING, 2010)

As part of the permitting process for the Bellekeno Mine, a limited groundwater investigation was undertaken in the area around the (at that time) proposed District Mill. The following bullets summarizes the study design and results.

- Geographic area of study:
   - Flame and Moth (Bellekeno Mill and Dry Stack Tailings Facility) – Keno City Area
- Number of monitoring wells installed:
   - 3 monitoring wells:
      - PH2;
      - PH5; and
      - PH6
- Number of Wells relied upon for study:
   - 4 consisting of:
      - PH2
      - PH5
      - PH6 and
      - Well#3 (in Keno City)
- Total number of streams evaluated (as head boundaries for potential effect areas)
   - One:
      - Lightning Creek – not gauged, but discussed hypothetically as effecting control on groundwater flow downstream
      - Hypothesize that impacts to Lightning Creek from the district mill are unlikely
- Conclusions/Findings
   - Higher concentrations of chloride, sulphate and zinc at PH6 over PH5
   - PH6 is located in close proximity to Flame and Moth vein fault
   - Likely to be minor impacts to groundwater if any, from the district mill activities
   - The DSTF will have underdrains and diversion ditches, and graded to drain to the mill pond making it unlikely to affect groundwater.

- Risk to Keno City groundwater is considered negligible based on groundwater flow being away from Keno City
- Provides recommendations for ongoing groundwater monitoring for flow and quality in the District Mill area.

The report is included in Appendix B.

1.3 VALLEY TAILINGS AREA GROUNDWATER INVESTIGATION

SRK (2008) performed an analysis of groundwater impacts and flow patterns around the Valley Tailings Facility. The following bullets summarizes the study design and results.

- Geographic area of study
  - Valley Tailings Facility – Upper Flat Creek valley
- Number of wells installed
  - 12 monitoring wells advanced consisting of:
    - Six at upstream/downstream crests of Dams 1, 2 and 3 (5 locations were completed with thermistors to monitor thermal conditions in the vicinity of the dams
    - Six within the tailings deposit (consisting of 3 deep and 3 shallow pairs)
- Total number of wells relied upon in the study to draw conclusions
  - 12 consisting of:
    - H2
    - H3 (shallow and deep)
    - H4 (shallow and deep)
    - H5 (shallow and deep)
    - H6 (shallow and deep)
- Surface streams evaluated (as head boundaries or for potential effect areas)
  - None
- Study conclusions included the following:
  - A low hydraulic gradient exists in the groundwater under the Valley Tailings
  - Peat is present across the area, and is considered to be a geochemical filter to impede metal migration
  - Hydraulic conductivity was determined by using grain size, groundwater flux of 18m^3/day was determined migrating under dam3 (flux sensitive to hydraulic conductivity)

The report is included in Appendix C.

2 KENO DISTRICT SITE WIDE GROUNDWATER MONITORING PROGRAM (2013)

This current groundwater monitoring program has been initiated within the Keno District to begin to fulfill clauses 38-41 of the Yukon Water Board, Water Use Licence: QZ12-057. Groundwater monitoring wells have been installed at 11 specified sites across the district. The primary goal of this program is to:

- Determine potential impacts of those sites under care and maintenance which currently have treatment, or where elevated levels of contaminants of potential concern have been found to exist;
- Estimate, to a high degree of certainty, the hydraulic conductivity of all potentially impacted aquifers;
- Determine the groundwater flow direction;
- Determine vertical and horizontal hydraulic gradients, and
- Determine the potential flux of contaminants in groundwater in all receptors

A secondary goal of this investigation is to use the site wide hydrogeological information to help understand groundwater migration patterns or evaluate potential groundwater impacts in the broad areas that had not been studied before between the Valley Tailings and the Keno City. By having a broader focus that includes these sites and expanding the investigation to determine potential groundwater impacts from other historic operations, a complete albeit high level groundwater picture should be able to be described when the investigation is completed in 2016.

Achieving this ultimate objective has been initiated with the 2013 program by investigating the following sites by the installation of a well, and the evaluation of historic information about these mines(shown on Figure 1 in Appendix D):

- Silver King
- Husky Southwest
- Husky
- Ruby 400 Adit
- Bermingham
- Galkeno 300
- Galkeno 900
- Keno 700
- Sadie Ladue (two wells)
- Silver Trail Highway near Elsa and Husky mines near Flat Creek
- Onek in the receiving environment area near Christal Lake

The field program consisted of the following tasks:

- Borehole drilling and monitoring well installation
- Monitoring well development
- Groundwater sampling
- Insitu hydraulic conductivity testing to provide a measurement of hydraulic conductivity, which is a parameter that is necessary to understand the potential for groundwater migration

Table 1 provides a summary of the monitoring wells installed, completion depth, screen details and the formation the well is screened across.

Table 1 Monitoring Well Construction Table for 2013 Site Wide Groundwater Investigation

Well Location	Total Depth (m)	Screen length (m)	Formation (in which screen is set)
Keno 700 - KAR 13-010	15.89	3	bedrock - greenstone
Sadie Ladue – OB KAR 13-003	14.88	3	overburden - sand and gravel
Sadie Ladue – BR KAR 13-004	28.15	3	bedrock - graphitic schist and quartzite veins
ONEK - KAR 13-005	24.99	3	bedrock - graphitic schist and quartzite veins
Galkeno 900 - KAR 13-006	19.72	3	bedrock - quartzite
Galkeno 300 - KAR 13-013	29.30	3	bedrock - scericite schist and quartz veins
Bermingham - KAR 13-012	22.58	3	overburden - gravel and silt
Ruby 400 Adit - KAR 13-011	13.41	3	bedrock - graphitic schist
Husky - KAR 13-007	7.49	3	overburden - sand and gravel
Husky SW - KAR 13-008	14.00	3	overburden - gravel and sand
Silver King - KAR 13-009	44.41	4.57	bedrock - quartzite
Silver Trail Highway	48.16	-	Bedrock (quartzite and graphitic schist)

Table 2 provides the results of the first two sampling events conducted on these monitoring wells. The methodology for purging prior to groundwater sample collection consisted of purging three well volumes from the monitoring well followed by sample collection.

The guidance values applied for assessing groundwater quality across the district were taken from Table 3 Federal Interim Groundwater Quality Guidelines Generic Guidelines for Commercial and Industrial Land Uses - Tier 1 Lowest Guidelines.

These preliminary results from the groundwater investigation indicate the following metals and anions exceed the Tier 1 Guidelines:

- Sulphate exceeds guidelines in 10 locations across the district, ranging from a minor exceedance at the Ruby 400 Adit, to approximately 17 times the guideline at Galkeno 300.

- Cadmium concentrations exceed the guidelines at 11 locations across the district from minor exceedances at most sites. Concentrations in excess of 10,000 times the most stringent guidelines were returned in the Silver King well.
- Zinc exceeded guidelines at 4 sites ranging from approximately 10 times the guideline at Silver King to 50 times the guideline at Galkeno 300
- Arsenic exceeded guidelines at five sites across the district ranging from approximately 10 times at Ruby 400 and Galkeno 900 adits to approximately 100 times the Tier I Guideline at both the Silver King and Onek adits.
- Nickel exceedances occurred at two sites namely Galkeno 300 and Galkeno 900.
- Minor selenium exceedances of less than 5 times the Tier 1 guidelines occurred at Silver Trail Highway and Sadie Ladue Adit well.
- Minor thallium exceedances occurred at Silver King Adit.
- Minor uranium exceedances occurred at Galkeno 900.
- Aluminum exceedances occurred at Silver King, Galkeno 300 and Galkeno 900.

These groundwater monitoring results have provided preliminary indications of groundwater impacts in the district. Future study will provide a better understanding of groundwater to surface water interactions and the potential for loading to the surface water that is near these mines, and the extent of groundwater plumes that may exist near these mines.

Table 2 Groundwater monitoring results for 2013 monitoring wells

Station Name	Description	Sample Date	Water Level (Depth to Water) m	Geodetic Groundwater Level masl	Well Depth mbTOC	Well Purge Volume L	Turbidity (internal) NTU	pH (field) pH units	pH (lab) pH units	Specific Conductance (field) µS/cm	Specific Conductance (lab) µS/cm	Temperature (field) C	Dissolved Oxygen (field) mg/L	Dissolved Oxygen (field) %	ORP (field) mV
Federal Interim Groundwater Quality Guidelines - Commercial and Industrial Land Uses -Tier 1 Lowest Guideline for Protection of Freshv								6.5-9	6.5-9						
ST-MW-1	Silver Trail Highway Monitoring Well	21/09/2013	6.88	811.0	53.83	5751	0.44	7.08	7.57	530.4	440	2.7	5.58	42.4	193.6
ST-MW-1	Silver Trail Highway Monitoring Well	13/10/2013	6.43	811.5	52.6	816		7.13	7.57	497.2	427	1.8	8.11	58.5	-40.5
SK-MW-1	Silver King Adit Monitoring Well	17/09/2013	24.63	751.36	44.95	487.68	8.83	**6.39**	7.22	2190	1840	2.7	1.52	11.3	29.8
SK-MW-1	Silver King Adit Monitoring Well	30/10/2013	23.8	752.2	45.35	130		**6.36**	6.84	2077	1560	2.40	3.6	26.3	-5.8
HS-MW-1	Husky Shaft Monitoring Well	15/09/2013	1.42	740.8	7.485	39.24	108.8	6.93	7.75	1034	861	4.5	1.77	13.6	99.7
HS-MW-1	Husky Shaft Monitoring Well	13/10/2013	0.93	741.3	7.49	39.36		7.15	7.47	781.3	666	4.6	1.48	11.4	74.4
HS-MW-2	Husky South West Shaft Monitoring Well	15/09/2013	8.315	734.86	13.98	147.29	182	**6.38**	7.38	1388	1210	0.9	0.82	5.8	87.5
HS-MW-2	Husky South West Shaft Monitoring Well	13/10/2013	7.2	736	14.02	40.92		6.9	7.12	1181	1020	1.4	1.09	7.7	109.4
RB-MW-1	Ruby 400 Adit Monitoring Well	15/09/2013	3.745	1092.9	14.26	294.42	41.9	6.66	7.60	568	445	0.6	0.62	4.4	-59.7
RB-MW-1	Ruby 400 Adit Monitoring Well	13/10/2013	3.53	1093	14.25	64.32		6.99	7.09	451.8	366	1.1	1.1	8.2	-101.3
BH-MW-1	Bermingham Adit Monitoring Well	18/09/2013	16.62	1231.7	29.31	304.56	114	**5.97**	6.94	2696	236	1.6	1.24	9.3	160.9
BH-MW-1	Bermingham Adit Monitoring Well	14/10/2013	15.85	1232.5	22.87	42.12		**6.39**	7.22	259.1	239	2.3	6.29	48.3	222.1
G300-MW-1	Galkeno 300 Adit Monitoring Well	18/09/2013	16.365	1097.88	22.59	149.4	10.75	**6.45**	**6.47**	294.9	2010	2.1	5.86	45.1	132.2
G300-MW-1	Galkeno 300 Adit Monitoring Well	14/10/2013	15.69	1098.6	29.31	82		**5.97**	**6.39**	2384	1870	2.9	1.18	9.1	231.2
G900-MW-1	Galkeno 900 Adit Monitoring Well	16/09/2013	11.465	872.465	19.73	198.36	13.1	**6.43**	7.34	2409	2110	1.2	0.68	4.9	37
G900-MW-1	Galkeno 900 Adit Monitoring Well	13/10/2013	11.34	872.59	19.74	50.5		6.57	7.05	2132	1560	1.2	1.11	7.9	-2.4
G900-MW-1	Galkeno 900 Adit Monitoring Well	17/10/2013	11.31	872.62	19.74										
ON-MW-4	Onek Adit Monitoring Well	17/09/2013	19.89	862.22	26.18	150.96	20	6.72	7.77	1119	875	1.6	0.97	7.1	-6.8
ON-MW-4	Onek Adit Monitoring Well	13/10/2013	19.86	862.25	26.38	39.12		6.57	7.36	929	727	1.7	1.46	10.6	-28.5
ON-MW-4	Onek Adit Monitoring Well	17/10/2013	19.83	862.28	26.19										
K700-MW-1	Keno 700 Adit Monitoring Well	17/09/2013	8.525	1460.0	15.84	175.56	5.05	6.99	7.95	803.8	616	1.5	10.19	78.9	154.1
K700-MW-1	Keno 700 Adit Monitoring Well	09/10/2013	8.525	1460.0	15.835	44		7.26	7.64	667.5	530	1.5	9.96	78.6	86.3
SL-MW-1	Sadie Ladue 600 Adit Monitoring Well	17/09/2013	13.91		14.73	19.68		7.3	8.06	772.9	653	1.6	7.81	58.1	28.2
SL-MW-1	Sadie Ladue 600 Adit Monitoring Well	09/10/2013	13.61		15.74	12.5		7.07	7.74	682.6	558	1.8	6	46.1	-11.3
SL-MW-2	Sadie Ladue 600 Adit Monitoring Well (lower pad)	16/09/2013	7.375		28.07	496.68	135	7.62	8.21	777.6	615	0.4	0.81	5.8	-131.9
SL-MW-2	Sadie Ladue 600 Adit Monitoring Well (lower pad)	09/10/2013	6.835		28.08	127.5		6.95	7.85	685.9	546	0.4	0.75	5.6	112.8

Station Name	Sample Date	Hardness (from dissolved) mg/L	Alkalinity, total mg/L	Chloride mg/L	Fluoride mg/L	Sulphate, dissolved mg/L	Nitrite (N) mg/L	Nitrate (N) mg/L	Aluminum (Al), dissolved mg/L	Calculated Al-D CCME PAL mg/L	Antimony (Sb), dissolved mg/L	Arsenic (As), dissolved mg/L	Barium (Ba), dissolved mg/L	Beryllium (Be), dissolved mg/L	Bismuth (Bi), dissolved mg/L	Boron (mg/L
Federal Interim Groundwater Quality Guidelines - Commercial and Industrial Land Uses -Tier 1 Lowest Guideline for Protection of Freshv				120	0.12	100	0.06	3	*		2	0.005	2.9	0.0053		5
ST-MW-1	21/09/2013	254	194	<0.50	0.079	60.7	<0.0010	0.165	<0.0010	0.1	0.00064	0.00081	0.0717	<0.00010	<0.00050	<0.010
ST-MW-1	13/10/2013	266	216	<0.50	0.078	64.0	<0.0010	0.205	0.0018	0.1	0.00057	0.00078	0.0749	<0.00010	<0.00050	<0.010
SK-MW-1	17/09/2013	1230	383	<5.0	**0.23**	**834**	<0.010	<0.050	**0.0054**	0.005	0.0327	**0.624**	0.0219	<0.00020	<0.0010	<0.020
SK-MW-1	30/10/2013	1210	385	<5.0	**0.22**	**760**	<0.010	<0.050	0.0036	0.005	0.00325	**0.780**	0.0195	<0.00010	<0.00050	<0.010
HS-MW-1	15/09/2013	522	294	<5.0	**0.22**	**216**	<0.010	0.137	<0.0010	0.1	0.00125	0.00047	0.0256	<0.00010	<0.00050	<0.010
HS-MW-1	13/10/2013	441	300	<2.5	**0.25**	**188**	0.0064	0.133	0.0018	0.1	0.00120	0.00042	0.0267	<0.00010	<0.00050	<0.010
HS-MW-2	15/09/2013	753	215	1.37	**0.170**	**472**	<0.0010	0.0130	0.0013	0.005	0.00108	0.00139	0.0168	<0.00010	<0.00050	<0.010
HS-MW-2	13/10/2013	711	231	<5.0	**0.27**	**489**	<0.010	<0.050	0.0010	0.1	0.00103	0.00188	0.0130	<0.00010	<0.00050	<0.010
RB-MW-1	15/09/2013	234	139	1.16	**0.210**	98.3	0.0011	0.0092	0.0011	0.1	0.00018	**0.0488**	0.0961	<0.00010	<0.00050	<0.010
RB-MW-1	13/10/2013	193	111	1.03	**0.196**	**102**	<0.0010	<0.0050	0.0020	0.1	0.00023	**0.0192**	0.149	<0.00010	<0.00050	<0.010
BH-MW-1	18/09/2013	122	77.3	0.61	**0.217**	43.1	<0.0010	0.187	0.0028	0.005	0.00012	0.00014	0.00137	<0.00010	<0.00050	<0.010
BH-MW-1	14/10/2013	132	85.5	0.64	**0.225**	46.0	<0.0010	0.203	0.0026	0.005	0.00012	0.00012	0.00160	<0.00010	<0.00050	<0.010
G300-MW-1	18/09/2013	1500	89.5	<10	**<0.40**	**1580**	<0.020	<0.10	**0.013**	0.005	<0.0010	<0.0010	0.00848	<0.0010	<0.0050	<0.10
G300-MW-1	14/10/2013	1530	109	<10	**<0.40**	**1690**	<0.020	0.35	**<0.010**	0.005	<0.0010	<0.0010	0.0110	<0.0010	<0.0050	<0.10
G900-MW-1	16/09/2013	1440	293	<10	**0.58**	**1110**	<0.020	<0.10	**0.0082**	0.005	0.00116	**0.0444**	0.0100	<0.00020	<0.0010	<0.020
G900-MW-1	13/10/2013	1370	325	<10	**0.57**	**1160**	<0.020	<0.10	0.0059	0.1	0.00078	**0.0383**	0.00690	<0.00020	<0.0010	<0.020
G900-MW-1	17/10/2013									pH not recorded for this sample						
ON-MW-4	17/09/2013	524	189	<2.5	**0.43**	**323**	<0.0050	<0.025	0.0033	0.1	0.00011	**0.325**	0.0103	<0.00010	<0.00050	<0.010
ON-MW-4	13/10/2013	502	192	<2.5	**0.47**	**310**	<0.0050	<0.025	0.0039	0.1	<0.00010	**0.427**	0.00936	<0.00010	<0.00050	<0.010
ON-MW-4	17/10/2013									pH not recorded for this sample						
K700-MW-1	17/09/2013	358	180	0.61	**0.164**	**160**	<0.0010	0.290	0.0025	0.1	0.00052	0.00044	0.0211	<0.00010	<0.00050	<0.010
K700-MW-1	09/10/2013	354	187	0.62	**0.168**	**168**	0.0027	0.227	0.0036	0.1	0.00050	0.00081	0.0190	<0.00010	<0.00050	<0.010
SL-MW-1	17/09/2013	384	211	<0.50	0.052	**156**	0.0017	0.151	0.0011	0.1	0.00084	0.00184	0.117	<0.00010	<0.00050	<0.010
SL-MW-1	09/10/2013	377	220	<0.50	0.046	**160**	0.0016	0.151	0.0018	0.1	0.00087	0.00025	0.0459	<0.00010	<0.00050	<0.010
SL-MW-2	16/09/2013	374	215	<0.50	0.059	**150**	<0.0010	0.0081	0.0024	0.1	<0.00010	**0.0243**	0.117	<0.00010	<0.00050	<0.010
SL-MW-2	09/10/2013	364	219	<0.50	0.062	**151**	<0.0010	<0.0050	0.0019	0.1	0.00012	**0.0135**	0.125	<0.00010	<0.00050	<0.010

…d), dissolved

Table 2 Groundwater monitoring results for 2013 monitoring wells

Station Name	Description	Sample Date	Cadmium (Cd), dissolved mg/L	Calcium (Ca), dissolved mg/L	Chromium (Cr), dissolved mg/L	Cobalt (Co), dissolved mg/L	Copper (Cu), dissolved mg/L	Calculated Cu-D CCME PAL mg/L	Iron (Fe), dissolved mg/L	Lead (Pb), dissolved mg/L	Calculated Pb-D CCME PAL mg/L	Lithium (Li), dissolved mg/L	Magnesium (Mg), dissolved mg/L	Manganese (Mn), dissolved mg/L	Mercury (Hg), dissolved mg/L	Molybdenum (Mo), dissolved mg/L	Nickel (Ni… mg/L
Federal Interim Groundwater Quality Guidelines - Commercial and Industrial Land Uses -Tie			0.000017		0.0089		*		0.3	*					0.000026	0.073	*
ST-MW-1	Silver Trail Highway Monitoring Well	21/09/2013	**0.000022**	76.0	<0.00010	<0.00010	0.00045	0.004	<0.010	0.000126	0.007	0.00256	15.5	0.000627	<0.000010	0.000353	<0.00050
ST-MW-1	Silver Trail Highway Monitoring Well	13/10/2013	**0.000022**	80.1	<0.00010	<0.00010	0.00053	0.004	<0.010	0.000212	0.007	0.00241	16.1	0.000429	<0.000010	0.000353	<0.00050
SK-MW-1	Silver King Adit Monitoring Well	17/09/2013	**0.189**	329	<0.00020	0.0181	0.00112	0.004	**5.22**	0.00011	0.007	0.0166	99.2	2.84	<0.000010	0.00215	0.0439
SK-MW-1	Silver King Adit Monitoring Well	30/10/2013	**0.0188**	320	<0.00010	0.0108	0.00040	0.004	**7.11**	0.000144	0.007	0.0181	99.0	2.44	<0.000010	0.00101	0.0259
HS-MW-1	Husky Shaft Monitoring Well	15/09/2013	**0.000475**	144	<0.00010	0.00078	0.00024	0.004	<0.010	<0.000050	0.007	0.00714	39.8	1.74	<0.000010	0.000755	0.00230
HS-MW-1	Husky Shaft Monitoring Well	13/10/2013	**0.000462**	121	<0.00010	0.00063	0.00050	0.004	<0.010	0.000464	0.007	0.00691	33.8	1.51	<0.000010	0.000891	0.00227
HS-MW-2	Husky South West Shaft Monitoring Well	15/09/2013	**0.000304**	227	<0.00010	0.00689	0.00027	0.004	0.015	<0.000050	0.007	0.0242	45.2	4.02	<0.000010	0.000550	0.00917
HS-MW-2	Husky South West Shaft Monitoring Well	13/10/2013	**0.000350**	213	<0.00010	0.00541	0.00043	0.004	<0.010	0.000106	0.007	0.0221	43.7	3.47	<0.000010	0.000703	0.00582
RB-MW-1	Ruby 400 Adit Monitoring Well	15/09/2013	0.000016	69.7	<0.00010	0.00256	<0.00020	0.004	**7.78**	0.000084	0.007	0.00382	14.5	2.31	<0.000010	0.00159	0.00260
RB-MW-1	Ruby 400 Adit Monitoring Well	13/10/2013	**0.000024**	55.5	<0.00010	0.00275	<0.00020	0.004	**5.65**	<0.000050	0.007	0.00296	13.3	2.74	<0.000010	0.00154	0.00307
BH-MW-1	Bermingham Adit Monitoring Well	18/09/2013	**0.000084**	36.0	<0.00010	<0.00010	<0.00020	0.00280	<0.010	0.000515	0.00410	0.00305	7.89	0.00539	<0.000010	0.000051	0.00091
BH-MW-1	Bermingham Adit Monitoring Well	14/10/2013	**0.000120**	39.4	0.00012	<0.00010	0.00052	0.00300	0.017	0.000053	0.00453	0.00335	8.12	0.00547	<0.000010	0.000055	0.00089
G300-MW-1	Galkeno 300 Adit Monitoring Well	18/09/2013	**0.0733**	468	<0.0010	0.0915	<0.0020	0.004	**2.13**	0.00073	0.007	0.120	79.7	77.3	<0.000010	0.00067	**0.311**
G300-MW-1	Galkeno 300 Adit Monitoring Well	14/10/2013	**0.0785**	476	<0.0010	0.0936	<0.0020	0.004	**1.16**	0.00119	0.007	0.131	82.1	85.7	<0.000010	<0.00050	**0.328**
G900-MW-1	Galkeno 900 Adit Monitoring Well	16/09/2013	**0.000172**	490	<0.00020	0.0456	<0.00040	0.004	**4.15**	0.00020	0.007	0.0436	53.8	10.1	<0.000010	0.00106	**0.221**
G900-MW-1	Galkeno 900 Adit Monitoring Well	13/10/2013	**0.000130**	461	<0.00020	0.0411	<0.00040	0.004	**4.16**	<0.00010	0.007	0.0461	52.9	8.67	<0.000010	0.00090	**0.208**
G900-MW-1	Galkeno 900 Adit Monitoring Well	17/10/2013						Hardness is 0 or not recorded for this sample			Hardness is 0 or not recorded for this sample						
ON-MW-4	Onek Adit Monitoring Well	17/09/2013	**0.000665**	177	<0.00010	0.00254	<0.00020	0.004	**3.64**	<0.000050	0.007	0.0184	19.8	1.44	<0.000010	0.000773	0.00702
ON-MW-4	Onek Adit Monitoring Well	13/10/2013	**0.000257**	169	<0.00010	0.00171	<0.00020	0.004	**6.52**	0.000237	0.007	0.0166	19.4	1.31	<0.000010	0.000827	0.00468
ON-MW-4	Onek Adit Monitoring Well	17/10/2013						Hardness is 0 or not recorded for this sample			Hardness is 0 or not recorded for this sample						
K700-MW-1	Keno 700 Adit Monitoring Well	17/09/2013	**0.000095**	118	<0.00010	0.00014	0.00027	0.004	<0.010	<0.000050	0.007	0.00442	15.2	0.00803	<0.000010	0.00213	0.00131
K700-MW-1	Keno 700 Adit Monitoring Well	09/10/2013	**0.000091**	117	<0.00010	0.00029	0.00038	0.004	<0.010	0.000681	0.007	0.00447	15.3	0.0169	<0.000010	0.00201	0.00166
SL-MW-1	Sadie Ladue 600 Adit Monitoring Well	17/09/2013	**0.000049**	102	<0.00010	0.00100	<0.00020	0.004	<0.010	<0.000050	0.007	0.00324	31.7	0.327	<0.000010	0.00157	0.00218
SL-MW-1	Sadie Ladue 600 Adit Monitoring Well	09/10/2013	**0.000118**	97.7	<0.00010	0.00019	0.00087	0.004	<0.010	0.000175	0.007	0.00335	32.3	0.0189	<0.000010	0.00130	0.00123
SL-MW-2	Sadie Ladue 600 Adit Monitoring Well (lower pad)	16/09/2013	<0.000010	90.2	<0.00010	0.00044	<0.00020	0.004	**1.62**	0.000672	0.007	0.00195	36.2	0.200	<0.000010	0.00662	0.00056
SL-MW-2	Sadie Ladue 600 Adit Monitoring Well (lower pad)	09/10/2013	<0.000010	87.2	<0.00010	0.00046	0.00021	0.004	<0.010	<0.000050	0.007	0.00196	35.5	0.170	<0.000010	0.00688	0.00076

…), dissolved

Table 2 Groundwater monitoring results for 2013 monitoring wells

Station Name	Description	Sample Date	Calculated Ni-D CCME PAL	Phosphorus (P), dissolved	Potassium (K), dissolved	Selenium (Se), dissolved	Silicon (Si), dissolved	Silver (Ag), dissolved	Sodium (Na), dissolved	Strontium (Sr), dissolved	Sulphur (S), dissolved	Thallium (Tl), dissolved	Tin (Sn), dissolved	Titanium (Ti), dissolved	Uranium (U), dissolved	Vanadium (V), dissolved	Zinc (Zn), dissolved	Zirconium (Zr), dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Federal Interim Groundwater Quality Guidelines - Commercial and Industrial Land Uses -Tie						0.001		0.0001				0.0008		0.1	0.015		0.03	
ST-MW-1	Silver Trail Highway Monitoring Well	21/09/2013	0.15	<0.050	0.58	**0.00109**	3.08	<0.000010	1.13	0.300	19.6	0.000089	<0.00010	<0.010	0.00155	<0.0010	0.0025	<0.00080
ST-MW-1	Silver Trail Highway Monitoring Well	13/10/2013	0.15	<0.050	0.53	**0.00117**	2.88	<0.000010	1.12	0.300	20.1	0.000074	<0.00010	<0.010	0.00163	<0.0010	0.0018	
SK-MW-1	Silver King Adit Monitoring Well	17/09/2013	0.15	0.060	2.54	0.00062	10.4	<0.000020	4.66	0.583	260	**0.00458**	<0.00020	<0.020	0.0121	0.0021	**0.713**	<0.0016
SK-MW-1	Silver King Adit Monitoring Well	30/10/2013	0.15	0.241	2.69	<0.00010	11.3	<0.000010	4.73	0.596	264	**0.00270**	<0.00010	<0.010	0.00331	<0.0010	**0.412**	<0.00080
HS-MW-1	Husky Shaft Monitoring Well	15/09/2013	0.15	<0.050	0.84	<0.00010	4.48	<0.000010	1.41	0.316	65.6	0.000163	<0.00010	<0.010	0.00299	<0.0010	0.0023	<0.00080
HS-MW-1	Husky Shaft Monitoring Well	13/10/2013	0.15	<0.050	0.77	<0.00010	4.33	<0.000010	1.45	0.302	47.3	0.000179	<0.00010	<0.010	0.00229	<0.0010	0.0023	
HS-MW-2	Husky South West Shaft Monitoring Well	15/09/2013	0.15	<0.050	1.60	<0.00010	5.54	<0.000010	1.90	0.329	165	0.000184	<0.00010	<0.010	0.00162	<0.0010	0.0058	<0.00080
HS-MW-2	Husky South West Shaft Monitoring Well	13/10/2013	0.15	<0.050	1.61	<0.00010	5.56	<0.000010	2.07	0.315	149	0.000298	<0.00010	<0.010	0.00171	<0.0010	0.0046	
RB-MW-1	Ruby 400 Adit Monitoring Well	15/09/2013	0.15	<0.050	1.41	<0.00010	6.73	<0.000010	3.16	0.161	32.5	<0.000010	<0.00010	<0.010	0.00172	<0.0010	0.0048	<0.00080
RB-MW-1	Ruby 400 Adit Monitoring Well	13/10/2013	0.15	<0.050	1.05	<0.00010	6.97	<0.000010	2.72	0.139	32.9	<0.000010	<0.00010	<0.010	0.000411	<0.0010	0.0034	
BH-MW-1	Bermingham Adit Monitoring Well	18/09/2013	0.111	<0.050	0.25	0.00091	3.38	<0.000010	1.00	0.0645	14.3	<0.000010	<0.00010	<0.010	0.000020	<0.0010	0.0084	<0.00080
BH-MW-1	Bermingham Adit Monitoring Well	14/10/2013	0.118	<0.050	0.26	0.00082	3.32	<0.000010	0.997	0.0653	15.4	<0.000010	0.00042	<0.010	0.000019	<0.0010	0.0126	
G300-MW-1	Galkeno 300 Adit Monitoring Well	18/09/2013	0.15	<0.050	4.29	<0.0010	3.16	<0.00010	5.62	1.21	501	<0.00010	<0.0010	<0.10	0.00209	<0.010	**16.4**	<0.0080
G300-MW-1	Galkeno 300 Adit Monitoring Well	14/10/2013	0.15	<0.050	3.18	<0.0010	3.00	<0.00010	3.42	1.34	497	<0.00010	<0.0010	<0.10	0.00254	<0.010	**16.6**	
G900-MW-1	Galkeno 900 Adit Monitoring Well	16/09/2013	0.15	<0.050	0.99	<0.00020	3.86	<0.000020	2.40	0.605	349	<0.000020	<0.00020	<0.020	0.0148	<0.0020	**5.02**	0.0022
G900-MW-1	Galkeno 900 Adit Monitoring Well	13/10/2013	0.15	<0.050	0.90	<0.00020	3.73	<0.000020	2.29	0.590	339	<0.000020	<0.00020	<0.020	**0.0154**	<0.0020	**4.75**	
G900-MW-1	Galkeno 900 Adit Monitoring Well	17/10/2013	Hardness is 0 or not recorded for this sample															
ON-MW-4	Onek Adit Monitoring Well	17/09/2013	0.15	<0.050	0.59	0.00013	4.77	<0.000010	1.35	0.263	101	<0.000010	<0.00010	<0.010	0.00220	<0.0010	**0.663**	<0.00080
ON-MW-4	Onek Adit Monitoring Well	13/10/2013	0.15	<0.050	0.58	<0.00010	4.82	<0.000010	1.50	0.245	97.8	<0.000010	<0.00010	<0.010	0.00221	<0.0010	**0.524**	
ON-MW-4	Onek Adit Monitoring Well	17/10/2013	Hardness is 0 or not recorded for this sample															
K700-MW-1	Keno 700 Adit Monitoring Well	17/09/2013	0.15	<0.050	0.45	0.00067	3.62	<0.000010	1.85	0.260	53.0	<0.000010	<0.00010	<0.010	0.00879	<0.0010	0.0046	<0.00080
K700-MW-1	Keno 700 Adit Monitoring Well	09/10/2013	0.15	<0.050	0.39	0.00072	3.58	<0.000010	2.01	0.265	53.9	<0.000010	<0.00010	<0.010	0.00920	<0.0010	0.0027	
SL-MW-1	Sadie Ladue 600 Adit Monitoring Well	17/09/2013	0.15	<0.050	0.77	**0.00376**	3.42	<0.000010	1.84	0.388	51.7	<0.000010	<0.00010	<0.010	0.0110	<0.0010	0.0035	<0.00080
SL-MW-1	Sadie Ladue 600 Adit Monitoring Well	09/10/2013	0.15	<0.050	0.73	**0.00302**	3.19	<0.000010	1.93	0.389	50.4	<0.000010	0.00019	<0.010	0.00951	<0.0010	0.0018	
SL-MW-2	Sadie Ladue 600 Adit Monitoring Well (lower pad)	16/09/2013	0.15	<0.050	0.81	<0.00010	4.19	<0.000010	2.72	0.770	49.4	<0.000010	<0.00010	<0.010	0.0122	<0.0010	0.0026	<0.00080
SL-MW-2	Sadie Ladue 600 Adit Monitoring Well (lower pad)	09/10/2013	0.15	<0.050	0.81	<0.00010	3.92	<0.000010	3.10	0.748	47.3	<0.000010	<0.00010	<0.010	0.0125	<0.0010	<0.0010	

APPENDIX A

INTERRALOGIC INC.

TECHNICAL MEMORANDUM UPDATE:

KENO CITY GROUNDWATER EVALUATION, (MARCH 2012)

Technical Memorandum

TO: **Access Consulting Group**

FROM: **Interralogic, Inc.**

DATE: **March 27, 2012**

SUBJECT: **Update: Keno City Groundwater Evaluation**

This memorandum describes a groundwater evaluation that was conducted in the Keno City area from October 2010 through March 2012. The activities performed for this evaluation are described below.

Test Trenches At Onek 400 Adit

On October 9, 2010, two observation trenches were excavated in the dry stream channel downstream of the Onek 400 portal. At times the channel has had surface water flow that can be traced back to the portal. Trenches 1 and 2 were located about 180 and 150 m, respectively, downstream (west) of portal (see Figure 1). The purpose of the trenches was to evaluate if discharge from the Onek 400 adit was migrating west within the shallow stream alluvium, as there was no observed surface water flow in the channel at the trench locations. On the day of trenching, the adit discharge was about 1 L/s and free water extended from the portal to a location about 80 m downstream where it was assumed to infiltrate below an ice surface.

The trenches were excavated using a Case model 325 excavator. The trenches extended across the apparent stream channel and had depths of about 2 to 2.5 meters. The following observations were made in each trench.

Trench 1 *(further west):* The geology consisted of an upper 0.3 m layer of cobbles and boulders (active stream channel) underlain by silty sand with gravel, cobbles, and some boulders. The soil contained 25 to 35 percent fines. At some locations in the trench, the soil might be classified as sandy silt. The soils were moist, but nowhere wet. No permafrost was observed. Thirty minutes after excavation, no free water was observed on the trench walls, and no water accumulated in the trench bottom.

Trench 2 *(further east):* The geology consisted of an upper 0.3 meter layer of cobbles and boulders (active stream channel) underlain by a 0.25 m layer of wet coarse sand with gravel. Below the sand, and extending to the bottom of the trench, was clayey silt with cobbles and boulders. No permafrost was observed. Thirty minutes after excavation, no free water was observed on the trench walls, and no water accumulated in the trench bottom.

No water samples were taken from either trench due to the absence of free water.

The following GPS (easting/northing) coordinates were measured:

Midpoint of road above culvert	0485123	7087382
Trench 1	0485056	7087396
Trench 2	0485083	7087396

Keno City Water Wells

Keno City uses a water supply well completed in bedrock (Firehall Well) to provide drinking water for its residents (see location on Figure 1). The well provides good quality water, with no recent exceedances of Canada drinking water standards, except for manganese, which in December 2010 was just over the 50 ug/L limit. On an annual basis, a water sample is obtained from the pump discharge pipe and analyzed for organic and inorganic constituents. The well is not accessible for water levels due to the installed pump and piping.

During the week of 10 October 2010, Fred Marinelli conducted a reconnaissance of the townsite with resident Sonia Stange and identified four existing private water wells. Information on these wells is summarized in Table 1 and the locations are shown on Figure 1. One of the wells is sealed and abandoned, leaving three accessible wells. Note that the VanSut Well is identified as Well #3 in reports pertaining to the Bellekeno Mine.

On 26-27 Nov 2010, the VanSut and Café Wells were purged with an electric submersible pump to remove a minimum of three wellbore volumes and then sampled. On 8 December 2010, the Hotel well was bailed to remove three well volumes and sampled, the Firehall water supply well was sampled during routine pumping, and VanSut Well was bailed and re-sampled.

Using an electric probe, water levels were monitored during pumping and recovery of the VanSut and Café wells. The maximum pumping rates were 19.7 liters per minute (lpm) from the VanSut well and 1.0 liters lpm from the Café well. Water level hydrographs of the two pumping tests are shown on Figures 2 and 3, respectively. Recovery analyses indicate the following transmissivities of materials within the well completion intervals:

VanSut Well: $T = F / (2\pi) * SC = 0.875 * 1.68 \text{ lpm/m} = 2.1 \text{ m}^2/\text{day}$

Café Well: $T = F / (2\pi) * SC = 0.875 * 0.11 \text{ lpm/m} = 0.14 \text{ m}^2/\text{day}$

where SC is specific capacity measured during recovery (flow rate / drawdown) and the shape factor F is assigned a standard value of 5.5. Both wells are completed in fractured bedrock, with the VanSut well exhibiting moderate transmissivity and the Café well exhibiting relatively low transmissivity.

New Monitoring Wells

From 15 March to 22 April, 2011, five groundwater monitoring wells were installed in the Keno City Area. Completion information is summarized in Table 2 and the well locations are shown on Figure 1. The wells were drilled using the ODEX air-hammer method and completed with either 2- or 4-inch schedule 40 PVC pipe/screen depending on depth. Geologic logs, well-completion diagrams, and other information pertaining to the wells were compiled by EBA Consulting and their completion report is provided in Attachment A.

Onek Monitoring Well

While not funded as part of the closure program, an additional monitoring well was installed in the area of the historic Onek Mine to understand bedrock groundwater elevations east-southeast of the Onek 400 portal. An Alexco diamond corehole designated K-11-0337 was drilled in the Keno mine area during April 2011 (see Figure 1). After reaching at total depth of 76.2 m, the corehole was completed as a monitoring well with alternating sections of 3.05 m screen and 6.10 m solid casing. All casing and screen were 2 inch schedule 40 PVC. EBA Consulting documented the well installation and their completion report is provided in Attachment B.

Groundwater Sampling

Between December 2010 and February 2012, groundwater samples were obtained from the existing Keno City water wells, the new (MW) monitoring wells, the Onek monitoring well. Note that well MW-4 was not sampled until February 2012 due to a stuck bailer that was removed just before the sampling event. The laboratory results for these sampling events are summarized in Table 4. Where highlighted in yellow, the table shows constituents that exceeded Canada drinking water standards. These exceedances are summarized in Table 5. The highlighted values on Table 5 indicate exceedences for cadmium and zinc, constituents that are interpreted to be associated with historical mining in the Keno area.

Groundwater Flow Evaluation

The Keno City area currently contains eight wells that can be used to measure groundwater elevations; Café well, VanSut well, Onek well, and monitoring wells MW-1A, 1B, 2, 3, 4. At various times during 2011 and winter 2012, depth-to-water measurements were made in these wells using an electric water level probe. Water-level elevation is computed by subtracting depth-to-water from the top-of-casing elevation. The resulting water level elevations are provided in Table 3.

On May 12 and 13, 2011 a complete round of water levels was taken in the Keno City water wells and monitoring wells. These data were combined with a single measurement in the Onek well taken on April 15, 2011. On Figure 14 these water levels have been used to develop a water level contour map of the Keno City area. It is assumed in this interpretation that Lightning Creek, a perennial stream, defines where the local water table intersects ground surface. Flow lines, solid and dashed, indicate the inferred groundwater flow directions. A similar map is presented on Figure 5 based on water levels measured during February 2012. While interpretive, the contour maps on Figures 4 and 5 indicate the following:

- There is a convergence of southwest and northward flowing groundwater below the central portion of Keno City.

- The groundwater below Keno City is conveyed northwest along a feature that appears to have higher permeability than adjacent geologic units. Evidence for this is (1) the interpretation that groundwater converges toward this feature, (2) the change in hydraulic head is relatively small between upgradient wells in Keno City and downgradient wells MW-1A, MW-1B, and MW-2, and (3) the relatively high initial yield of the Firehall well (57 to 96 lpm). The higher permeability feature could be associated with a buried glacial valley (overburden) and/or fracture zone (bedrock).

- Water level contours suggest that groundwater discharges to Lightning Creek east of Keno City. South of Keno City, there appears to be seepage loss from the stream that recharges the groundwater system below the townsite. The zone of high seepage loss from the stream could be associated with the southeast extension of the postulated higher permeability feature.

- At and downstream (west) of the Onek 400 portal, the groundwater flow direction is generally southwest towards the postulated higher permeability feature, but not towards any of the Keno City water wells.

Possible Groundwater Impacts and Migration

Outflow from the Onek 400 adit is known to have relatively high concentrations of zinc (29 to 194 mg/L) and cadmium (0.31 to 5.9 mg/L). These constituents are therefore used as circumstantial indicators of impacts associated with the Onek 400 discharge. Review of the data in Table 4 suggests the following:

- Some of the Onek 400 discharge is infiltrating to groundwater as indicated by relatively high zinc and cadmium in MW-3, which is located in overburden just west of the adit portal.

- Elevated concentrations of zinc and/or cadmium suggest that Onek 400 discharge may have affected groundwater at MW-1A/1B and MW-2.

- Wells located in the central portion of Keno City (southeast of MW-1A/1B) do not appear to be impacted.

Discharge from the Onek 400 adit has the potential to travel west as surface water. While it appears that some of the discharge infiltrates near the portal, it is possible that at certain times of the year impacted mine water could infiltrate from the channel west of the portal. With this in mind and considering wells with possible groundwater impacts, the dashed magenta arrows on Figure 1 show *possible* groundwater migration pathways that could be chemically related to the Onek 400 discharge.

Potential impact to groundwater at wells MW-1A/1B, MW-2, and MW-3 is consistent with groundwater flow directions and the possible migration pathways shown on Figures 4 and 5. The absence of impact within the central portion of Keno City is also consistent with the interpreted pathways. Onek 400 discharge has not impacted the Firehall well, the current Keno City water supply, and is unlikely to impact it in the future.

Possible Field Work for 2012

Water-level monitoring and groundwater sampling will continue on a quarterly basis during 2012. The associated laboratory results will be added to the current database shown on Table 4.

Consideration is being given to drilling additional monitoring wells during the 2012 field season. Possible locations for six new monitoring wells are shown on Figure 1. It is anticipated that three new wells will be installed north of the Silver Trail Highway during 2012 to investigate southwest flowing groundwater that could be associated with historical mining areas located northeast of Keno City. Three possible well locations are shown south of the Silver Trail Highway to investigate northwest flowing groundwater that may migrate toward Crystal Creek. The decision to install any or all of these wells will require mutual agreement between Alexco and participating Government agencies.

Table 1 Keno City Water Wells

Well Name	Owner(s)	Northing/ Easting (m)	Casing	Approx Ground Surface (gs) Elev. (m msl)	Well Depth (m bgs)	Yield (L/min)	Geologic Material in Completion Interval	Comments
VanSut (Well #3)	Sharen Vandemier Gordon Sutton	0485016 7086862	6-inch steel Open hole in bedrock	939	67.8	19.7	Bedrock	Pump and discharge pipe removed November 2010.
Hotel Well	Leo Martel	0485104 7086913	6-inch steel	945	32.9	n/a	Unknown	Wellhead in basement. Well is open. No pump. Approx 1 m of water in well. Likely perched groundwater.
Café Well	Mike Mancini	0485164 7087033	6-inch steel Open hole in bedrock	946	67.8	1.0	Bedrock	Pump and discharge pipe removed November 2010
Abandoned House Well	Unknown	0484882 7086851	6-inch steel	935	n/a	n/a	Unknown	No pump. Obstruction at 3.78 m below ground surface. No water. Cannot be sampled.
Firehall Well	Yukon Govt	0484993 7086979	8-inch steel to 36 m 6-inch steel to 57 m Open hole in bedrock to 93 m	936	93	57 to 96 (1987)	Bedrock (top of bedrock at 55.2 m bgs)	Used for municipal water supply. Cannot measure current water level due to installed pump. 1987 water level about 882 m msl.

Table 2 Keno City Monitoring Wells

Well ID	Easting/ Northing (m)	Casing/ Screen	Borehole Diameter (mm)	Approx Ground Surface (gs) Elev. (m msl)	Top of Sand Pack (m bgs)	Top of Screen (m bgs)	Bottom of Screen (m bgs)	Bottom of Sand Pack (m bgs)	Borehole Total Depth (m bgs)	Geologic Material within Completion Interval
MW-1A	08 V 0484923 7087116	2-in Sch 40 PVC	114 (4.50 in)	930	82.9	84.7	93.9	93.9	93.9	Bedrock
MW-1B	08 V 0484913 7087105	2-in Sch 40 PVC	114 (4.50 in)	930	48.8	50.3	59.4	59.4	59.4	Overburden
MW-2	08 V 0484517 7087547	4-in Sch 40 PVC	169 (6.65 in)	907	36.4	38.1	47.1	47.1	47.1	Overburden
MW-3	08 V 0485144 7087330	4-in Sch 40 PVC	169 (6.65 in)	958	6.7	8.2	17.4	17.4	17.4	Bedrock
MW-4	08 V 0485197 7086921	2-in Sch 40 PVC	114 (4.50 in)	943	56.4	57.9	67.1	67.1	67.1	Overburden
Onek	08 V 0485383 7087277	2-in Sch 40 PVC	91 (3.58 in)	998	15.24	17.07 (a)	74.98 (a)	76.20	76.20	Bedrock

(a) Alternating sections of 3 m screen and 6 m solid pipe

Table 3 Groundwater Level Measurements

Well	Date	MP Description	MP Elevation m msl	DTW m bmp	WLE m msl
MW-1a	12-May-11	Top of 2-inch PVC casing	930.88	53.20	877.7
	16-May-11	Top of 2-inch PVC casing	930.88	56.55	874.3
	05-Jul-11	Top of 2-inch PVC casing	930.88	50.08	880.8
	04-Oct-11	Top of 2-inch PVC casing	930.88	49.25	881.6
	09-Feb-12	Top of 2-inch PVC casing	930.88	50.24	880.6
MW-1b	12-May-11	Top of 2-inch PVC casing	930.61	53.14	877.5
	16-May-11	Top of 2-inch PVC casing	930.61	53.04	877.6
	05-Jul-11	Top of 2-inch PVC casing	930.61	50.68	879.9
	04-Oct-11	Top of 2-inch PVC casing	930.61	49.65	881.0
	09-Feb-12	Top of 2-inch PVC casing	930.61	51.68	878.9
MW-2	12-May-11	Top of 4-inch PVC casing	907.91	31.19	876.7
	16-May-11	Top of 4-inch PVC casing	907.91	31.17	876.7
	05-Jul-11	Top of 4-inch PVC casing	907.91	29.20	878.7
	27-Sep-11	Top of 4-inch PVC casing	907.91	27.65	880.3
	08-Feb-12	Top of 4-inch PVC casing	907.91	28.65	879.3
MW-3	12-May-11	Top of 4-inch PVC casing	958.78	9.65	949.1
	16-May-11	Top of 4-inch PVC casing	958.78	9.51	949.3
	05-Jul-11	Top of 4-inch PVC casing	958.78	9.95	948.8
	27-Sep-11	Top of 4-inch PVC casing	958.78	8.59	950.2
	07-Feb-12	Top of 4-inch PVC casing	958.78	10.34	948.4
MW-4	12-May-11	Top of 2-inch PVC casing	944.35	58.37	886.0
	16-May-11	Top of 2-inch PVC casing	944.35	58.35	886.0
	05-Jul-11	Top of 2-inch PVC casing	944.35	57.77	886.6
	15-Feb-12	Top of 2-inch PVC casing	944.35	58.35	886.0
VanSut (Well #3)	11-Feb-10	Ground surface	938.94	42.83	896.1
	26-Nov-10	Top of 6-inch steel casing	939.13	43.44	895.7
	12-May-11	Top of 6-inch steel casing	939.13	44.32	894.8
	12-May-11				894.8
Café well	25-Nov-10	Top of 6-inch steel casing	945.82	50.32	895.5
	13-May-11	Top of 6-inch steel casing	945.82	52.20	893.6
	14-Feb-12	Top of 6-inch steel casing	945.82	50.79	895.0
Onek	15-Apr-11	Top of 2-inch PVC casing	999.26	38.47	960.8
	21-Nov-11	Top of 2-inch PVC casing	999.26	37.25	962.0
	11-Feb-12	Top of 2-inch PVC casing	999.26	38.21	961.1
Hotel	10-Oct-10	Top of 6 inch steel casing	Not surveyed	31.71	n/a
	27-Nov-10	Top of 6 inch steel casing	Not surveyed	31.84	n/a

(yellow) Used to construct water-level contour map on Figure 4

(light blue) Used to construct water-level contour map on Figure 5

Table 4 Groundwater Quality

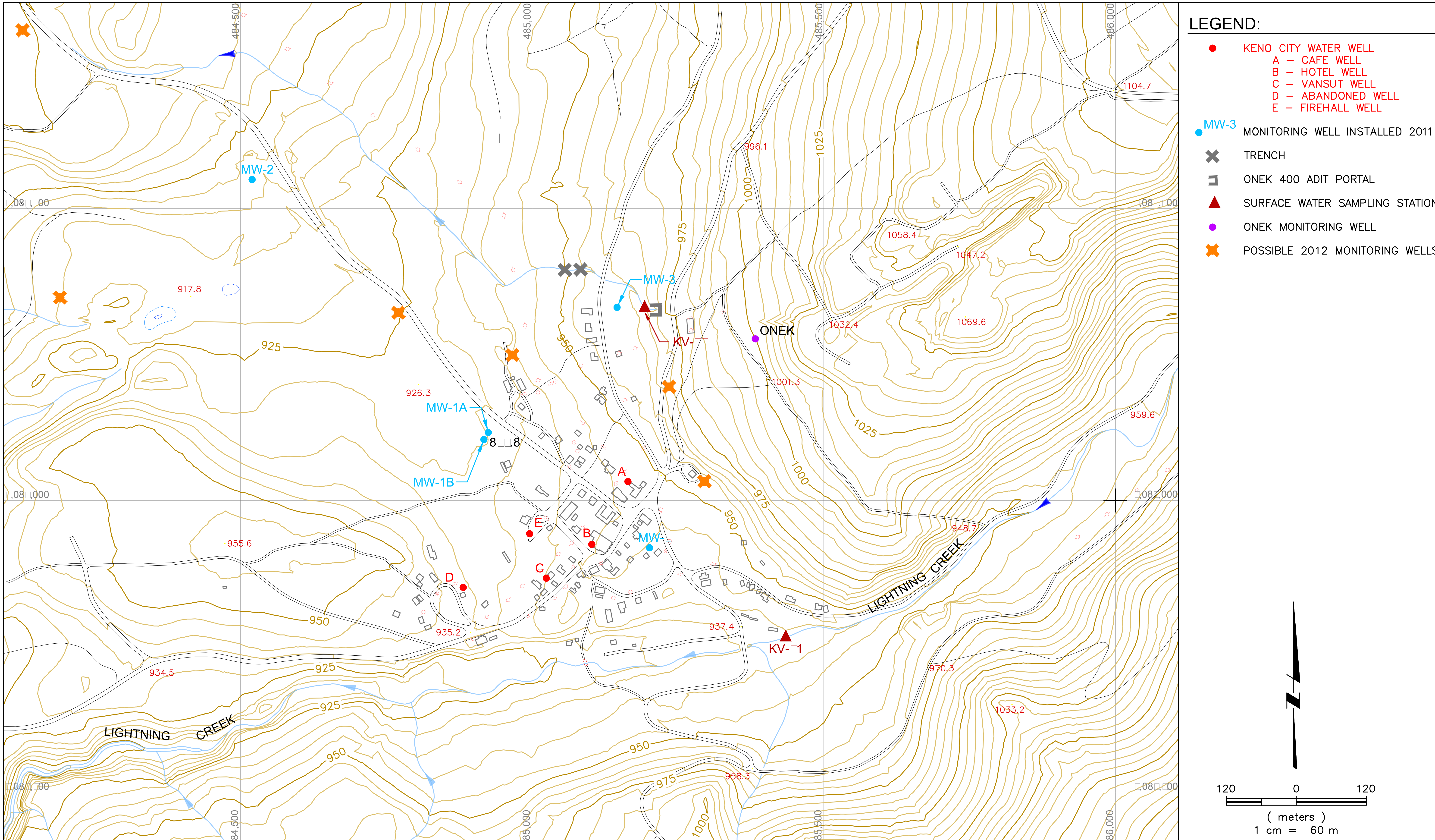
Analyte		Units	Canada Drinking Water Standard	Keno City Monitoring Wells (New)															Onek			Keno City Water Wells (Existing)				
				MW-1A (KV-84)			MW-1B			MW-2				MW-3				MW-4	MW-1			Hotel	VanSut		Café	Firehall
				16-May-11	4-Oct-11	13-Feb-12	16-May-11	4-Oct-11	9-Feb-12	16-May-11	27-Sep-11	21-Nov-11	9-Feb-12	16-May-11	27-Sep-11	21-Nov-11	7-Feb-12	19-Feb-12	21-Nov-11	19-Jan-12	11-Feb-12	8-Dec-10	26-Nov-10	8-Dec-10	26-Nov-10	8-Dec-10
Alkalinity (PP as CaCO3)	Dissolved	mg/L	-	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5		<0.5	<0.5		<0.5						
Alkalinity (Total as CaCO3)	Dissolved	mg/L	-	200	240	253	240	330	329	100	95		91.7	130	120		120	<0.5		307	348					
Bicarbonate (HCO3)	Dissolved	mg/L	-	250	300	309	300	400	401	130	120		112	160	150		146			375	424					
Calcium (Ca)	Dissolved	mg/L	-	319	347	362	379	403	417	84.3	65.8	58	80	105	159	142	143	319	363	308	409	32.6	69.8	44.2	145	103
Carbonate (CO3)	Dissolved	mg/L	-	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5		<0.5	<0.5		<0.5						
Chloride (Cl)	Dissolved	mg/L	250	1.9	2.8		3.1	3.9		1.3	1.3			0.8	2.4											
Fluoride (F)	Dissolved	mg/L	1.5	0.41			0.26			0.07				0.47												
Hardness (CaCO3)	Dissolved	mg/L	-	965	1040	1080	1170	1200	1270	283	216	192	268	311	474	428	426	1010	1070	889	1170	113	240	154	563	352
Hydroxide (OH)	Dissolved	mg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5		<0.5	<0.5		<0.5	<0.5					
Magnesium (Mg)	Dissolved	mg/L	-	41.1	41.1	41.7	54.2	47.9	55.9	17.7	12.5	11.5	16.7	11.9	18.7	17.8	17	52.1	39.3	29.2	37.4	7.57	16.0	10.6	49.0	22.8
Potassium (K)	Dissolved	mg/L	-	0.75	1.31	0.8	0.72	0.83		0.4	0.34	0.25	0.29	0.42	0.7	0.6	0.49	0.69	0.71	0.95	0.7	0.61	0.28	0.22	0.42	0.34
Sodium (Na)	Dissolved	mg/L	-	1.98	3.46	1.8	2.26	2.39	2.8	1.53	1.39	1.21	1.37	1.5	1.5	1.4	1.28	2.58	1.86	2.43	1.8	1.50	2.02	1.75	2.21	2.29
Sulphur (S)	Dissolved	mg/L	-	275	267	269	310	282	289	63	42	38	60	83	159	128	122	297	263	249	242	15	30	20	112	62
Aluminum (Al)	Dissolved	mg/L	0.1	<0.003	0.01	0.003	<0.003	0.011	0.003	0.007	0.0164	0.0023	0.0015	0.003	0.007	0.014	0.0034	0.0012	0.0031	0.0019	0.005	0.0018	0.0013	0.0025	0.0014	0.002
Antimony (Sb)	Dissolved	mg/L	0.006	0.0096	<0.01	0.001	<0.0005	<0.01	<0.0001	<0.0005	0.00045		0.00008	<0.0005	0.0003		0.00051	<0.00002	0.00017	0.00026	<0.0001	0.00003	0.0001	0.00008	0.00006	0.00013
Arsenic (As)	Dissolved	mg/L	0.01	0.047	0.0538	0.109	0.0002	0.001	0.0004	0.0005	0.00077	0.00143	0.00075	0.0003	<0.0002	0.0007	0.00027	0.00073	0.00245	0.0021	0.0082	0.00008	0.00248	0.00169	0.00005	0.00263
Barium (Ba)	Dissolved	mg/L	1	0.006	0.015	0.0056	0.012	0.026	0.0181	0.104	0.0779	0.0888	0.0958	0.009	0.0178	0.0153	0.0118	0.0065	0.0245	0.0277	0.0268	0.0938	0.114	0.111	0.057	0.103
Beryllium (Be)	Dissolved	mg/L	-	<0.0001	<0.0001	<0.00005	<0.0001	<0.0001	<0.00005	<0.0001	<0.0001	<0.00001	<0.00001	<0.0001	<0.0001	<0.00005	0.00003	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth (Bi)	Dissolved	mg/L	-	<0.001	<0.001	<0.00003	<0.001	<0.001	<0.00003	<0.001	<0.00005	<0.000005	<0.000005	<0.001	<0.00005	<0.00003	0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	0.000006	<0.000005	<0.000005
Boron (B)	Dissolved	mg/L	5	<0.05	<0.05	<0.03	<0.05	<0.05	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.050	<0.050	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium (Cd)	Dissolved	mg/L	0.005	0.00121	0.001	<0.00003	0.00469	0.00551	0.00327	0.00016	0.00686	0.00057	0.000156	0.633	1.2	0.937	0.733	0.0016	0.000138	0.000021	<0.00003	0.000007	0.000314	0.000129	0.000155	0.00124
Chromium (Cr)	Dissolved	mg/L	0.05	<0.001	<0.001	<0.0005	<0.001	<0.001	0.0013	<0.001	0.0004	0.0002	0.0001	<0.001	<0.001	<0.0005	<0.0001	<0.0001	0.0002	0.0006	0.0009	0.0002	0.0005	0.0005	0.0003	0.0004
Cobalt (Co)	Dissolved	mg/L	-	0.0096	0.008	0.00617	0.0428	0.0719	0.0504	<0.0005	0.000155	0.000044	0.000028	0.0029	0.00242	0.00373	0.00236	0.000093	0.00546	0.00472	0.00123	0.000177	0.000017	0.000035	0.00013	0.00018
Copper (Cu)	Dissolved	mg/L		0.0013	0.0163	<0.0003	0.0004	0.004	0.0013	0.0008	0.00191	0.00085	0.00078	0.0034	0.003	0.0043	0.00408	0.00005	0.00007	0.00027	<0.0003	0.00018	0.00063	0.00046	0.00015	0.0209
Iron (Fe)	Dissolved	mg/L	0.3	1.27	1.6	4.98	0.012	0.023	0.045	<0.005	0.017	0.003	0.002	0.011	<0.01	<0.005	0.003	0.005	4.27	2.83	0.697	0.055	0.015	0.013	0.012	0.025
Lead (Pb)	Dissolved	mg/L	0.01	<0.0002	0.0019	<0.00003	0.0002	0.0018	0.001	<0.0002	0.00309	0.000982	0.000263	0.0003	0.00433	0.00177	0.000341	0.000081	0.000058	0.000131	<0.00003	0.00011	0.000182	0.000478	0.000115	0.000493
Lithium (Li)	Dissolved	mg/L	-	0.023	0.025	0.029	0.028	0.03	0.032	<0.005	0.0022	0.0037	0.0057	0.014	0.022	0.018	0.0171	0.0316	0.028	0.0224	0.027	0.0011	0.0017	0.001	0.0118	0.0045
Manganese (Mn)	Dissolved	mg/L	0.05	2	2.07	1.88	5.13	6.38	5.29	0.036	0.0392	0.00956	0.00067	0.011	0.0105	0.0267	0.00693	0.707	1.54	1.51	1.42	0.226	0.00078	0.00195	0.0306	0.0554
Mercury (Hg)	Dissolved	mg/L	0.001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00001	<0.00001	<0.00001	<0.00005	<0.0001	<0.00005	<0.00001	<0.00001	<0.00002	<0.00001	<0.00005					
Molybdenum (Mo)	Dissolved	mg/L	0.25	0.002	0.002	0.0012	<0.001	<0.001	<0.0003	<0.001	0.00051	0.00014	0.00015	<0.001	<0.0005	0.0004	0.00101	0.00008	0.00354	0.00523	<0.0003	0.00021	0.00017	0.0002	0.00008	0.00023
Nickel (Ni)	Dissolved	mg/L	-	0.04	0.033	0.0223	0.035	0.042	0.0396	0.002	0.00248	0.00085	0.00111	0.027	0.0358	0.0312	0.0303	0.00964	0.00728	0.00741	0.0033	0.00083	0.00049	0.00044	0.00164	0.0188
Selenium (Se)	Dissolved	mg/L	0.01	0.0037	0.0041	<0.0002	<0.0001	<0.0005	<0.0002	0.0017	0.00148	0.00124	0.00124	0.0005	0.0005	0.0004	0.00068	0.00018	0.00005	0.00022	<0.0002	0.00063	0.00267	0.0023	0.0139	0.00201
Silicon (Si)	Dissolved	mg/L	-	4.69	4.8	4.7	7.44	7	7.1	3.64	3.4	3	3.5	4.22	5	4	4	6.6	7.7	7.2	7	1.27	3.38	3.03	4.5	3.85
Silver (Ag)	Dissolved	mg/L	-	<0.00002	<0.00002	<0.00003	<0.00002	<0.00002	<0.00003	<0.00002	0.000007	<0.000005	<0.000005	0.00004	0.00006	<0.00003	0.000023	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	0.000006	<0.000005	<0.000005
Strontium (Sr)	Dissolved	mg/L	-	0.676	0.675	0.681	0.701	0.718	0.696	0.187	0.132	0.128	0.163	0.14	0.218	0.194	0.183	0.615	0.772	0.645	0.751	0.108	0.185	0.131	0.347	0.257
Thallium (Tl)	Dissolved	mg/L	-	<0.00005	<0.00005	<0.00001	<0.00005	<0.00005	<0.00001	<0.00005	0.000004	<0.000002	<0.000002	<0.00005	<0.00002	0.00001	0.000012	0.000003			<0.00001	<0.000002	<0.000002	<0.000002	<0.000002	0.000009
Tin (Sn)	Dissolved	mg/L	-	<0.005	<0.005	<0.001	<0.005	<0.005	<0.001	<0.005	0.00031	0.00018	<0.0002	<0.005	<0.0001	0.00013	0.0007	<0.0002	0.0001	<0.0002	<0.001	0.00002	<0.00001	0.00001	<0.00001	0.00005
Titanium (Ti)	Dissolved	mg/L	-	<0.005	<0.005	<0.003	<0.005	<0.005	<0.003	<0.005	<0.0005	<0.0005	<0.0005	<0.005	<0.005	<0.003	0.0006	<0.0005	<0.0005	<0.0005	<0.003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium (U)	Dissolved	mg/L	0.02	0.0115	0.011	0.0129	0.0206	0.0207	0.0213	0.004	0.00148	0.00256	0.00445	0.0005	0.00036	0.00103	0.000855	0.0252	0.0107	0.0089	0.00371	0.000117	0.00143	0.000564	0.00301	0.00934
Vanadium (V)	Dissolved	mg/L	-	<0.005	<0.005	<0.001	<0.005	<0.005	<0.001	<0.005	<0.0002	<0.0002	<0.0002	<0.005	<0.002	<0.001	0.0005	<0.0002	<0.0002	<0.0002	<0.001	0.0003	<0.0002	0.0003	<0.0002	0.0002
Zinc (Zn)	Dissolved	mg/L	5	0.823	0.657	0.8	0.171	0.222	0.211	0.013	0.289	0.0287	0.0124	41.8	71.4	52.4	39.8	0.0461	0.0159	0.0107	0.0006	0.0022	0.0198	0.0364	0.0728	0.14
Zirconium (Zr)	Dissolved	mg/L	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0005	<0.0001	<0.0001	0.0002	0.0004	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ammonia (N)	Dissolved	mg/L	-	0.029			0.046			0.01				0.011						0.046		0.24	0.022	0.14	0.022	0.15
Conductivity		µS/cm	-	1600	1560	1650	1800	1820	1840	551	433	402	507	641	1010	933		1610	854	1690	1730	236	465	295	949	648
Filter and HNO3 Preservation		N/A	-	FIELD	FIELD		FIELD	FIELD	FIELD	FIELD	FIELD	FIELD	FIELD	FIELD	FIELD	FIELD		FIELD	FIELD	FIELD		FIELD	FIELD	FIELD	FIELD	FIELD
Nitrate (N)	Dissolved	mg/L	45	<0.02	<0.2		<0.02	<0.2		0.34	0.28			0.12	0.16											
Nitrate plus Nitrite (N)	Dissolved	mg/L	48.2	<0.02	<0.2		<0.02	<0.2		0.34	0.28			0.12	0.16											
Nitrite (N)	Dissolved	mg/L	3.2	<0.005	<0.05		<0.005	<0.05		<0.005	<0.005			<0.005	<0.005											
Nitrogen (N)	Dissolved	mg/L																				0.7	1.70	2.25	1.87	1.34
Organic Carbon (C)	Total	mg/L	-	1.8	8.5		<0.5	1		1.9	9			2.2	0.6							1.2	0.9	<0.5	3.7	<0.5
Organic Carbon (C)	Dissolved	mg/L	-	0.8	5	<0.5	1.2	1.8		1.5	1.1			2.5	0.9					2.08		0.6	0.8	<0.5	3.9	<0.5
Orthophosphate (P)	Dissolved	mg/L	-	<0.005	<0.005		<0.005	<0.005		<0.005	0.008			<0.005	<0.005											
Phosphorous (P)	Dissolved	mg/L	-			<0.01			0.01				0.007				<0.002	0.025				0.038	0.006	0.010	0.008	0.005
pH (lab)		pH Units	6.5-8.5	7.94	8.05		7.88	7.81	7.95	8.14	7.8	7.76	7.93	7.74	7.45	7.45	7.52	7.51	7.87	7.63	7.98	7.53	7.90	7.31	7.62	7.70
Sulphate (SO4)	Dissolved	mg/L	500	760	721		870	847	806	170	124	117	167	210	428	374	316	726	764	751	714					180
Total Dissolved Solids	Dissolved	mg/L	500	1400	1300		1600	1500		370	290			500	860							120	270	160	660	410
Total Suspended Solids	Suspended	mg/L	-	29	74		<4	57	15.7	260	130	11.1	<1.0	11	16	15	2.8	35.4	126	88.8	44.1	92	20	120	11	<1

Table 5 Exceedences of Canada Drinking Water Standards in Groundwater

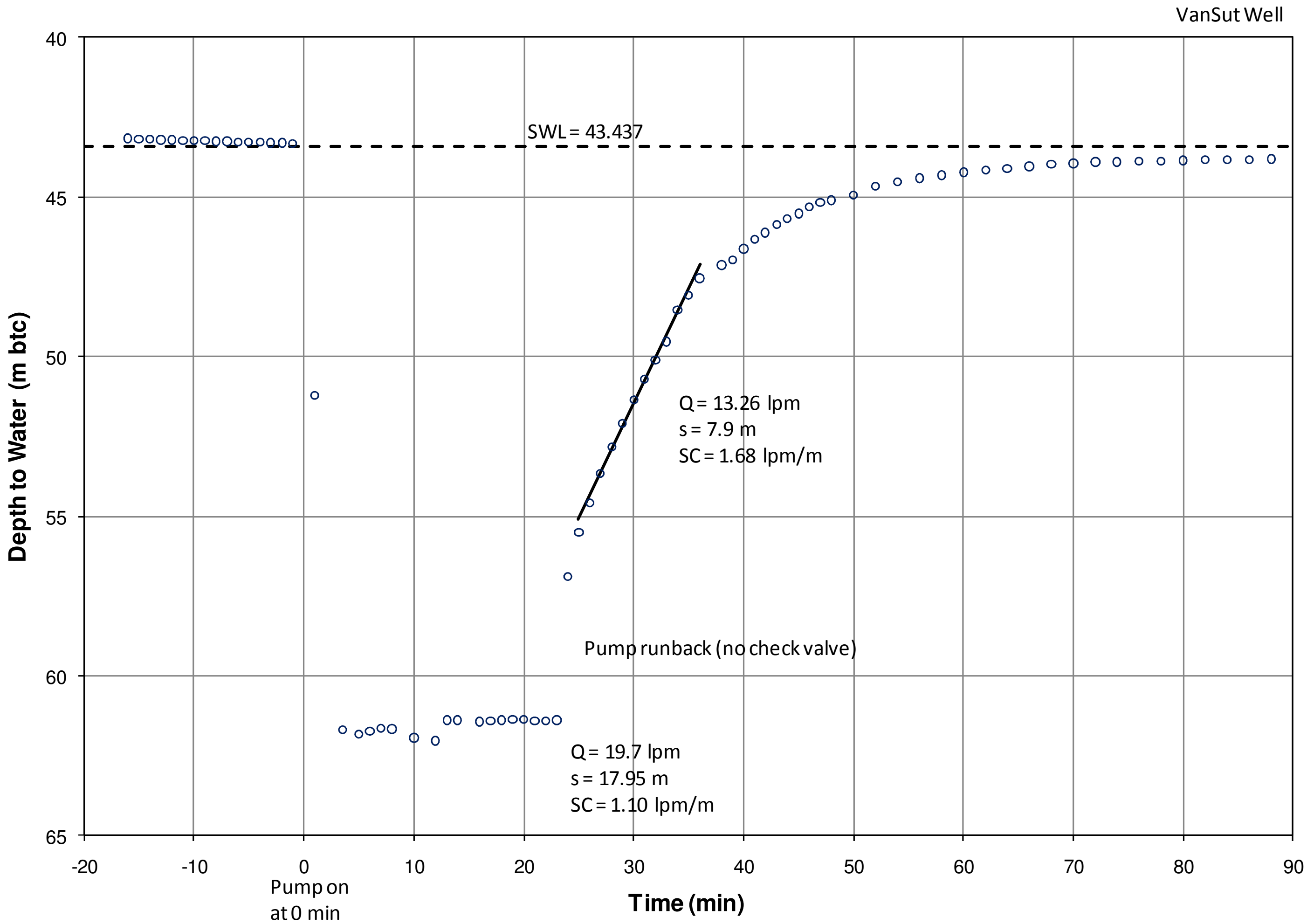
Constituent	Canada Drinking Water Standard mg/L	MW-1A	MW-1B	MW-2	MW-3	MW-4	Onek	Hotel	VanSut	Cafe	Firehall
Antimony	0.006	X									
Arsenic	0.01	X									
Cadmium	0.005		X	X	X						
Iron	0.3 (a)	X					X				
Manganese	0.05	X	X			X	X	X			X
Uranium	0.02		X			X					
Zinc	5				X						
Sulphate	500 (a)	X	X			X	X				
Total Dissolved Solids	500 (a)	X	X		X					X	

(a) Aesthetic standard (not related to health-risk)

Constituent interpreted to be related to historical mining



DRAWING REFERENCE(S):	PROJECT LOCATION: KENO CITY, YUKON, CANADA	INTERRA 4715 Innovation Drive, Suite 110 Fort Collins, Co 80525 970.225.8222
	PROJECT: KENO	
	TITLE: SITE MAP	PROJECT NO: 102002; REVISION: 1
DRAWING NAME: FIGURE 1; DATUM: NAD 83		DRAWING NAME: FIGURE 1; SHEET NUMBER



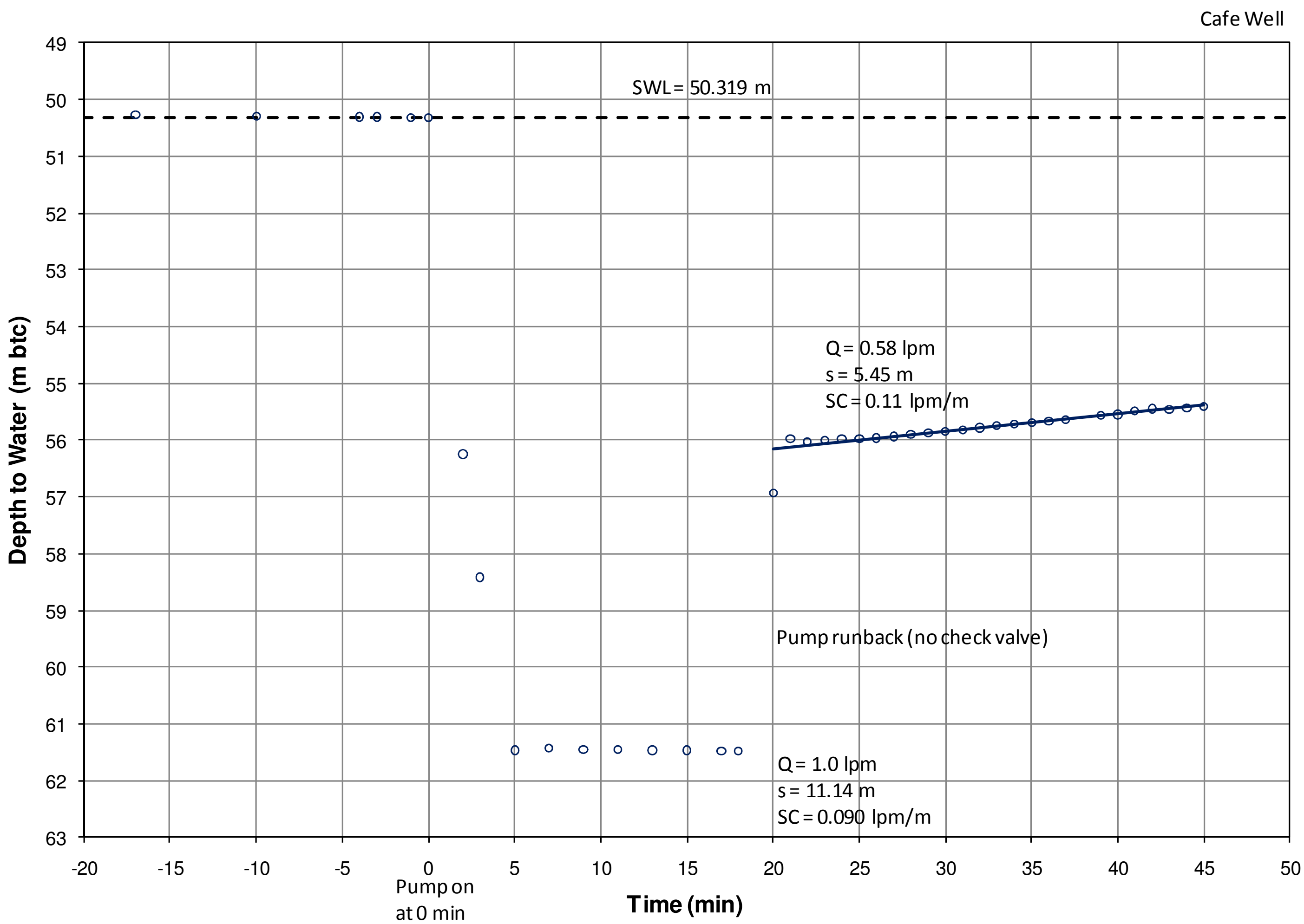
PROJECT NO.: 102003

INTERRAlogic
4715 Innovation Drive, Suite 110
Fort Collins, CO 80525
970.225.8222

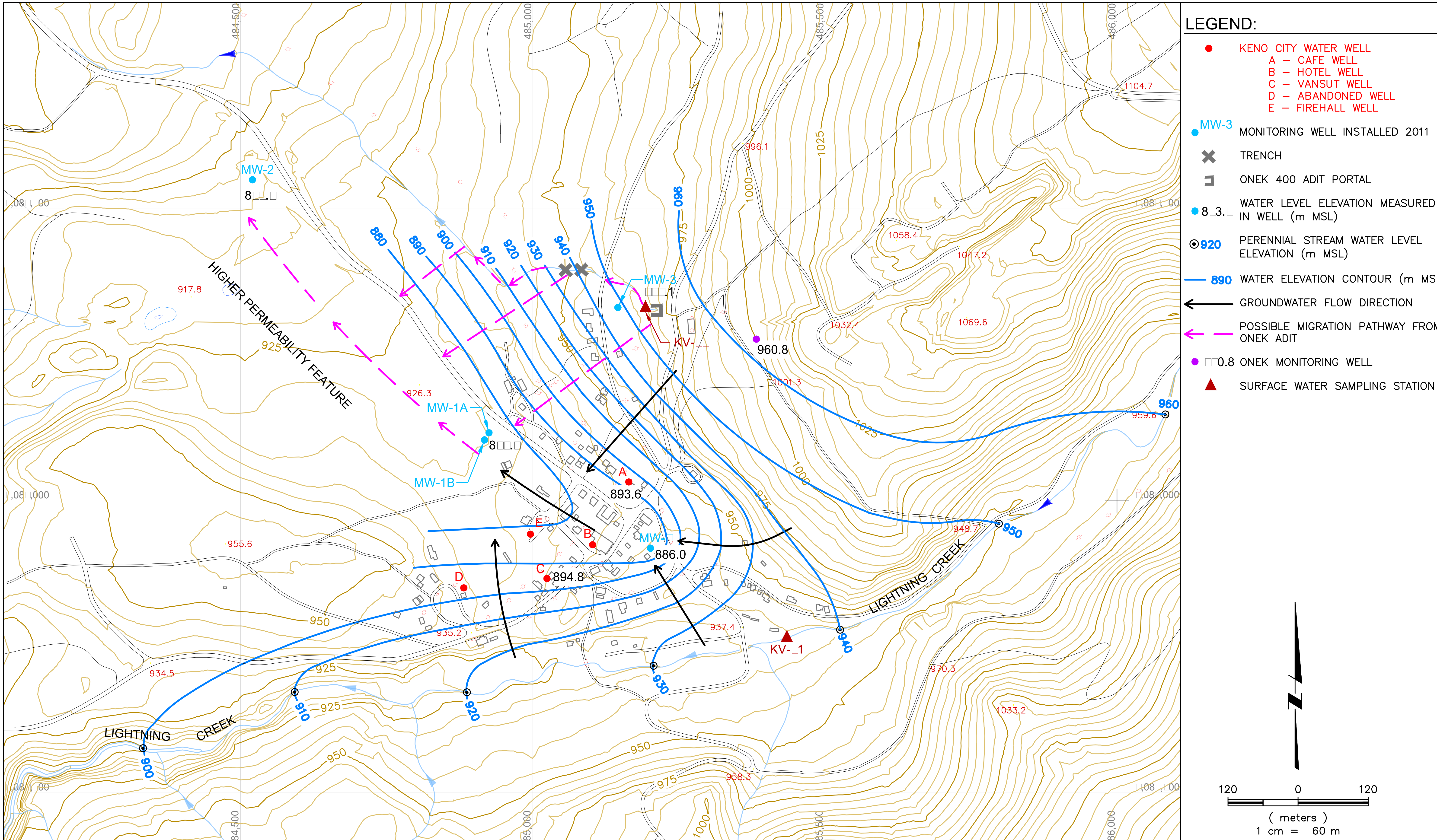
Figure 2
VanSut Well Test

PREPARED FOR:

Access Consulting Group



PROJECT NO.: 102003	**Figure 3** **Café Well Test**	PREPARED FOR: **Access Consulting Group**
INTERRAlogic 4715 Innovation Drive, Suite 110 Fort Collins, CO 80525 970.225.8222		



DRAWING REFERENCE(S):

DRAWING NAME: | DATUM: NAD 83

PROJECT LOCATION: KENO CITY, YUKON, CANADA

PROJECT: KENO

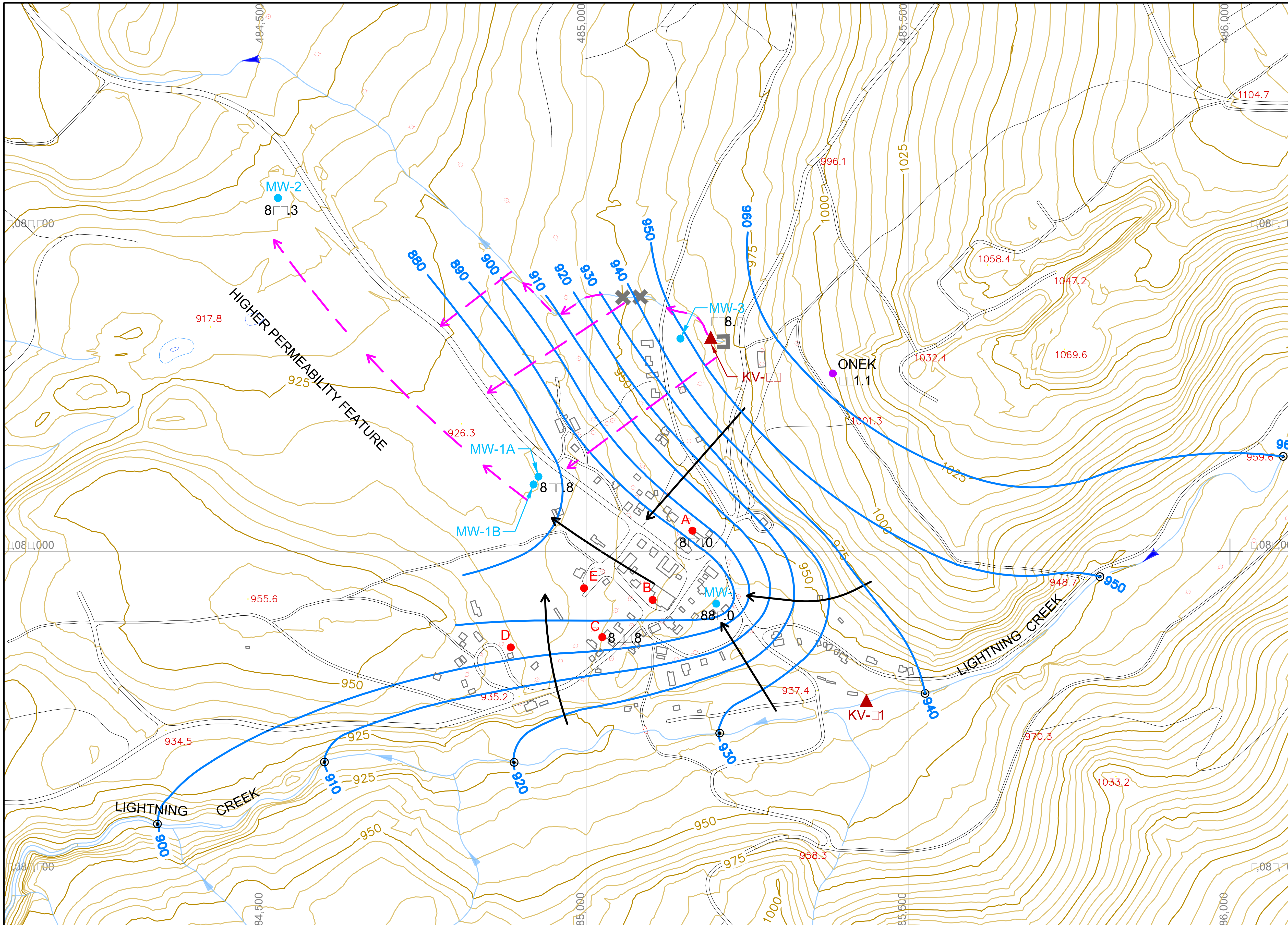
TITLE: MAY 2011 WATER-LEVEL CONTOUR MAP

4715 Innovation Drive, Suite 110
Fort Collins, Co 80525
970.225.8222

PROJECT NO: 102002

REVISION: 1

DRAWING NAME: FIGURE



LEGEND:

- KENO CITY WATER WELL
  - A – CAFE WELL
  - B – HOTEL WELL
  - C – VANSUT WELL
  - D – ABANDONED WELL
  - E – FIREHALL WELL
- MW-3 MONITORING WELL INSTALLED 2011
- TRENCH
- ONEK 400 ADIT PORTAL
- 8□3.□ WATER LEVEL ELEVATION MEASURED IN WELL (m MSL)
- 920 PERENNIAL STREAM WATER LEVEL ELEVATION (m MSL)
- 890 WATER ELEVATION CONTOUR (m MSL)
- GROUNDWATER FLOW DIRECTION
- POSSIBLE MIGRATION PATHWAY FROM ONEK ADIT
- □□1.1 ONEK MONITORING WELL
- SURFACE WATER SAMPLING STATION

WATER ELEVATION CONTOURS BASED ON FEBRUARY 2012 MEASUREMENTS FOR ALL WELLS EXCEPT VANSUT (C), WHICH WAS LAST MEASURED MAY 2011.

120 0 120
(meters)
1 cm = 60 m

DRAWING REFERENCE(S):		PROJECT LOCATION: KENO CITY, YUKON, CANADA	INTERRA 4715 Innovation Drive, Suite 110 Fort Collins, Co 80525 970.225.8222
DRAWING NAME: FIGURE □	DATUM: NAD 83	PROJECT: KENO	PROJECT NO: 102002 / REVISION: 1 / SCALE: 1 cm = □0 m
		TITLE: FEBRUARY 2012 WATER-LEVEL CONTOUR MAP	DRAWING NAME: FIGURE □ / SHEET NUMBER

Attachment A

Drilling and Completion Report for Keno City Monitoring Wells (MW series)

A TETRA TECH COMPANY

July 6, 2011

ISSUED FOR USE
EBA FILE: W23101422
Via Email: eallen@accessconsulting.com

Access Consulting Group
#3 Calcite Business Centre
151 Industrial Road
Whitehorse, Yukon Y1A 2V3

Confidential

Attention: Mr. Ethan Allen, M.Sc.

Subject: Consulting Services for the Installation of Monitoring Wells in the Keno City Area, Yukon

1.0 INTRODUCTION

1.1 Background

EBA, A Tetra Tech Company (EBA), was engaged by Access Consulting Group (Access) to provide hydrogeological consulting services during the installation of five (5) groundwater monitoring wells in the Keno City area, Yukon. The work was performed in accordance with the scope of work set out in our proposal (Doc Ref PW23100003_Alexco_MWs) dated February 8, 2010 and accepted by Access on March 8, 2011.

1.2 Purpose

The purpose of EBA's work was to provide onsite co-ordination during the drilling and installation of five groundwater monitoring wells in the Keno City area.

1.3 Scope and Sequence of Work

The scope of work included:

- co-ordinate the drilling, installation and construction of five groundwater monitoring wells;
- co-ordinate the development of the five groundwater monitoring wells;
- Onsite testing of the five groundwater monitoring wells for field parameters (pH, EC, temperature)

The work was undertaken with regard to the workplan provided to EBA by Access and additional directions provided by Access and InTerraLogic, Inc (InTerraLogic) during the drilling program.

Table 1-1 summarises the tasks and sequence of events to arrive at this report.

EBA, A Tetra Tech Company
Calcite Business Centre, Unit 6, 151 Industrial Road
Whitehorse, YT Y1A 2V3 CANADA
p. 867.668.3068 f. 867.668.4349

Table 1-1: Sequence of Events

Date	Activity
March 8, 2011	EBA formally appointed by Access Consulting Group to undertake the work
March 10, 2011	Project kick off meeting at Access Consulting, Whitehorse
15 March – 22 April 2011	Well drilling, installation and development program conducted
6 July 2011	Report Issued

2.0 METHOD

2.1 Groundwater Monitoring Well Installation

Wells were sited, named, drilled and installed in accordance with the work plan titled Keno City Groundwater Investigation (ERDC, September 2010) and verbal and email communication during the drilling program with Ethan Allen (Access), Scott Davidson (Access) and Fred Marinelli (InTerraLogic).

EBA was directed to install wells in general compliance with the depths and construction details outlined in the workplan. Note that EBA was directed to drill all boreholes to the top of bedrock prior to installing monitoring wells.

Five groundwater monitoring wells (MW-1, MW-2, MW-3, MW-4 and MW-5) were drilled and installed by Kirk Shaw of Geotech Drilling in March and April 2011. The assigned well numbers were provided to EBA by Access. All wells were drilled with a Fraste Multidrill XL rig using an ODEX drilling technique.

The following products were used in the drilling and construction of the five wells:

- MATEX R.D.O. 302 ES Vegetable oil based rock drill oil (for lubricating the hammer)
- Enviro Cote joint compound (lubricant for drill rod threads)
- KOPR-KOTE joint compound (lubricant for drill rod threads)
- Target Products 10/20 Filter Sand, grain size 0.85 mm – 1.25mm (for filter pack)
- Enviroplug Grout (for well grouting)
- Holeplug 3/8 Coarse Grade Bentonite (for sealing the borehole)

Drilled bore diameters ranged from 114 mm to 169 mm. Casing and factory-slotted screen, consisting of 50 mm and 100 mm PVC with threaded joints, were installed in the wells. A sand filter pack was installed from the base of each well to at least 1.5 m above the top of the screen and a bentonite seal was installed above the filter pack. Wells were grouted from the top of the bentonite seal to several meters below ground level, where a bentonite surface seal was placed to prevent ingress of surface water. Stick-up steel casing protectors with lockable caps were installed to limit access and potential damage to the wells. EBA did not lock the wells and it is recommended that the wells be locked to restrict access and potential damage/vandalism.

Well logs and construction diagrams are provided in Appendix B. Key bore details are presented in Table 2-1.

Table 2-1: Key Well Details

Well ID	Location (UTM NAD83, Zone 8)	Drilled Depth – bgl (m) / (ft)	Casing Diameter (mm) / (inch)	Screened Interval - bgl (m) / (ft)	Filter Pack Interval - bgl (m) / (ft)	Comments
MW-1	E 0484921 N 7087116	93.9 / 308'	50 / 2	84.7 – 93.9 / 278' – 308'	82.9 – 93.9 / 272' – 308'	▪ Monitoring well installed in bedrock. ▪ Borehole pre drilled and casing installed to 41.1 m bgl (135 ft) from previous drill program.
MW-2	E 0485205 N 7086914	74.1 / 243'	100 / 4	38.0 – 47.2 / 125' – 155'	36.4 – 47.2 / 119' – 155'	▪ Monitoring well installed in overburden. ▪ Borehole drilled to 74.1 m bgl. ▪ Bedrock encountered at approximately 72.5 m bgl. ▪ Borehole backfilled with grout from 74.1 – 47.2 m bgl.
MW-3	E 0485143 N 7087332	17.4 / 57'	100 / 4	8.2 – 17.4 / 27' – 57'	6.7 – 17.4 / 22' – 57'	▪ Monitoring well installed in bedrock.
MW-4	E 0485205 N 7086914	82.3 / 270'	50 / 2	57.9 – 67.1 / 190' – 220'	56.4 – 67.1 / 185' – 220'	▪ Monitoring well installed in overburden. ▪ Borehole drilled to 82.3 m bgl, bedrock not encountered
MW-5	E 0484917 N 7087105	59.4 / 195'	50 / 2	50.3 - 59.4 / 165' – 195'	48.8 – 59.4 / 160' – 195'	▪ Monitoring well installed in overburden.

The following points are noted in regards to the drilling and installation program:

- MW-1 had been pre-drilled to 41.1 m bgl by Geotech Drilling under the direction of InTerraLogic during the last drilling program in November 2010. Due to drill rig mechanical issues, the well was not completed during the 2010 program.
- MW-2 was drilled to 74.1 m bgl with bedrock inferred as being intercepted at 72.5 m bgl. The borehole was backfilled with grout to 47.2 m bgl and the monitoring well constructed above this elevation.
- MW-4 was drilled to 82.3 m bgl with bedrock not being encountered. Due to mechanical issues (drill bit spinning off the rods at 82.3 mbgl), the rods and casing were tripped out of borehole, resulting in the hole collapsing to 59.4 m bgl. Following consultation with Fred Marinelli (InTerraLogic) EBA was directed not to re-drill the hole in an attempt to intercept bedrock given the extra time associated with this option along with the driller only having 3 m more casing remaining than what had already been drilled. The collapsed hole was re-drilled from 59. 4 m bgl to 67.1 m bgl and the monitoring well installed.

2.2 Well Development

Of the five wells drilled and installed, only two wells (MW-2 and MW-3) could be developed during the drilling program. Monitoring wells MW-1, MW-4 and MW-5 were too deep to airlift using compressed air. At the direction of Access and InTerraLogic, EBA did not attempt to develop these wells using an alternative method.

Monitoring well MW-3 was developed on April 13, 2011 using an airlifting method. Development was undertaken using a surging technique with groundwater airlifted for a one minute period followed by the air being turned off for one minute. This was repeated for 20 min, with the air being turned off completely for 10 minutes after the 20 min lifting cycle. This process was repeated five times. Discharge water was noted to change from murky with particulates to being clear/slightly murky at the completion of the fifth airlift cycle.

Monitoring well #2 was developed by air lifting, with the PVC tube end placed near the top section of the screen (approximately 110 ft below ground) and lifted continuously for 1.5 hours. Two more 10 ft PVC pipe lengths were then added to develop the middle section of the screen and lifted for another 3 hours. Discharge water changed from cloudy and silty during the initial stages of development to cloudy with minor silt when development was ceased.

2.3 Well Gauging

Groundwater elevations recorded from each of the wells following drilling and installation are detailed in Table 2-2.

Note that the total depth recorded for MW-4 (60.36 m bgl) is quite different to the total depth of the well when it was installed (67.1 m bgl). The reason for this variation is unknown and should be investigated following confirmation of the reduction in depth.

Table 2-2: Groundwater Elevations (April 2011)

Well ID	SWL – bTOC (m / ft)	Total Well Depth – bTOC (m / ft)	GL to TOC (m / ft)
MW-1	52.55 / 172.41	93.88 / 308	0.38 / 1.25
MW-2	31.20 / 102.36	48.01 / 157.51	0.91 / 2.99
MW-3	12.03 / 39.47	17.66 / 57.94	0.76 / 2.49
MW-4	58.67 / 192.49	60.36 / 198.03	0.71 / 2.33
MW-5	53.21 / 174.57	59.68 / 195.80	0.60 / 1.97
SWL – Static water level TOC – Top of PVC casing b – below GL – Ground Level			

2.4 Field Water Quality Analysis

Grab samples were taken from each of the monitoring wells following installation and development (where applicable) and analysed in the field for pH, electrical conductivity and temperature. The results of this analysis are shown in Table 2-3.

Table 2-3: Field Analysis (April 2011)

Well ID	pH (units)	Electrical Conductivity (μS/cm)	Temperature (°C)	Other
MW-1	6.80	583	1.4	Clear, oily residue from DHH residue, peanut oil odor
MW-2	7.49	478	1.8	Cloudy, minor fine silt
MW-3	6.64	324	0.7	Clear, no odor
MW-4*	-	-	-	-
MW-5	6.72	684	1.1	Clear, no odor

*sample unable to be obtained due to bailer sticking to side wall of well

3.0 RECOMMENDATIONS

The following recommendations are made by EBA to complete the monitoring well installation program:

- MW1, MW4 and MW5 are developed prior to groundwater sampling being undertaken.
- All well are padlocked and access to the wells restricted to those involved in the gauging and sampling of the wells.

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Access Consulting Group and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Access Consulting Group, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix A of this report.

5.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Sincerely,
EBA, A Tetra Tech Company

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APPENDIX A

APPENDIX A EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

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Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B

APPENDIX B WELL LOGS AND CONSTRUCTION DIAGRAMS

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-1
	7087116N; 484921E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
0	Borehole already drilled to 41.1 m (135 ft)					0
1						
2						5
3						10
4						
5						15
6						20
7						
8						25
9						30
10						
11						35
12						40
13						
14						45
15						50
16						
17						55
18						60
19						
20						65

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 93.9m
	REVIEWED BY: SK	COMPLETE: 4/7/2011
	DRAWING NO:	Page 1 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-1
	7087116N; 484921E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
20						
21						70
22						
23						75
24						80
25						
26						85
27						90
28						
29						95
30						100
31						
32						105
33						110
34						
35						115
36						120
37						
38						125
39						130
40						131

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 93.9m
	REVIEWED BY: SK	COMPLETE: 4/7/2011
	DRAWING NO:	Page 2 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-1
	7087116N; 484921E; Zone 8	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Monitoring well	Depth (ft)
41	SAND and GRAVEL - occasional boulder and cobble, sub-angular to sub-rounded, well graded, damp		-DHH from 41.1 to 43.3 m (135-145 ft); hole caving, swapped to ODEX, reamed out DHH hole		135
52 (▼ 4/6/2011)			- drilling noted to be hard by driller - cuttings dry - left open at 53.3 m (175 ft) for 10 min; water blown to surface when air turned on		170 (▼ 4/6/2011)
55.6	SAND - silty, some gravel, poorly graded, damp, brown				
56.5	SAND - gravelly, well graded, sub to well rounded, damp, brown				
57.7	SAND and GRAVEL - some silt, poorly graded, saturated, brown with orange and yellow mottling				
58.6	SAND - some silt, some gravel, poorly graded, damp, brown				

Depth scale (m): 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

Depth scale (ft): 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 197

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 93.9m
	REVIEWED BY: SK	COMPLETE: 4/7/2011
	DRAWING NO:	Page 3 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-1
	7087116N; 484921E; Zone 8	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
60						
61						200
61.5	SAND and GRAVEL - poorly graded, saturated, brown with orange and yellow mottling - possible boulder or cobble, dry, hard					205
63	SAND and GRAVEL - well graded, damp, brown and grey					
64	SAND and GRAVEL - well graded, saturated, grey with minor orange and white			- saturated after air tuned off and rods and casing added		210, 215
67	SAND - some gravel, poorly graded, damp, brown and grey - saturated			- damp due to air pushing water back into aquifer		220
68	SAND - some silt, fine grained, damp, dark grey			- slow drilling; returns getting stuck between casing and rods		225
70	SILT - saturated, dark grey - cuttings damp			- water added to get returns to surface approx 1-2 GPM		230, 235, 240
74	SAND and GRAVEL and SILT - well graded, sub-rounded to rounded, grey with trace brown and orange					245, 250, 255, 260
80	GRAVEL - some sand, some silt, poorly graded, sub-angular, saturated, grey					262

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-1
	7087116N; 484921E; Zone 8	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
80	gravel with trace sand, yellow and brown - decreasing yellow and brown sands, some larger rounded gravel returns			- drilling hard; ODEX not progressing, swapped to DHH - cuttings smaller and more smashed up - large solid cuttings, up to 6 cm x 5 cm x 1 cm		265
81	BEDROCK - fresh, saturated, dark grey, minor white and orange					
82	- becomes dark grey, some white					270
83						
84						275
85	- becomes light grey, some yellow					280
86						
87						285
88	- becomes slightly weathered, dark grey, some yellow and orange					290
89	- fresh, dark grey, some orange and white					
90						295
91	- dark grey, some white, trace gold					300
92						
93						305
94	EOH @ 93.9 m (308 ft) NOTES: - sufficient water and depth to meet well consturction requirements - target actually 92.4 m (303 ft), however driller drilled 1.5 m (5 ft) extra					310
95						
96						315
97						
98						320
99						325
100						328

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 93.9m
	REVIEWED BY: SK	COMPLETE: 4/7/2011
	DRAWING NO:	Page 5 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-2
	7086914N; 485205E; Zone 8	

SAMPLE TYPE	DISTURBED	NO RECOVERY	SPT	A-CASING	SHELBY TUBE	CORE
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Depth (ft)
0	SAND and GRAVEL - trace silt, medium to coarse grained sand, dry, greyish brown				0
3	- possible boulder				10
4	SAND and GRAVEL - fine grained, moist, brown				15
6	SAND and GRAVEL - fine to medium grained sand, brown, moist				20
9	SAND and GRAVEL - some silt, fine to medium grained sand, moist, brown				30
12	- moist to damp				40
15	- damp				50
17	GRAVEL - some sand, fine grained gravel, subrounded, dry, grey, dusty				55
17.5	GRAVEL - some sand, coarse grained gravel, some medium to coarse sand, subrounded, dry, grey, dusty				60
21					69

EBA Engineering Consultants Ltd.	LOGGED BY: CM	COMPLETION DEPTH: 74.1m
	REVIEWED BY: SK	COMPLETE: 4/21/2011
	DRAWING NO:	Page 1 of 4

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-2
	7086914N; 485205E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Depth (ft)
21				70
21.3	SAND and GRAVEL - moist to damp, brown			
22				
23	SAND - some silt, fine grained sand, damp, brown			75
23.3	SAND and GRAVEL - medium to coarse grained sand, fine gravel, moist, brown			
24				
24.3	GRAVEL - some sand, fine to medium grained gravel, moist, brown			80
25	GRAVEL - some sand, coarse grained gravel, medium to coarse sand, subrounded, dry, grey, dusty			
26	GRAVEL - some sand, moist, brown			85
26.3	SAND - fine grained sand, moist, brown - becomes wet			
27	GRAVEL - some sand, fine grained gravel, medium to coarse grained sand, moist, brown			90
28				
29				95
30	SAND - fine to medium grained, damp, brown			100
31	GRAVEL - trace silt, medium to coarse grained gravel, damp, brown			
32				105
33				
34	SAND - medium to coarse grained sand, wet, brown			110
35	SAND and GRAVEL - coarse grained sand, saturated, brown			115
36				
37	GRAVEL - some sand and silt, medium to fine grained sand, brown			120
38				125
39	- increasing silt		- water added to assist returns to surface	130
40	SAND and GRAVEL - trace silt, coarse grained sand with some medium grained sand, saturated, grey			
41				135
42				138

EBA Engineering Consultants Ltd.	LOGGED BY: CM	COMPLETION DEPTH: 74.1m
	REVIEWED BY: SK	COMPLETE: 4/21/2011
	DRAWING NO:	Page 2 of 4

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-2
	7086914N; 485205E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
42–56				- tripped out 6" rods, hole sloughed to approx. 47.2 m (155 ft)		140–185
56–63	CLAY - grey					185–207

Depth (m) scale: 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63

Depth (ft) scale: 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 207

EBA Engineering Consultants Ltd.	LOGGED BY: CM	COMPLETION DEPTH: 74.1m
	REVIEWED BY: SK	COMPLETE: 4/21/2011
	DRAWING NO:	Page 3 of 4

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-2
	7086914N; 485205E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Monitoring well	Depth (ft)
63–72.5					210–235
72.5	BEDROCK		- drilling hard and slow		240
74.1	EOH @ 74.1 m (243 ft) NOTES: - target reached (bedrock)				
84					275

Depth (m) scale: 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84

Depth (ft) scale: 210, 215, 220, 225, 230, 235, 240, 245, 250, 255, 260, 265, 270, 275, 276

EBA Engineering Consultants Ltd.	LOGGED BY: CM	COMPLETION DEPTH: 74.1m
	REVIEWED BY: SK	COMPLETE: 4/21/2011
	DRAWING NO:	Page 4 of 4

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-3
	7087332N; 485143E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
0	SAND and GRAVEL - moderately to well sorted, subangular to subrounded, dry, grey and brown					0
1	SAND - uniformly graded, fine grained sand, damp, brown					
	SAND and GRAVEL - poorly sorted, subrounded with some subangular and rounded inclusions, dry, greyey brown with some white and trace yellow					5
2	BEDROCK (Quartzite) - slightly weathered with fine sand evident on weathered surfaces, low strength, dry, grey, some brown and white, trace pyrite					
3						10
4	BEDROCK (Quartzite) - fresh, low strength, dry, grey and white, trace brown			- drilling fast		
5	- becoming harder					15
6						20
7						
8						25
9						30
10						
11	- trace water in returns after air turned off and rods added					35
12 (4/12/2011)						40 (4/12/2011)
13						
14	- cuttings moist					45
15						50
16						
17	- significant water after air turned off and rods added					55
18	EOH @ 17.4 m (57.0 ft)					
	NOTES: sufficient water and depth to meet well construction requirements					60
19						
20						65

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 17.4m
	REVIEWED BY: SK	COMPLETE: 4/13/2011
	DRAWING NO:	Page 1 of 1

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-4
	7086914N; 485205E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Monitoring well	Depth (ft)
0	SAND and GRAVEL - moderately sorted, subangular to subrounded, dry, grey and brown				0
1.5	SAND - fine grained, damp, brown				5
1.9	SAND and GRAVEL - moderately sorted, fine to coarse grained sand, subangular to subrounded, dry, grey and brown - as above with occasional schist fragments and well rounded gravels				10
3.8	SAND - trace gravel,uniformly sorted, fine grained sand, dry, brown				
4.3	SAND and GRAVEL - moderately sorted, fine to coarse grained sand, subangular to subrounded, dry, grey and brown				15, 20, 25
8.6	SAND and GRAVEL - poorly sorted, fine grained sand, some coarse grained sand, subangular to subrounded, dry, grey, brown and white				
9.3	SAND - fine grained, damp, brown				30
9.9	SAND - uniformly graded, fine grained, moist to wet, brown/slightly grey				35
11.4	SAND and GRAVEL - poorly sorted, fine grained sand with some coarse grained sand, subangular to subrounded, dry, grey, brown and white				
12.1	SAND and GRAVEL - well sorted, coarse grained sand with some fine grained sand, subangular with occasional subrounded gravels, dry, grey, some white and brown				40, 45
15.3	SAND - some gravel, poorly sorted, gravel subrounded, dry, brown				50
15.9	SAND - uniformly sorted, fine grained, damp, brown				
16.9	SAND - uniformly sorted, fine grained, moist to wet, brown/slightly grey				55
18.1	SAND and GRAVEL - moderately sorted, fine to coarse grained, subangular to subrounded, dry, grey, some brown				60, 65
20					

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 82.3m
	REVIEWED BY: SK	COMPLETE: 4/18/2011
	DRAWING NO:	Page 1 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-4
	7086914N; 485205E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Depth (ft)
20	SAND and GRAVEL - well sorted, coarse grained sand, some fine grained sand, subangular with some subrounded gravels, dry, grey, some white and brown			
21				70
22				
23				75
24				80
25				
26				85
27	- trace schist present			90
28				
29				95
30	SAND - well sorted, fine and medium grained sand, dry, grey, brown and light brown			100
31	SAND and GRAVEL - well sorted, coarse grained sand, some fine to medium grained sand, fine grained gravel, rounded to subrounded, dry, grey, brown and white			
32				105
33	- as above with occasional schist fragments and well rounded gravels			
	SILT - soft, moist to damp, brown		- water in returns after casing and rods added - not significant amount - driller started to inject water as cuttings not returning to surface	110
34				
35	- became dark grey in colour			115
36				
37			- no water in cuttings after rods and casing added	120
38				125
39	SILTY GRAVEL - some sand, moderately sorted, generally subrounded, moist to damp, grey, brown and orange			
40	SAND and GRAVEL - trace silt, well graded, fine to coarse grained sand, fine grained gravel, subrounded, moist, grey, brown and orange			130

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 82.3m
	REVIEWED BY: SK	COMPLETE: 4/18/2011
	DRAWING NO:	Page 2 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-4
	7086914N; 485205E; Zone 8	

SAMPLE TYPE	DISTURBED	NO RECOVERY	SPT	A-CASING	SHELBY TUBE	CORE
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
40	- becoming drier, less silt					
41	SAND and GRAVEL - well graded, fine to coarse grained sand, fine grained gravel, subrounded, dry, grey with some orange and white					135
	GRAVEL - some sand, moderately to well graded, fine grained gravel, subrounded, dry, grey with trace white					
42	SAND - well graded, fine to medium grained sand, subrounded, dry, grey, brown, orange and white					
43	GRAVEL and SAND - moderately graded, fine grained gravel and fine grained sand, subrounded, damp, brown, grey, orange and white					140
	- dry					
44						145
45						
46						150
47	- boulder/cobble to around 46.5 m					155
48						
49						160
50						165
51						
52						170
53						175
54						
55						180
56						185
57	- boulder/cobble to around 56.7 m					
58						190
59	SAND - some gravel, well graded, fine to coarse grained sand, fine grained gravel, subangular to subrounded, damp, grey, orange and white				4/17/2011	195
60	- saturated					

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 82.3m
	REVIEWED BY: SK	COMPLETE: 4/18/2011
	DRAWING NO:	Page 3 of 5

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-4
	7086914N; 485205E; Zone 8	

SAMPLE TYPE	DISTURBED	NO RECOVERY	SPT	A-CASING	SHELBY TUBE	CORE
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
60						
61						200
62						
63						205
64						210
65						
66						215
67						220
68	SAND - well graded, fine to coarse grained, subrounded to rounded, saturated, brown with grey, white and orange					
69						225
70						230
71						
72						235
73						240
74						
75						245
76						250
77						
78						255
79	- increasing fine sand and silt					260
80				- slow drilling, bit worn?		262

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 82.3m
	REVIEWED BY: SK	COMPLETE: 4/18/2011
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Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-4
	7086914N; 485205E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
80						
81						265
82						270
83	EOH @ 82.3 m (270 ft) NOTE: bit not drilling, too worn. Bedrock not reached. Hole collapsed to 59.4 m (195 ft) when 4" casing pulled. Redrilled to 67.1 m (220 ft).					
84						275
85						280
86						
87						285
88						
89						290
90						295
91						
92						300
93						305
94						
95						310
96						315
97						
98						320
99						325
100						328

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 82.3m
	REVIEWED BY: SK	COMPLETE: 4/18/2011
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Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-5
	7087105N; 484917E; Zone 8	

SAMPLE TYPE	DISTURBED	NO RECOVERY	SPT	A-CASING	SHELBY TUBE	CORE
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Depth (ft)
0	SAND and SILT (FILL) - some gravel and cobble) - poorly graded, fine grained sand, subangular to subrounded, dry, brown to light brown, ice in returns			0
1	COBBLE (FILL) - dry, grey, some brown and white			
	SAND (FILL) - some silt and gravel), poorly graded, fine grained sand, moist with some frozen regions, brown, organic inclusions (tree branches),			5
2	SILT - some sand and gravel, moderately sorted, gravel rounded, wet, brown			
	SILT -damp, brown			
3	- water in returns; melted permafrost as ground frozen			10
4				
5				15
6				20
7	SAND and GRAVEL - poorly graded, subangular to subrounded, wet (water being added), grey, some white, trace orange		- water added from 20ft as cuttings not returning to surface	
	GRAVEL - some sand and silt, poorly graded, rounded to subrounded, dry, grey, trace orange and white			25
8	SAND and SILT and GRAVEL - occasional cobble, moderately sorted, subrounded, dry, brown and grey			
9				30
10				35
11	SILT - trace gravel, damp, brown - boulder or cobble			
12	SILT - some cobble, subrounded to subangular cobble, damp, brown			40
	SAND and GRAVEL - trace silt, poorly graded, gravel subrounded to subangular, sand subrounded to rounded, dry, light brown and grey			
13				
14				45
15				50
16	SAND - some silt, well graded, subangular to subrounded moist, grey, brown and orange - increasing gravel, subrounded to subangular			
17				55
18				60
19				
20				65

EBA Engineering Consultants Ltd.

LOGGED BY: AS	COMPLETION DEPTH: 59.4m
REVIEWED BY: SK	COMPLETE: 4/10/2011
DRAWING NO:	Page 1 of 4

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-5
	7087105N; 484917E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Monitoring well	Depth (ft)
20	SAND - some gravel,well graded, rounded to subrounded, damp, light brown, some grey and orange				
21	- increasing moisture, damp to moist				70
22					
23	SAND and SILT - sand fine grained, soft, moist, brown				75
24					80
25					
26			- water added as cuttings not returning to surface		85
27	- became greyer in colour				90
28					
29					95
30					100
31					
32					105
33					110
34	SAND and GRAVEL - occasional boulder/cobble, well graded, subangular to subrounded, damp, light brown and grey, some white and orange				
35					115
36	- dry				120
37					
38					125
39					130
40					131

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 59.4m
	REVIEWED BY: SK	COMPLETE: 4/10/2011
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Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-5
	7087105N; 484917E; Zone 8	

SAMPLE TYPE	DISTURBED	NO RECOVERY	SPT	A-CASING	SHELBY TUBE	CORE
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS	Depth (ft)
40				
41				135
42				
43				140
44				145
45				
46				150
47				155
48				
49				160
50				165
51				
52				170
53 (▼ 4/9/2011)			- cuttings wet after air turned off to add rods and casing, cuttings dry after approx 30 sec of air being turned on	175 (▼ 4/9/2011)
54				
55				180
56	- cuttings slightly darker, increased moisture			185
57	- cuttings wet and water blown from hole after rods and casing added - return water changed from brown to orange/brown		- cuttings wet and water blown from hole after rods and casing added	
58				190
59				195
60	EOH @ 59.4 m (195 ft)			197

Monitoring well

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 59.4m
	REVIEWED BY: SK	COMPLETE: 4/10/2011
	DRAWING NO:	Page 3 of 4

Monitoring Well Installation	CLIENT: Access Consulting Group	PROJECT NO. - BOREHOLE NO.
Keno City, YT	DRILL: Air Rotary	W23101422-MW-5
	7087105N; 484917E; Zone 8	

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
60	NOTE: sufficient water and depth to meet well construction requirements					

EBA Engineering Consultants Ltd.	LOGGED BY: AS	COMPLETION DEPTH: 59.4m
	REVIEWED BY: SK	COMPLETE: 4/10/2011
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ENVIRONMENTAL W23101422.GPJ EBA.GDT 11/7/5

Attachment B

Completion Report for Onek Monitoring Well

A TETRA TECH COMPANY

July 15, 2011

ISSUED FOR USE
EBA FILE: W23101440
Via Email: eallen@accessconsulting.com

Alexco Resource Corp.
#3 Calcite Business Centre
151 Industrial Road
Whitehorse, Yukon Y1A 2V3

Attention: Mr. Ethan Allen, M.Sc.

Subject: Consulting Services for the Installation of a Monitoring Well at Onek Mine, Keno Hill, Yukon

1.0 INTRODUCTION

1.1 Background

EBA, A Tetra Tech Company (EBA) was engaged by Alexco Resource Corp. (Alexco) to provide hydrogeological consulting services during the installation of one (1) groundwater monitoring well at the Onek Mine in the Keno Hill area, Yukon. The work was performed in general accordance with the scope of work set out in our proposal (Doc Ref PW23100003_Alexco_Onek_MW) dated March 30, 2011 and accepted by Alexco on May 16, 2011.

1.2 Purpose

The purpose of EBA's work was to design a groundwater monitoring well for installation in a pre-drilled exploration borehole and to provide onsite co-ordination during construction of the well.

1.3 Scope and Sequence of Work

The scope of work included:

- design of a groundwater monitoring well that would enable long term gauging of groundwater elevations at the Onek Mine site in the Keno Hill area;
- co-ordinate the installation and construction the groundwater monitoring well;
- in addition to the agreed scope, onsite testing of the groundwater monitoring well for field parameters (pH, EC, temperature) was also undertaken.

The work was conducted with regard to the scope of work provided to EBA by Alexco and additional verbal directions provided by Ethan Allen and Scott Davidson of Alexco during the fieldwork program.

EBA, A Tetra Tech Company
Calcite Business Centre, Unit 6, 151 Industrial Road
Whitehorse, YT Y1A 2V3 CANADA
p. 867.668.3068 f. 867.668.4349

2.0 METHOD AND RESULTS

2.1 Groundwater Monitoring Well Design and Installation

EBA was advised by Alexco that the purpose of the monitoring well was to enable long term monitoring of the groundwater elevation in the vicinity of the Onek mine site. Given the potential for the groundwater elevation to be lowered through dewatering during proposed future mining activities, the well design agreed by EBA and Alexco incorporated a long screen interval to accurately measure the unconfined water table elevation.

It is noted that the long screened interval does not allow for discrete groundwater samples to be obtained from individual depths within the well.

The groundwater monitoring well was installed in an exploratory diamond drill hole identified by Alexco as K-11-0337. The borehole was drilled by Kluane Drilling between April 11, 2011 and April 13. Key borehole details are provided in Table 2-1.

Table 2-1: Key Borehole Details

Alexco Borehole ID	Driller	Started	Completed	Total Depth (m bgl)	Core Size	Location (UTM NAD83, Zone 8)	Ground Elevation (m asl)
K-11-0337	Kluane Drilling	11/4/2011	13/4/2011	76.20	HTW OD - 91.0 mm ID – 81.6 mm	E 485382.616 N 7087276.948	998.86
m – meters bgl – below ground level asl – above sea level							

The monitoring well was constructed following completion of the exploratory borehole. The well was constructed using 50 mm PVC casing and factory-slotted screen with threaded joints.

Due to lubricants used during the coring process potentially smearing the borehole walls (possibly leading to sticking and bridging of the sand/bentonite/backfill material during installation), the drill rods were left in the borehole and the PVC well installed within the rods. Systematically, small amounts of sand/bentonite/backfill (approx. 0.2 to 0.4 m) were poured in to the annulus between the drill rods and the well, then the rods raised allowing the sand/bentonite/backfill to fall into the annulus between the borehole wall and PVC casing. This process was repeated to surface. This method was employed to minimize the risk of bridging. During installation, the well was lifted approximately 1.2 m to dislodge sand that had bridged during pouring. When lifted, the bottom 1.2 m of the borehole had filled with sand and the well was not able to be lowered back to its original depth.

Given the difficulties inherent in installing the 50 mm monitoring well in the narrow internal diameter HTW rods (typically bridging of sand and bentonite), a Geotech Drilling representative with skill in monitoring well installations assisted in the installation of the monitoring well. This was done with the approval of Alexco to save time and minimise the potential for the installation to fail.

The final well construction details are summarized below and in Table 2-2. Well logs and construction diagrams are provided in Appendix B. EBA notes that the lithological codes detailed in the soil description column of the logs were provided by Alexco. Lithological descriptions were not provided to EBA for inclusion on logs.

- Alternating lengths of 3 m of screened PVC casing then 6 m of solid PVC casing from the well base (74.98 m bgl) to 17.07 m bgl.
- Solid casing from ground level to 17.07 m bgl.
- A sand filter pack was installed from the base of the borehole to 15.24 m bgl.
- A bentonite seal at the top of the sand filter pack from 13.41 m bgl to 15.24 m bgl.
- The borehole was backfilled with native soils from 13.41 m bgl to approximately 1.5 m bgl.
- A bentonite surface seal was placed to prevent ingress of surface water.

Table 2-2: Key Well Details

Alexco Borehole ID	Drilled Depth (m bgl)	Total Borehole Depth (m bTOC)	Casing Diameter (mm)	Borehole Diameter (mm)	Screened PVC Intervals (m bgl)	Solid PVC Intervals (m bgl)	Filter Pack Interval (m bgl)
K-11-0337	76.20	76.60	50	91	17.07 - 20.12 26.21 - 29.26 35.36 - 38.40 44.50 - 47.55 53.64 - 56.69 62.79 - 65.84 71.93 - 74.98	0.00 – 17.07 20.12 - 26.21 29.26 - 35.36 38.40 - 44.50 47.55 - 53.64 56.69 - 62.79 65.84 - 71.93	15.24 – 76.20
m – meters bTOC – below top of PVC casing bgl – below ground level							

The following points are noted in regards to the drilling and installation program:

- K-11-0337 had been pre-drilled to 76.20 m bgl by Kluane Drilling under the direction of Alexco as part of the mining exploratory drilling program.
- The monitoring well was installed by a representative of Geotech Drilling with installation coordinated by an EBA representative.
- Alternating segments of screened PVC and solid PVC pipe were installed to maximize the screened interval whilst also minimizing costs and equipment used. Following discussion with Alexco representatives (Ethan Allen and Scot Davidson), it was concluded that designing the well in this manner would enable long term monitoring of groundwater elevations both under current conditions as well as during mine dewatering, which may substantially lower groundwater elevations .

The following products were used in the construction of the well:

- Target Products 10/20 Filter Sand, grain size 0.85 mm – 1.25mm (for filter pack)
- Holeplug 3/8 Coarse Grade Bentonite (for sealing the borehole).
- Soil sourced from the local vicinity (to backfill the borehole above the water table.

2.2 Well Gauging

The groundwater elevation recorded from K-11-0337 on April 15, 2011, two days after drilling and installation is detailed in Table 2-3.

Table 2-3: Groundwater Elevations (April 2011)

Alexco Borehole ID	Date	gl elevation (m asl)	gl to TOC (m)	SWL (m bTOC)	SWL (m bgl)	SWL (m asl)
K-11-0337	April 15, 2011	998.86	0.40	38.47	38.07	960.79

SWL – Static water level m – meters TOC – Top of PVC casing b – below gl – Ground Level
asl – above sea level

2.3 Field Water Quality Analysis

A grab sample was taken from the monitoring well following installation and analysed in the field for pH, electrical conductivity and temperature. The results of this analysis are shown in Table 2-4.

Table 2-4: Field Analysis (April 2011)

Alexco Borehole ID	Date	pH	Electrical Conductivity (µS/cm)	Temperature (°C)	Other
K-11-0337	April 15, 2011	7.09	645	2.0	Clear with some clear/white particulates present.

3.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Alexco Resource Corp. and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Alexco Resource Corp., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix A of this report.

4.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Sincerely,
EBA, A Tetra Tech Company

Adam Seeley, M.Sc.
Hydrogeologist
Pacific Region
Direct Line: 867.668.2071 x243
aseeley@eba.ca

Stephan Klump, PhD
Hydrogeologist, Team Lead
Pacific Region
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APPENDIX A

APPENDIX A EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA’s client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA’s Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B

APPENDIX B WELL LOG AND CONSTRUCTION DIAGRAM

Monitoring Well Installation	CLIENT: Alexco Resource Corp.	PROJECT NO. - BOREHOLE NO.
Onek Mine	DRILL: Diamond Core	Alexco ID: K-11-0337
Keno Hill, YT	7087276.948N; 485382.6162E; Zone 8	Ground Elevation (m asl): 998.86

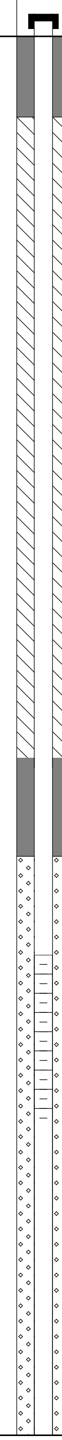
SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	NOTES & COMMENTS
0	OVB		**Additional Well Details:** Borehole Diameter: 91 mm Casing Diameter: 50 mm Stickup (m agl): 0.40 m SWL 4/15/2011 (m asL): 960.79
3.4	ICQS		
5	TQTZT		
12	GNST		
18.5	TQTZT		
20.4	GNST		
22.9	ICQS		
24.5	QTZT		

Depth (m): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

Monitoring well



Depth (ft): 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

	LOGGED BY: Client	COMPLETION DEPTH: 76.20 m
eba A TETRA TECH COMPANY	REVIEWED BY: SK	COMPLETE: 4/13/2011
	DRAWING NO:	Page 1 of 3

Monitoring Well Installation	CLIENT: Alexco Resource Corp.	PROJECT NO. - BOREHOLE NO.
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BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
26						
27						
28						90
29	TQTZT					95
30						
31	GNST					100
32						105
33						
34						110
35	MCQ					115
36						
37						120
38	GNST					125
39	GNST TQTZT					
40						130
41	ICQS					135
42						
43						140
44						145
45	CHSCH					
46						150
47						155
48						
49						160
50						165
51						
52						170 171

	LOGGED BY: Client	COMPLETION DEPTH: 76.20 m
eba A TETRA TECH COMPANY	REVIEWED BY: SK	COMPLETE: 4/13/2011
	DRAWING NO:	Page 2 of 3

Monitoring Well Installation	CLIENT: Alexco Resource Corp.	PROJECT NO. - BOREHOLE NO.
Onek Mine	DRILL: Diamond Core	Alexco ID: K-11-0337
Keno Hill, YT	7087276.948N; 485382.6162E; Zone 8	Ground Elevation (m asl): 998.86

SAMPLE TYPE: DISTURBED, NO RECOVERY, SPT, A-CASING, SHELBY TUBE, CORE

BACKFILL TYPE: BENTONITE, PEA GRAVEL, SLOUGH, GROUT, DRILL CUTTINGS, SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE		NOTES & COMMENTS	Monitoring well	Depth (ft)
52–55						175, 180
55	GSCH					
56	ICQS					185
57–63	GNST					190, 195, 200, 205
63	ICQS					
64	TQTZT					210
66	GSCH					215, 220, 225
69	TQTZT					230, 235, 240, 245
75	ICQS					
75.5	QTZT					250
76.2	EOH @ 76.20 m					
77–78						255, 256

LOGGED BY: Client	COMPLETION DEPTH: 76.20 m
REVIEWED BY: SK	COMPLETE: 4/13/2011
DRAWING NO:	Page 3 of 3

eba A TETRA TECH COMPANY

APPENDIX B

SRK CONSULTING

2010 BELLEKENO GROUNDWATER PROGRAM

Alexco Keno Hill Mining Corp
1150-200 Granville Street
Vancouver BC V6C 1S4

May 14, 2010

Yukon Water Board
Suite 106, 419 Range Road
Whitehorse, Yukon   Y1A 3V1

Attention: Ms. Joelle Janes, Licencing Officer

Dear Ms. Janes:

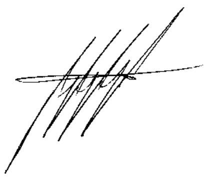
Re: Bellekeno Mine Water Licence Application QZ09-092, Supplemental Information

Please see attached finalized SRK report on groundwater investigations undertaken in support of the Bellekeno Mine Type A water licence application. Findings of this report while it was in draft form were referred to in our earlier responses during adequacy review (e.g. Exhibit 1.10 question 73).

Please note that Alexco Keno Hill Mining Corp. accepts and agrees with all recommendations of this SRK report.

Should you have any questions, please contact our office at (604)-663-4888.

Sincerely,
Alexco Keno Hill Mining Corp



Robert L. McIntyre, R.E.T.
Vice President, Business Development
Alexco Keno Hill Mining Corp

cc. external   D. Buyck, FNNND, R. Holmes, YG EM&R, R. Lamb, YG Environment, C. Scheu, Yukon Water Board, S. Arell, Environment Canada
cc. internal   C.Nauman, B.Thrall, T.Hall, D.Whittle, Alexco Resource Corp.
E. Allen, T. Lunday, Access Consulting Group

Attachments:

- *SRK Report 2010 Bellekeno Groundwater Program*

2010 Bellekeno Groundwater Program

Prepared for:

Alexco Resource Corporation

Prepared by:

SRK Consulting
Engineers and Scientists

Project Reference Number
SRK 1CA009.003

May 2010

2010 Bellekeno Groundwater Program

Alexco Resource Corporation

Suite 1150 – 200 Granville Street
Vancouver, BC, V6C 1S4

SRK Consulting (Canada) Inc.
Suite 2200, 1066 West Hastings Street
Vancouver, B.C. V6E 3X2

Tel: 604.681.4196 Fax: 604.687.5532
E-mail: vancouver@srk.com Web site: www.srk.com

SRK Project Number 1CA009.003

May 2010

Executive Summary

Alexco Resources Corporation is proposing to construct the Bellekeno Mill and dry stack tailings facility (DSTF) at the Flame & Moth area approximately one kilometer west of Keno City, Yukon. SRK Consulting (Canada) Inc. was contracted by Alexco to plan and implement a groundwater investigation with the objectives of installing a groundwater monitoring system around the mill and DSTF sites, collecting information to update the conceptual model for groundwater flow, and assessing the potential for impacts to groundwater quality and quantity.

Three monitoring wells were drilled and completed in early February 2010 (PH2, PH5 and PH6). Drilling was conducted with an air-rotary drill and PVC monitoring wells were installed in each drill hole with sand packs and bentonite annular seals. Vibrating wire pressure transducers were attached to the outside of PH5 and PH6 to allow collection of water level data in the event the monitoring wells freeze closed.

In the DSTF area at the north end of the site, bedrock is found at relatively shallow depths, with the thickness of overburden materials increasing towards the marshy ground to the west of the site. Only minor groundwater was identified in overburden sediments; bedrock is the primary aquifer. On the southern edge of the site, below the proposed mill area, overburden is much thicker and significant flow was produced during drilling of PH5 (estimated at 15 L/s) suggesting that groundwater flow through these overburden materials is significant.

Water levels measured in the newly installed monitoring wells were compared to those in Well #3 in Keno City to determine groundwater flow directions. Well #3, which is about 80m south of the community supply well (the Firehall Well), was used to represent water levels in the Keno City area. The water level in the Firehall Well could not be measured due to the wellhead construction. Drill logs indicate that both Well #3 and the Firehall Well get water from bedrock. The water table drops by about 4 m between Keno City and PH6 on the eastern edge of the site, then drops steeply by another 20 or so meters under the site. The groundwater flow direction is from Keno City towards the site.

The water level in Well#3 was monitored continuously with a datalogger for a period of about 5 days during the investigation. During this period, it was reported by the Water Steward that approximately 4,000 imperial gallons of water were delivered to local residents. Well #3 water level data indicate no effects from pumping of the Firehall Well to replenish storage tanks, nor effects from day-to-day supply to the public shower and laundry facilities. These observations indicate that either the aquifer is not being significantly drawn down or that recharge is sufficient for the aquifer to quickly reciver from any periods of lower water levels.

Samples from the new monitoring wells were analysed for water quality. Results indicate higher concentrations of chloride, sulphate and dissolved zinc at PH6 relative to PH5. PH6 is located uphill of the proposed DSTF on the eastern edge of the site, closest to Keno City and down gradient of the

city dump. It is also in close proximity to the Flame & Moth vein fault and water quality may indicate the influence of the city dump or natural mineralization.

Potential effects on the groundwater system due to the site are limited to water quality. The current plans for mill water supply do not include groundwater extraction, thus there will be no effects on groundwater quantities. Water management structures planned as part of the mill and DSTF construction, including an underdrain for the DSTF and diversion ditches, are designed to intercept and convey any site runoff to a lined pond, from which water will be treated prior to discharge or re-used as part of the mill water supply. Leakage from or bypass of water management structures is the only potential pathway for effects to groundwater quality. These structures have been graded and designed to freely drain to the mill pond. The combination of compaction and sloping of the DSTF to promote runoff and the free-draining nature of the interception structures will all limit the chance of significant leakage.

The risk to water quality at the Keno City Firehall Well and other Keno City private wells is considered insignificant. Groundwater flows east to west, away from Keno City, and the water level in Well #3 is similar to the water level measured in the Firehall Well during construction in 1987, indicating that either there has been no significant drawdown of the Keno City bedrock aquifer or that it recovers from pumping during periods of relatively low extraction. In either case, the groundwater flow direction (i.e., the entire local water table) would have to be reversed for an extended period of time for water from the site to reach Keno City wells. Such a reversal would require pumping at rates many times greater than currently possible and over durations long enough to completely change the regional groundwater flow system.

It is recommended that groundwater quality and levels be monitored regularly:

- The groundwater monitoring wells should be sampled and water levels recorded twice annually, if not frozen and accessible. If frozen, the vibrating wire transducers on PH6 and PH5 should be monitored quarterly.
- If the monitoring wells are found to freeze and remain frozen, the wells should be freeze protected or alternate methods should be implemented to allow groundwater sampling.
- Following finalization of the mill and DSTF engineering, three monitoring points should be located within shallow sediments down gradient of the DSTF drainage ditches and mill pond to monitor for potential ditch leakage. These wells should be sampled twice during the summer.

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1 Introduction

This report presents results of groundwater investigations at the proposed Bellekeno Flame and Moth mill site and dry stack tailings facility (DSTF). The work was completed by SRK Consulting (Canada) Inc. for Alexco Resources Corporation.

The scope of this program included:

- A review of available data and a meeting with Keno City residents to discuss groundwater issues related to the project.
- Design and implementation of a groundwater field program.
- Interpretation of field program results, an update of the conceptual model for groundwater flow and an updated assessment of potential effects to groundwater related to the proposed Flame and Moth mill and DSTF.
- Recommendations for future groundwater monitoring.

2 Background

As part of the proposed Bellekeno development, Alexco plans to build a mill and DSTF at the Flame and Moth site (the site), which is located approximately one kilometer west of Keno City, Yukon. The general site layout is shown in Figure 1. Groundwater characterization and monitoring will be required as part of the site operations and water management.

Keno City obtains potable water from groundwater extraction. Many residents and business' are supplied from the Firehall Well. Water is delivered by truck to those with storage tanks; and piped directly to the public laundry and restroom facilities. A tap is provided for general public use. Maintaining the quality and quantity of the groundwater resource is an important issue for residents. From the perspective of the environment, groundwater is primarily a pathway from the site.

Surface water quality and aquatic resources have also been identified as a valued component by local First Nations, governments and the local community. Potential effects to groundwater that could contribute to effects on Lightning Creek and the wetlands above Christal Lake are also considered.

2.1 Flame & Moth Mill and DSTF Plan

Ore from the Bellekeno underground development will be hauled to the mill site, where it will be ground and separated into concentrate and tailings. The general site layout is shown in Figure 1.

Tailings from the mill will be dewatered and managed in two streams:

1. High-pyrite tailings will be hauled back to the underground workings, mixed with cement and placed as backfill.

2. Low-pyrite tailings will be placed in the dry stack tailings facility, north of the mill at the Flame and Moth site. Low-pyrite tailings not placed in the DSTF will also be hauled to the underground workings.

Design of the surface water management infrastructure and DSTF has been completed by EBA Engineering (EBA 2010a, 2010b). Water management structures have been incorporated to minimize, divert or treat water contacting the DSTF and mill facilities. The DSTF will be located adjacent to the mill, on a westward facing slope. Low-pyrite tailings routed to the DSTF will be end-dumped, graded and compacted in lifts. Water management structures will include:

- An uphill berm to divert runoff around the DSTF.
- A 0.5 m drainage blanket beneath the entire DSTF for seepage interception.
- A series of runoff collection ditches along the toe of the DSTF.
- A runoff conveyance flume that will route water from the drainage blanket and collection ditches to the mill pond.
- Grading of the DSTF surface to increase runoff and minimize infiltration.
- Placement of a till cover over the DSTF to further reduce infiltration of precipitation, minimize dust and promote re-growth of vegetation.
- A low permeability till pad will be constructed underneath the ore stockpile, which will be milled at closure.

Site runoff and seepage from the DSTF will be collected in a lined runoff collection pond (i.e., the mill pond). The mill pond will be located in the topographically lowest area of the site, below the mill and DSTF. Water in the pond will be used to supplement mill water supply or treated, if necessary, and discharged.

Mill operations will use re-cycled process water with a freshwater “makeup”, or supplement, of about 43 m^3/day (about 8 US gallons per minute). Freshwater will be supplied from the Galkeno 900 water treatment facility (WTF) and from the mill pond. Extraction from Cristal Lake or Cristal Creek will be used as a backup if necessary. Water from the Galkeno 900 WTF will be conveyed to the mill via an insulated, heat-traced pipeline. The current plan does not include a provision for groundwater extraction, but notes that if investigations indicate that groundwater can be extracted without impact to users or the environment, use may be assessed (Access, 2009).

2.2 Available Data

Data available at the commencement of this program included both site-specific data and general information on local and regional geology. Information on subsurface conditions included geotechnical drilling and test pit logs for the mill and DSTF site, subsurface temperature data from thermistor strings installed at the site and drill logs for a limited number of Keno City wells. Current water level data was only available from existing monitoring wells at the mill and DSTF site. The only water level data for Keno City was that collected during well installation and reported on well logs.

2.3 Previous Assessments of Potential Groundwater Impacts

SRK had previously completed initial assessments of potential impacts of the proposed mill and DSTF site on groundwater quantity and quality (SRK, 2009a; SRK, 2009b). At the time that those assessments were completed, there were no groundwater monitoring wells at the site and little information available about the Keno City water supply, thus, interpretations were based on available mine plans, hydrogeologic principles and previous work in the Keno Hill district and overall region.

The initial assessment indicate that the risks of impacts to the Keno City water supply were low, but that data on groundwater flow directions and Keno City water well pumping rates were needed before a definitive conclusion and be drawn available.

3 Field Program

3.1 Site Reconnaissance and Initial Meeting with Keno City Residents

Dan Mackie, Senior Consultant with SRK, inspected the site between January 14 and 19, 2010. The visit included a reconnaissance of potential drill hole locations and access, a tour and visual inspection of the Keno City water supply system, and a meeting with residents of Keno City. Findings included:

Keno City water supply – Residents, businesses and services not connected to a private well are supplied by Keno City. Keno City extracts groundwater from a well located next to the Keno City firehall. The well is called the Firehall well (Yukon Department of Environment Well ID 213140003) and has the following details:

- The well was drilled in 1987 to a total depth of 93 m. Bedrock was intersected at a depth of 55 m and steel casing was seated about 2 m into bedrock. The well is an open bedrock well from about 57 m to 93 m (i.e., there is no screen in the well). The well log does not include any information about a surface seal.
- The submersible pump is a Grundfos 15 SQ15C-290 with a rated capacity of 0.95 to 1.3 L/s (12.5 to 16.7 Igpm). The well is housed in an unlocked plywood box with ditching to divert runoff. The wellhead itself does not allow access for water level measurement; the access port typically used for a water level sounding tube is being used to run heat trace for the pump riser pipe.
- The static water level during drilling was reported as 55 m below ground, or at about the overburden – bedrock contact. Due to the wellhead construction, water levels cannot be measured without removing the heat trace or disassembling the wellhead. Both would probably require deactivation of the well and removal of the pump.
- The well and water quality are managed by the town Water Steward. Water is disinfected by chlorination within the firehall. Water is stored in multiple tanks and delivered to individual tanks with a dedicated water truck. Water quality data, including physical parameters, dissolved

anions and total metals are available since 1998; dissolved metals have been analyzed on occasion. Water quality has met the Guidelines for Canadian Drinking Water Quality for the majority of parameters, with occasional exceedances of iron and lead, though notes indicate the lead exceedance may have resulted from inappropriate sampling methods.

- Historically, water extraction rates have not been quantified. Deliveries are recorded and provide the only long term record of approximate water use. The supply system has a cumulative flow meter, but it has not been monitored regularly.

The well log is included in Appendix A1. Water quality data is included in Appendix A2. A review of the water supply system, completed in May 2002 by N.A. Jacobsen, P.Eng. is included as Appendix A3.

Meeting with Keno City residents – On January 15, 2010, Mr. Mackie met with residents of Keno City. The proposed water management plan was presented and historical observations of the Keno City groundwater system were discussed. Residents expressed concerns about potential impacts on water quality and provided input on requirements and locations for groundwater monitoring wells.

3.2 Drilling and Monitoring Well Installation

Three groundwater monitoring wells were installed between February 10^{th} to February 15^{th}, 2010. Monitoring well locations were positioned to provide information on groundwater flow directions and for use in long term monitoring. Drilling was completed by Geotech Drilling of Prince George, BC using ODEX air-rotary methods and a down-the-hole hammer. Jacek Scibek, an Intermediate Consultant with SRK, supervised the drilling, chip logging and the installation of the monitoring wells. All drill holes were vertical. Monitoring well locations are shown on Figure 1.

The following summarizes lithology and groundwater occurrences observed during drilling:

- PH2, located down gradient and west of the proposed DSTF, intersected a shallow layer of gravel and moist silt (till), solid ice between 4 and 6 m below ground surface, then 3 metres of frozen gravel and 2 metres of dry, gravelly silt (till) over bedrock. Bedrock was encountered from a depth of 11.3 to 43 m. Bedrock became moist at about 33 m and began producing about 0.3 L/s (5 USgpm) at about 41 m.
- PH5, located to the southwest of the mill between the mill and Duncan Creek Road, intersected moist, gravelly to clayey, silt (till) with occasional gravel lenses to a depth of about 29 m, then water bearing gravel and sand to the end of the hole at 36 m. Within the lower gravel to coarse sand unit, water was produced at estimated rates of up to 15 L/s (> 200 USgpm). Drill casing could not be pushed past this point and this drill hole did not intersect bedrock.
- PH6, located at the approximate eastern extent of the proposed DSTF and at roughly 40 m higher elevation than the mill pad, intersected bedrock at a depth of 2.7 m below ground surface. The thin layer of overburden was not recovered. The drill-hole ended at 57 metres in a water producing section of bedrock. Water was only produced after shutting down the drill and

allowing the water levels to recover. Total volumes on the order of 10 to 20 litres were observed when air was pumped down the drill hole, but these volumes were not sustained.

PVC monitoring wells were completed in each of the drill holes. Monitoring wells in PH2 and PH5 have 5 cm (2-inch) construction and the monitoring well in PH6 has 2.5 cm (1-inch) construction. All wells were constructed with threaded, flush joint Schedule 40 PVC and a three metre length of slotted PVC for the well screen. Filter sand was used around the screen zones, topped with a layer of bentonite chips or pellets. The drillhole was then grouted to surface using a bentonite grout. Completion information for the new wells, as well as for the Firehall Well and Well #3 are provided in Table 1. Completion logs for the three new wells are provided in Appendix B.

Table 1: Monitoring Well Completion Information

Drill Hole ID	Easting	Northing	Installed On	Drill Hole Depth (mbgs)	Screen Depth (mbgs)	Stick-Up (m)
PH2	483864	7086952	15-Feb-10	42.7	38.1 to 41.1	0.85
PH5	483836	7086707	12-Feb-10	36.0	31.1 to 34.1	0.45
PH6	484104	7086854	11-Feb-10	57.9	53.3 to 56.4	1.16
Well #3 Yukon ID: 213140005	485024	7086865	21-Aug-83	67.1	Open Hole	At ground surface
Firehall Yukon ID: 213140003	484993	7086979	22-Aug-87	92.9	Open Hole	n/a

Coordinates are NAD 83, UTM Zone 8V – all coordinates taken with hand-held Garmin GPSmap 60Cx.
mbgs = metres below ground surface.
masl = meters above sea level.
Open hole = well was cased through overburden and left open in bedrock.

Vibrating wire pressure transducers (vibe wires) were installed on the outside of monitoring wells PH5 and PH6 to allow the measurement of water level in the event that water within the wells froze near surface.

The vibe wires are model VW2100-0.7 (0.7 MPa range) produced by RST Instruments of Coquitlam, B.C. Each transducer has a 60 m long communication cable. The transducer and cable was taped to the outside of the monitoring well PVC as it was installed. The transducer itself is within the sand pack of the monitoring well screen zone. A RST VW2106 portable readout unit was used to take readings and left at site for future use. Calibration and information sheets for the vibe wires and readout unit are provided in Appendix C.

3.3 Water Level Data

Water levels were measured in the three new monitoring wells and Well #3 to establish groundwater flow directions. Well #3 is located approximately 80 m to the south of the Firehall Well (Figure 1). Water level data was collected from Well #3 in Keno City and not the Firehall Well due to the well access issues described in section 3.1. Water level data are presented in Table 2.

Table 2: Depth to Water in Monitoring Wells

Drill Hole ID	Date	Depth to Water (m below top of casing)	Stick-Up (m)	Depth to Water (mbgs)	Ground Elevation (masl)	Water Level Elevation (masl)
Well #3	11-Feb-10	42.83	0	42.83	940.3	897.5
PH2	15-Feb-10	27.86	0.85	27.01	898.5	871.5
PH5	14-Feb-10	28.45	1.05	27.4	900.0	872.6
PH6	14-Feb-10	44.31	0.95	43.36	937.0	893.6

Well #3 had been reported as going dry during the summer of 2008, but the owners provided authorization to access and recheck the well. A hole was drilled in the top of the wellhead to allow access as, similar to the Firehall Well, the port for a water level sounding tube has been used for heat trace. Water level soundings indicated that there was a water column of about 20 m, suggesting that either the well has recovered since it went dry or that the pump may have failed and been interpreted as the water level dropping below the pump. The hole drilled for water level access was fitted with a removable plug.

Figure 3 is a water table map inferred from the above data. Water level elevations indicate an overall east to west flow direction, from the Keno City area towards the site. The water table drops steeply westward at the site.

In an effort to assess the radius of influence of the Firehall Well when pumping, a water level datalogger was installed in Well #3 between February 10 and 15. The Firehall Well and Well #3 are both designed to extract water from bedrock and are relatively close together. Mr. Jim Milley, the Water Steward, reported that during the monitoring period:

- The potable water storage tank was cleaned on February 10, thus empty;
- Deliveries of 2000 imperial gallons were made on the February 11 and 12; and
- The pump runs every day to supply water to the public laundry and shower facilities.

Using the maximum design pumping rate of about 17 Igpm for the Firehall Well pump, the pump would have to run for about 100 minutes to provide 2000 Igpm.

Figure 4 shows water level data for Well #3 for the monitoring period. The water level in Well #3 was approximately the same as the water level measured in the Firehall Well in 1988, indicating that either the aquifer has not been significantly drawn down or that recharge is sufficient to reverse any periods of lower water levels. Water levels fluctuated by less than 5 cm during the monitoring period and show no drawdown or recovery characteristics that would indicate effects of pumping in the Firehall Well. The cyclic variation in water level coincides more closely to changes in atmospheric pressure.

At a distance of 80m, Well #3 is not influenced by day-to-day operation of the Firehall Well, even during the winter season when groundwater inflows would be low. These results suggest that normal operation of the Firehall Well are unlikely to cause a significant change in the local water table.

3.4 Water Quality

Following installation, each of the three new monitoring wells were developed and sampled for water quality analyses. The wells were developed by pumping out at least three well volumes of water using a Waterra Hydrolift pump, or by hand. Field measurements of pH and electrical conductivity were used to assess the progress of development. Once these field parameters had stabilised, samples were collected. For quality assurance, a duplicate sample was collected from PH5, as well as a field blank, though the field blank appears to not have been submitted to the laboratory for analyses. Table 3 summarizes well development information.

Table 3: Monitoring Well Development

Drill Hole ID	Date of Development	Total Volume Pumped (L)	Duration of Pumping (min)	Final Temperature (deg C)	Final Electrical Conductivity (µS/cm)	Final pH
PH2	15-Feb-10	120	15	0.5	1830	7.10
PH5	14-Feb-10	200	25	0.7	690	6.70
PH6	14-Feb-10	620	180	0.9	2360	6.89

Samples for water quality were field filtered, stabilized and stored in a refrigerator at the Alexco office in Elsa. Samples were submitted by Alexco staff to Exova Group Ltd of Surrey, BC. Four samples were analysed, including the duplicate from PH5. The sample from PH2 was of limited volume due to difficulties encountered while pumping; following development, sufficient sample could not be collected for the full suite of analyses due to a pump failure and subsequent freezing of the sampling line. As a result, only pH and electrical conductivity were tested for that sample. The sample analysis results are presented in Table 4, along with the most recent water quality data from the Keno City Firehall Well for comparison. The complete laboratory report is included in Appendix D.

Table 4: Water Quality Data

Drill Hole ID		Drinking Water Guideline	Guideline Note	Firehall	PH6	PH5	PH5-Dupl.	PH2
Date of Sample	**Unit**			**18-Apr-08**	**14-Feb-10**	**14-Feb-10**	**14-Feb-10**	**15-Feb-10**
Field Parameters								
pH		-	-	-	6.89	6.7	6.7	7.1
Electrical Conductivity	µS/cm	-	-	-	2360	690	690	1830
Physical Parameters (lab)								
pH		6.5-8.5	1	7.72	7.1	6.85	6.79	7.28
Electrical Conductivity	µS/cm	-		562	2280	693	700	1770
Total Dissolved Solids	mg/L	5001	1	386	1850	422	428	-
Anions								
T-Alkalinity	mg/L	-	-	147	482	93	93	-
Hardness as $CaCO_3$	mg/L	-	-	281	1650	359	358	-
Chloride	mg/L	250	1	6.26	9.18	0.54	0.58	-
Sulfate (SO_4)	mg/L	500	1,5	129	953	229	236	-
Total Metals								
Aluminum	mg/L	-	-	0.036	15.1	0.038	0.035	-
Antimony	mg/L	0.006	4,5	<0.001	0.024	<0.0002	<0.0002	-
Arsenic	mg/L	0.01	-	0.005	0.048	0.0012	0.0012	-
Barium	mg/L	1	-	0.14	0.1	0.051	0.049	-
Boron	mg/L	5	4	<0.05	<0.02	<0.005	<0.005	-
Cadmium	mg/L	0.006	-	0.0009	0.00008	0.00037	0.00038	-
Calcium	mg/L	-	-	80.4	493	118	117	-
Chromium	mg/L	0.05	-	<0.001	0.0098	<0.0004	<0.0004	-
Copper	mg/L	1	1,6	0.18	0.006	0.002	0.001	-
Iron	mg/L	0.3	1	0.42	12.4	0.157	0.149	-
Lead	mg/L	0.01	6,5	<0.001	0.01	0.0005	0.0004	-
Magnesium	mg/L	-	-	21.6	136	32.3	32	-
Manganese	mg/L	0.05	1	0.004	1.39	0.0209	0.0191	-
Potassium	mg/L	-	-	0.3	5.4	0.5	0.6	-
Selenium	mg/L	0.01	-	0.002	<0.003	<0.0006	<0.0006	-
Sodium	mg/L	200	1	2.43	19.5	1.6	1.59	-
Uranium	mg/L	0.02	4	0.0067	0.167	0.0034	0.0034	-
Zinc	mg/L	5	1,6	0.16	0.37	0.042	0.038	-
Dissolved Metals								
Aluminum	mg/L	-	-	-	<0.005	<0.005	<0.005	-
Antimony	mg/L	-	-	-	0.0407	<0.0002	<0.0002	-
Arsenic	mg/L	0.025	6	-	0.0192	0.0003	0.0004	-
Barium	mg/L	1	-	-	0.02	0.048	0.048	-
Boron	mg/L	5	6	-	<0.004	<0.004	<0.004	-
Cadmium	mg/L	0.005	-	-	<0.00001	0.00033	0.00035	-
Calcium	mg/L	-	-	-	425	99.2	99.1	-
Chromium	mg/L	0.05	-	-	<0.0004	<0.0004	<0.0004	-
Copper	mg/L	1	1,3	-	<0.001	0.001	0.001	-
Iron	mg/L	0.3	1	-	<0.01	<0.01	<0.01	-
Lead	mg/L	0.01	3,7	-	<0.0001	<0.0001	<0.0001	-
Magnesium	mg/L	-	-	-	144	27	27	-
Manganese	mg/L	0.05	1	-	1.09	0.0148	0.0152	-
Potassium	mg/L	-	-	-	2.1	0.3	0.3	-
Selenium	mg/L	0.01	-	-	<0.0006	0.0006	0.0007	-
Sodium	mg/L	200	1	-	15.5	1.4	1.4	-
Uranium	mg/L	0.1	-	-	0.142	0.0031	0.0031	-
Zinc	mg/L	5	1,3	-	0.064	0.036	0.037	-

Water quality data provide an initial sense of local variability in water quality. While only a single sample has been collected from two wells, drill holes were completed with air-rotary methods and well developed, thus, the data are considered representative.

Firehall Water Quality

A water sample collected from the Firehall well in April 2008 was slightly alkaline (lab pH 7.72) and had an Electrical Conductivity (EC) of 562 µS/cm. Total Dissolved Solids (TDS) was 386 mg/L, and chloride concentration was 6.3 mg/L. Sulphate, bicarbonate, calcium and magnesium were the most abundant ions measured, although it should be noted that metal analyses are reported as Total Metals only.

PH2 Water Quality

A water sample collected from PH2 in February 2009 had neutral pH (field pH 7.1) and EC of 1830 µS/cm. No results for metals or anions are available from PH2. The EC value for PH2 indicates that TDS in this sample were intermediate between the PH5 and PH6 samples from the same monitoring round.

PH5 Water Quality

A water sample collected from PH5 in February 2009 had near-neutral pH (field pH 6.7) and EC of 690 µS/cm. Total Dissolved Solids (TDS) was 422 mg/L. Sulphate and calcium were the most abundant ions measured. The chloride concentration was low (0.54 mg/L)

Both total and dissolved metals samples were collected. Based on the higher total metal concentrations (e.g. iron and aluminum), it appears that some sediment was entrained during sample collection and the reported total metal results reflect the influence of both dissolved metals and of suspended solids.

Dissolved trace metal concentrations were generally low (<0.05 mg/L). The slightly elevated sulphate level may be an indication that the water has contacted naturally mineralized material.

Field duplicate samples from this station returned acceptable results, with duplicate values for all parameters having relative percent differences (RPDs) less than 10% for all parameters where concentrations were at least five times higher than the method detection limit. Based on these results, the water quality analyses are considered to be representative and reliable.

PH6 Water Quality

A water sample collected from PH6 in February 2009 had neutral pH (field pH 6.89) and EC of 2360 µS/cm. Total Dissolved Solids (TDS) was 1850 mg/L, and the chloride concentration was elevated (9.18 mg/L). Sulphate, bicarbonate, calcium and magnesium were the major ions measured. Sulphate is elevated and total arsenic, antimony, iron and manganese exceed drinking water guidelines.

Both total and dissolved metals samples were collected. The high total iron and aluminum, concentrations clearly indicate that some sediment was entrained during sample collection.

Dissolved trace metal concentrations were low (generally <0.05 mg/L, with the exception of uranium (0.142 mg/L)). As shown in Figure 1, PH6 appears to be situated downgradient of the Keno City landfill, and it may be that the elevated chloride and sodium concentrations in PH6 may reflect the influence of leaching from the landfill. Elevated metals in PH6 may also be due to proximity to known mineralized structures in the area (Figure 1). The elevated uranium concentration should be checked in subsequent sampling and analysis.

4 Conceptual Model for Groundwater Flow

A conceptual model for groundwater flow in the area of the mill, DSTF and Keno City, or a “picture” of how the groundwater system works, has been developed from the available information. Figures 5 and 6 present cross-sections through the site, including generalized geology and the inferred water table. Cross-section locations are shown on Figure 5. The following points summarize the conceptual model:

- Groundwater is present in both overburden and bedrock aquifers. In areas where bedrock is close to ground surface, shallow groundwater may be present, probably within depths that freeze or thaw seasonally. A thicker overburden aquifer is present to the south of the site. The relatively thick overburden sequence encountered at PH5 likely represents sediments and old stream channels deposited during glaciations. Groundwater flow within this thicker aquifer is probably significant, as indicated by the volume of water encountered during drilling. A bedrock aquifer is apparent both below the site and at Keno City. Groundwater flow within this aquifer will be controlled by the presence of fractures and geologic structures, though different lithologies and mineralized zones may create areas of higher porosity. Bedrock permeability within the vicinity of Keno City is thought to be generally low, as indicated by low yield observed during the drilling of PH6. Geologic structures cross the site, but none have been mapped as connecting the site and Keno City. The bedrock aquifer probably has a lower capacity to transmit water than the thick overburden aquifer to the south of the site.
- The measured water level elevations and the inferred water table shown in Figure 3 indicate that the overall groundwater flow direction is from east to west, or from the area of Keno City towards the site. Available data suggests that the water table is relatively flat between Well #3 and PH6, dropping only about 4 m. The water table drops significantly more to the west under the site, by about 20m between PH6 and both PH5 and PH2. The water table in vicinity of Keno City is more than 20m higher in elevation than the water table down gradient of the mill and DSTF.
- The groundwater system at the site is likely recharged by runoff from the surrounding mountains, infiltration of direct precipitation and, possibly, leakage from Lightning Creek, which is higher than the measured groundwater levels. Shallow groundwater probably discharges to a limited degree to low elevation marshes and Christal Lake, while deeper groundwater within overburden sediments and bedrock will flow parallel to the Duncan Creek and Christal Creek drainages.

5 Updated Effects Assessment

5.1 Environmental Effects

The current mill and DSTF plan includes no provision for groundwater extraction, thus there will be no effects on groundwater flows. The potential for effects to groundwater quality and either the lower elevation marshy areas or Lightning Creek will be controlled through the mill and DSTF water management plans.

As described in section 2.1, the water management plan includes surface water diversion structures, drainage ditches and a drainage blanket under the DSTF. The purpose of this system is to intercept site runoff and seepage though the DSTF and re-direct it to the lined mill pond, for treatment and discharge. The only pathway for affected waters to reach the groundwater system will be via leakage from these structures.

The significance of leakage from the water management structures will be a function of the quality and volume of leakage. The potential volume of leakage will be minimized in a number of ways:

- A diversion berm will be constructed uphill of the DSTF to divert clean runoff around the DSTF.
- During operations, the DSTF surface will be progressively graded and compacted to enhance runoff, or limit the amount of water infiltrating into the tailings. The compacted tailings will have a low permeability (estimated at approximatley7x10-7 m/s by Alexco), thus promoting runoff and decreasing infiltration or displacement of pore water.
- During progressive closure and reclamation annually during operations, a 0.5 m thick cover will be placed over the DSTF, graded and re-vegetated.
- Any water that does flow into and through the tailings will be collected by the underdrain, which will itself be graded to drain to collection ditches and the lined mill pond. The conveyance flume and mill pond will be lined with a geosynthetic liner, the type of which has not yet been chosen (EBA, 2010a).

Flows within diversion ditches will most likely be seasonal, primarily related to freshet and significant rain events. Any water that may leak from ditches or the mill pond into shallow, unfrozen overburden materials will flow east (downhill) towards organic-rich soils in the marshy ground near Christal Creek. Natural attenuation mechanisms in peat and other organic-rich soils have been observed to remove metals from mine-impacted water at other locations in the Keno Hill district and elsewhere in Yukon (e.g., Valley Tailings Facility (Elsa); Rose Creek Valley Tailings Facility (Faro)) (SRK, 2009c).

The groundwater flow direction under the site is generally east to west, towards marshy ground. To the south of the site, water level data from PH5 indicates that the groundwater table is lower than Lightning Creek. While the groundwater table may merge with Lightning Creek downstream, the site water management controls, the east to west flow direction, the long groundwater flow path and the high flow in Lightning Creek make the likelihood of water quality impacts to Lightning Creek very low.

5.2 Keno City Water Supply

The current plan does not use groundwater extraction for freshwater supply to the mill, thus there will be no effects on the amount of water that can be extracted by the Firehall Well or other Keno City private wells.

The risk that water quality at the Firehall Well or other Keno City private wells will be affected by the mill or DSTF is insignificant. First, as discussed above:

- Seepage from the DSTF is very unlikely to reach the bedrock groundwater system.
- Second, pumping at the Firehall Well would have to lower the water table *in the area of PH6* by over 20m to reverse the groundwater flow direction from underneath the site towards Keno City. Such a decline in water table elevation at a distance of over one kilometre down gradient of the pumping well would require the entire local water table to be changed by a similar or greater magnitude. Currently, the aquifer appears to recharge during the low extraction season and effectively recover completely from higher extraction periods, thus indicating that wholesale lowering of the area water table is not occurring, or recovering on an annual basis.

6 Conclusions and Recommendations

Results from the groundwater investigation reported herein indicate that the water table within the bedrock aquifer under the site and within a relatively thick overburden aquifer to the south is at considerable depth. Water level data from monitoring wells at site and that collected from Well #3 in Keno City, the only well that could be accessed, indicate that groundwater flows from east to west, or from Keno City towards the site and Christal Lake, not towards Keno City or Lightning Creek from the site.

Water quality analyses of samples taken immediately following monitoring well development indicate that, in general, concentrations of dissolved anions and metals are low. The only notable exceptions are elevated concentrations of chloride and sodium in PH6, which is located down could be indicative of seepage from the city dump and elevated concentrations of sulphate in PH5 and PH6, which could be indicative of natural mineralization.

The likelihood of effects to groundwater quality in general related to the mill and DSTF are considered very low, due primarily to the site water management plans for seepage interception and diversion. Leakage from water management structures represents the only source of impacted waters to the environment.

The current plan for the mill does not involve groundwater extraction, thus there will be no effects on the amount of water available for extraction from the Keno City water supply well. The chance of water quality at the supply well or other Keno City private wells being affected by site outflow is considered insignificant due to the direction of the groundwater gradient and the large distance between the site and the supply well.

The following recommendations are presented:

- The groundwater monitoring wells should be checked monthly for the first year to determine if they remain accessible and not frozen.
- The groundwater monitoring wells should be sampled and water levels recorded twice annually, if not frozen. If frozen, the vibe wire transducers on PH6 and PH5 should be monitored quarterly.
- If the monitoring wells are found to freeze and remain frozen, the wells should be freeze protected or alternate methods should be implemented to allow groundwater monitoring.
- Following finalization of the mill and DSTF engineering, three monitoring points should be located within shallow sediments down gradient of the DSTF drainage ditches and mill pond to monitor for potential ditch leakage. These wells should be sampled twice during the summer.
- Samples should be analyzed for dissolved metals, anions and physical parameters.

7 References

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EBA (2010a). Preliminary Engineering Design and Management Plan, Dry-Stacked Tailings Facility, Bellekeno Mine Mill Site, Yukon. Report prepared for Alexco Resource Corp. EBA File # W14101178.003

EBA (2010b). Response to Water Board Questions, Water Management Preliminary Designs. Letter prepared for Alexco Resources Corp. EBA File # W14101178.003.

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SRK Consulting (Canada) Inc. (2009b). Assessment of Potential Groundwater Impacts from the Bellekeno Mill Site and Dry Stack Tailings Facility. Letter to Alexco Resource Corp. SRK Project # 1CE012.003.

SRK Consulting (Canada) Inc. (2009c). 2007/08 Geochemical Studies, Keno Hill Silver District, YT. Report prepared for Elsa Reclamation and Development Company Ltd. SRK Project # 1CE012.001.

This report **"2010 Bellekeno Groundwater Program"**, has been prepared by SRK Consulting (Canada) Inc.

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Daryl Hockley
Principal

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Figures

N

Meters
0 50 100 150 200

LEGEND

Symbol	Description
● (orange)	New monitoring wells (Feb 2010)
⊕ (red)	Keno City wells
✛ (green)	EBA geotechnical boreholes
◎	Thermistor Drillhole
(magenta dash-dot line)	Tailings (Year 4)
(orange dashed line)	Ditch (Year 4)
(yellow line)	Roads
(white line)	Elevation (masl)

SRK Consulting
Engineers and Scientists

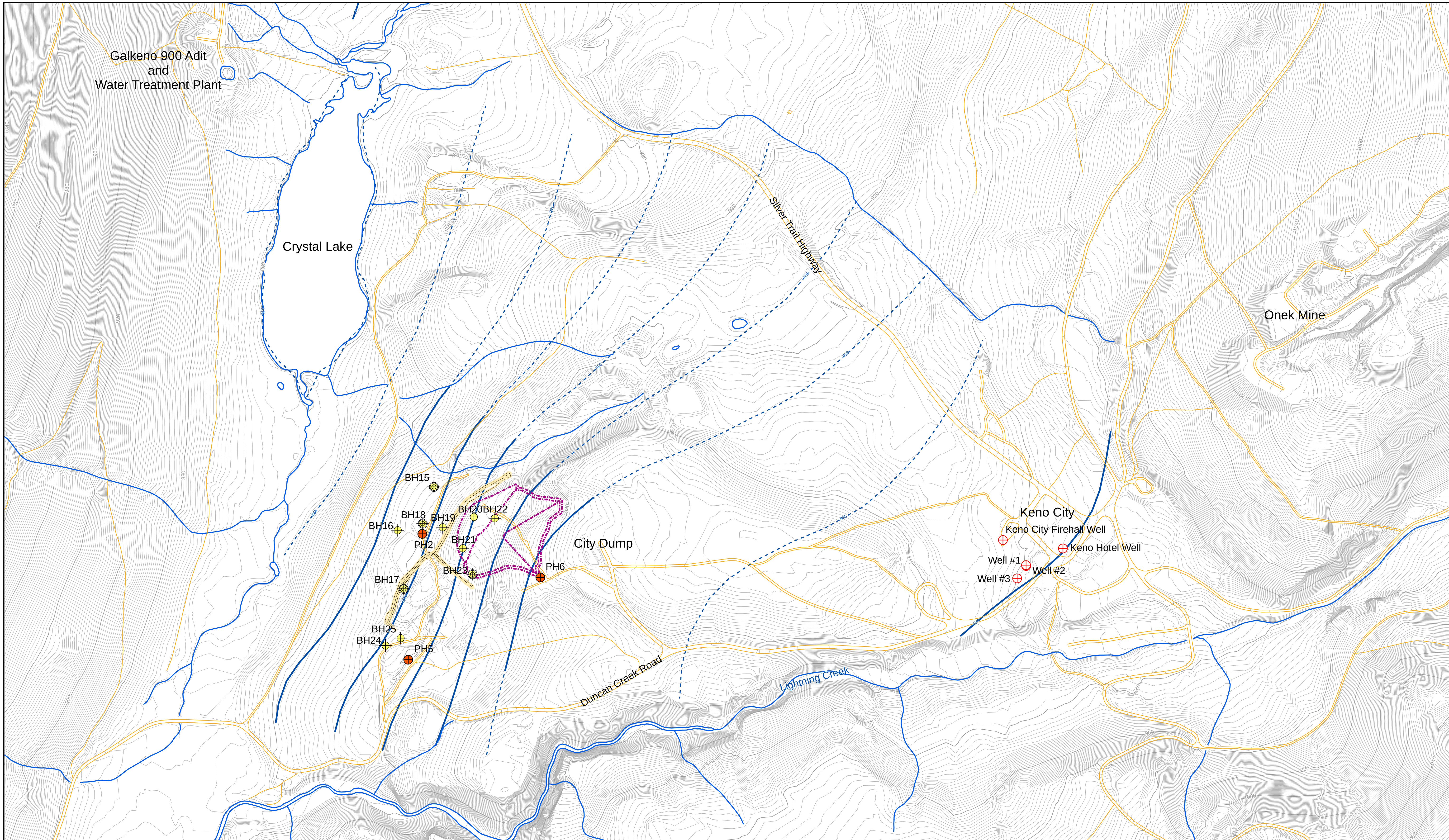
UTM Zone 8N

DESIGN: JS/GF	DRAWN: JS/GF	REVIEWED: DM
SCALE: 1 inch = 583.3 feet		DATE: 03/16/2010
FILE NAME: Fig1 - Bellekeno - Site Location map.mxd		

ALEXCO

Bellekeno Mine Project

DRAWING TITLE:	**Bellekeno Site Map And Well Locations**
ISSUED FOR:	**ALEXCO**
Revision No	**1**
SRK JOB NO.	**1CA009.003**
FIGURE	1



N

Meters

0 50 100 150 200

LEGEND

- New monitoring wells (Feb 2010)
- Keno City wells
- EBA geotechnical boreholes
- Thermistor Drillhole
- Tailings (Year 4)
- Ditch (Year 4)
- Water table (masl)
- Inferred water table (masl)
- Elevation (masl)

SRK Consulting
Engineers and Scientists

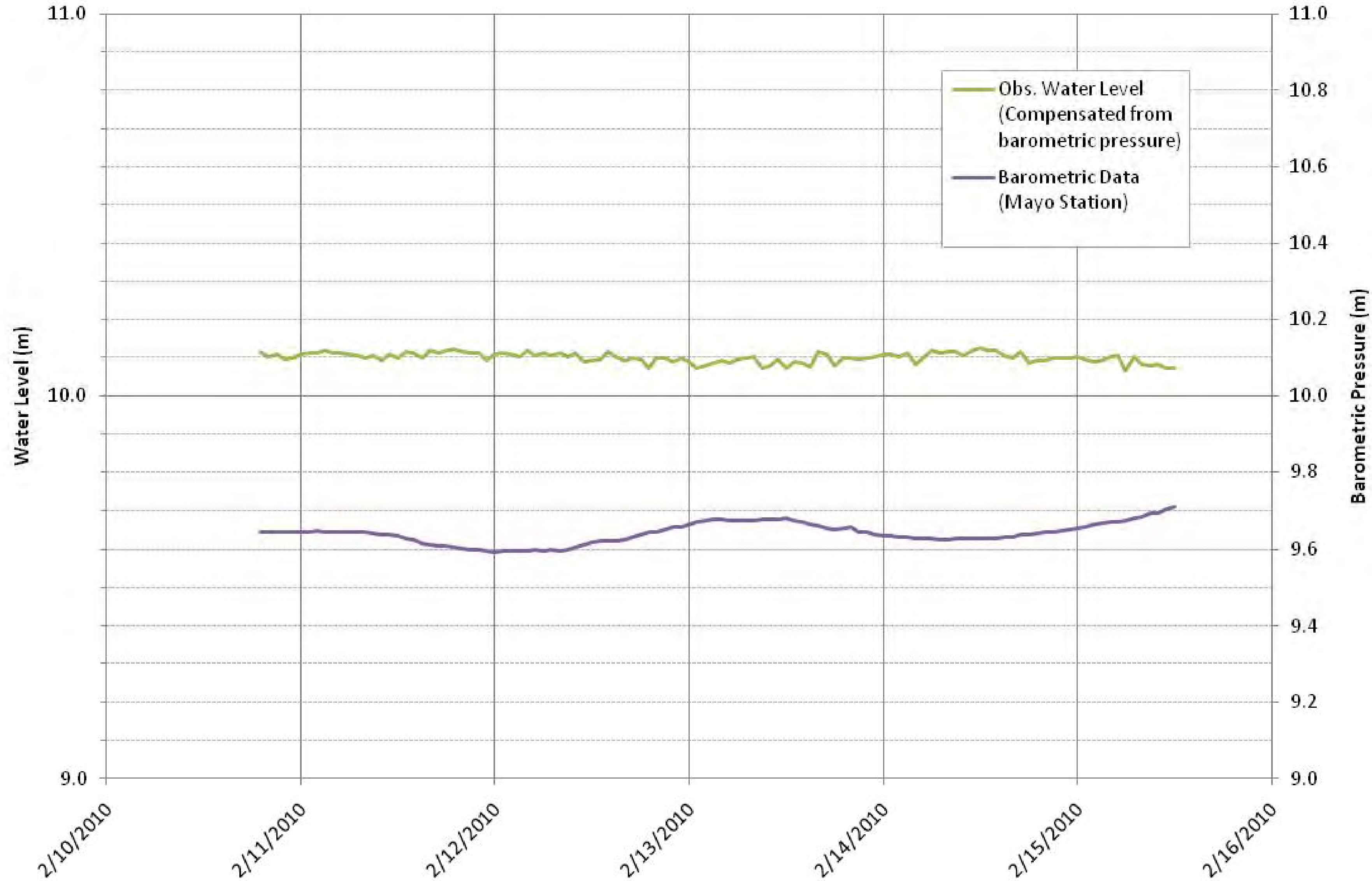
UTM Zone 8N					
DESIGN:	JS/GF	DRAWN:	JS/GF	REVIEWED:	DM
SCALE:	1 inch = 583.3 feet			DATE:	03/16/2010
FILE NAME:	Fig2 - Bellekeno - Interpreted water table.mxd				

ALEXCO

Bellekeno Mine Project

DRAWING TITLE:	**Interpreted Water Table**
ISSUED FOR:	ALEXCO
Revision No	1
FIGURE	2
SRK JOB NO.	1CA009.003

Path:

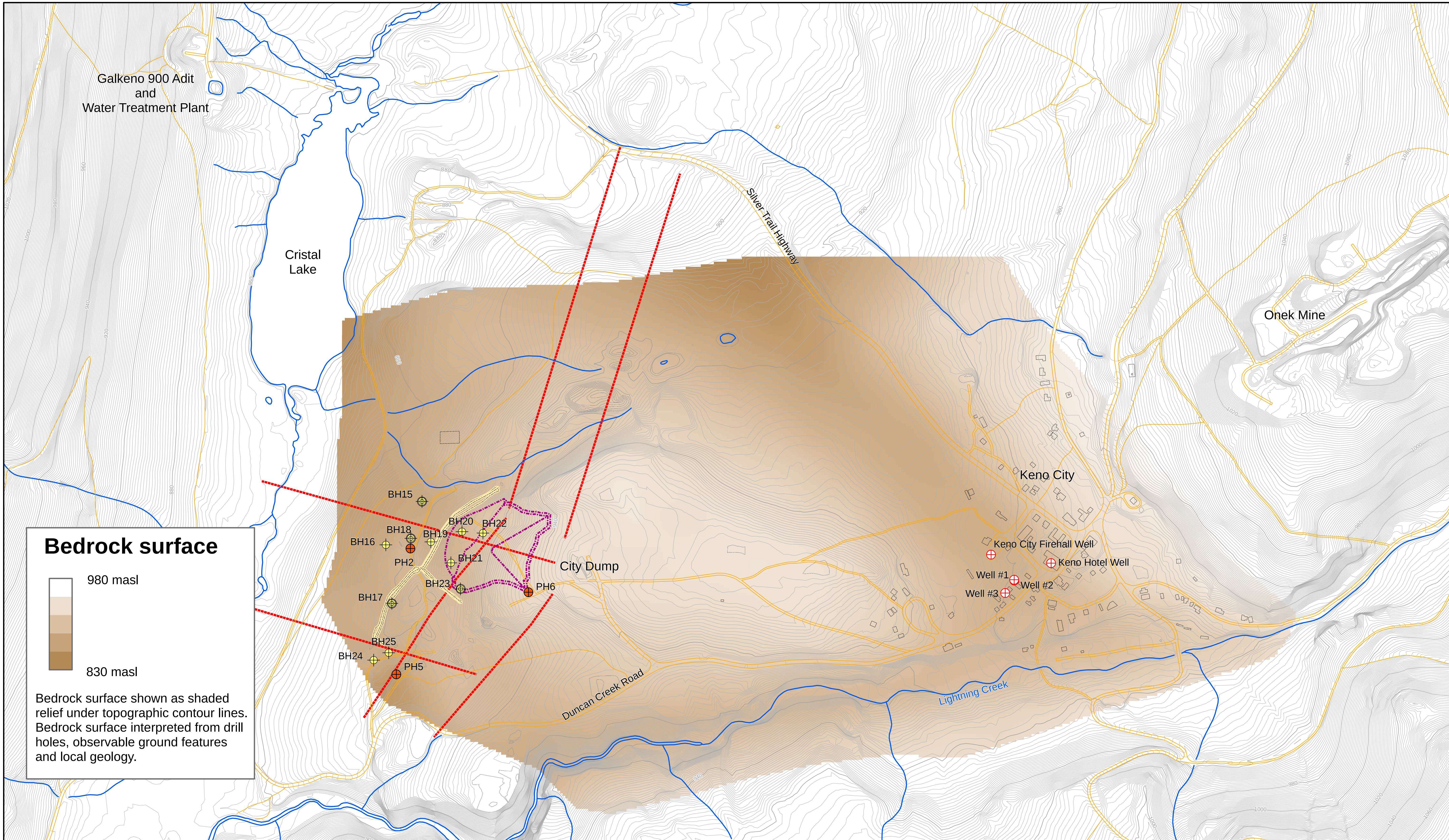


SRK Consulting
Engineers and Scientists
VANCOUVER

ALEXCO

Compensated Vibewire Measurements at Well#3

Job No: 1CA009.003	Bellekeno Mine Project	Date: March 2010	Approved: DM
Filename: Fig3_Well#3 monitoring GWL Observation.ppt		Figure: 3	



LEGEND

- New monitoring wells (Feb 2010)
- Keno City wells
- EBA geotechnical boreholes
- Thermistor Drillhole
- Tailings (Year 4)
- Ditch (Year 4)
- Elevation (masl)
- NE-SW Structures

SRK Consulting
Engineers and Scientists

UTM Zone 8N

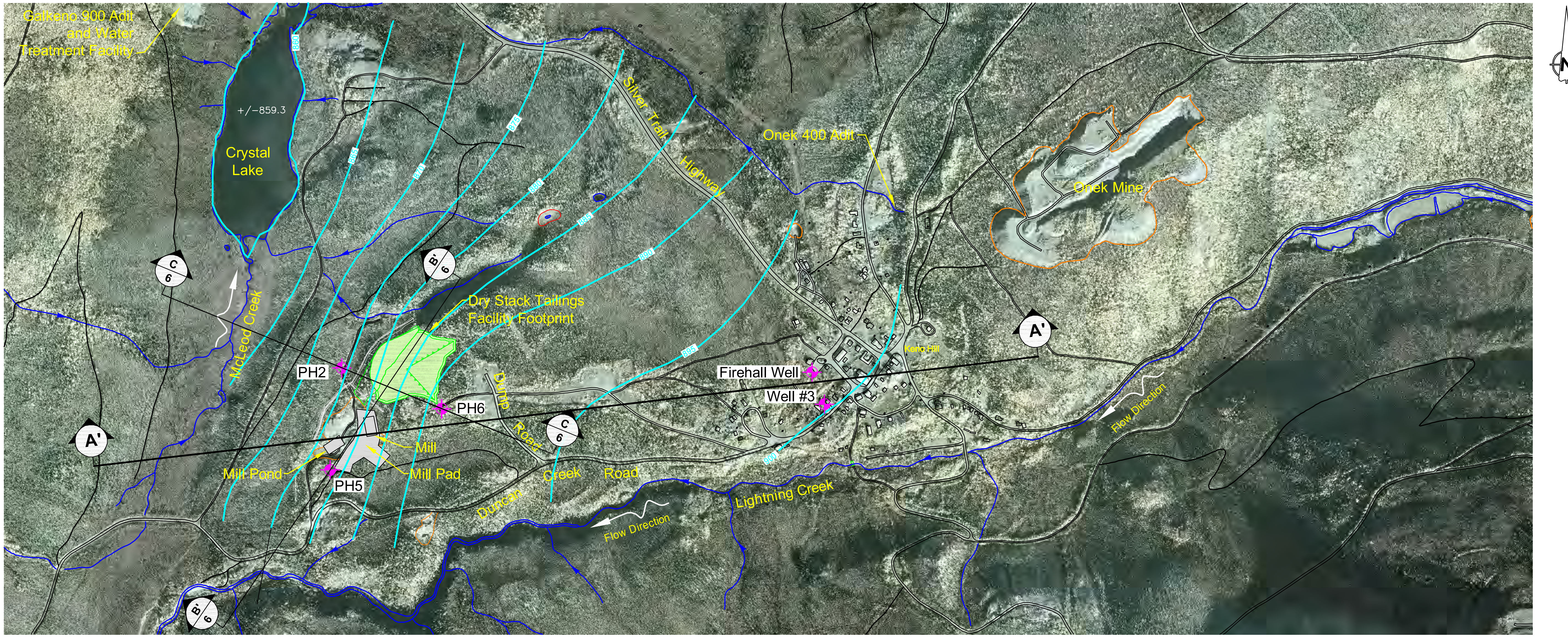
DESIGN: JS/GF	DRAWN: JS/GF	REVIEWED: DM	
SCALE: 1 inch = 583.3 feet		DATE: 03/16/2010	
FILE NAME: Fig4 - Bellekeno - Interp bedrock surface.mxd			

ALEXCO

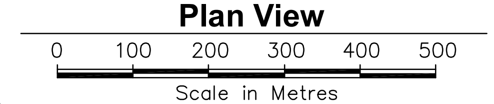
Bellekeno Mine Project

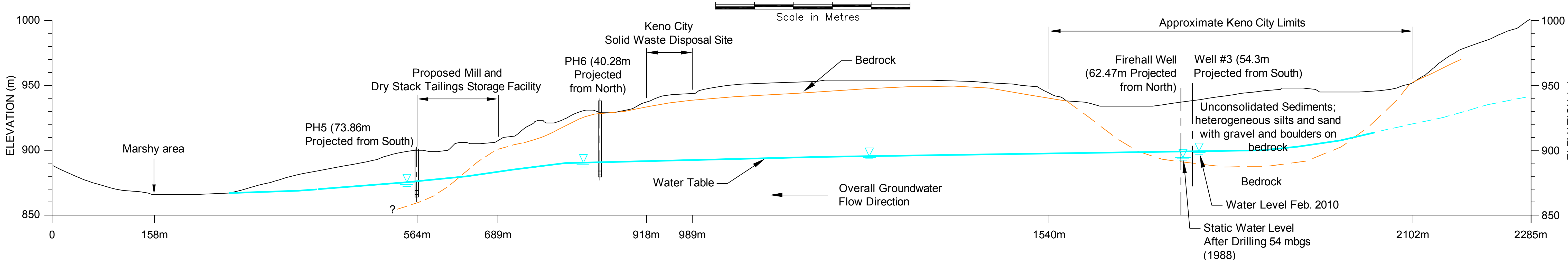
DRAWING TITLE:	Interpreted Bedrock Surface		
ISSUED FOR:	ALEXCO		
Revision No	1	FIGURE	4
SRK JOB NO.	1CA009.003		

Path:



Plan View





A CROSS SECTION A - A'

0 60 120 180 240 300

Horizontal Scale in Metres
Vertical Exaggeration X2

LEGEND

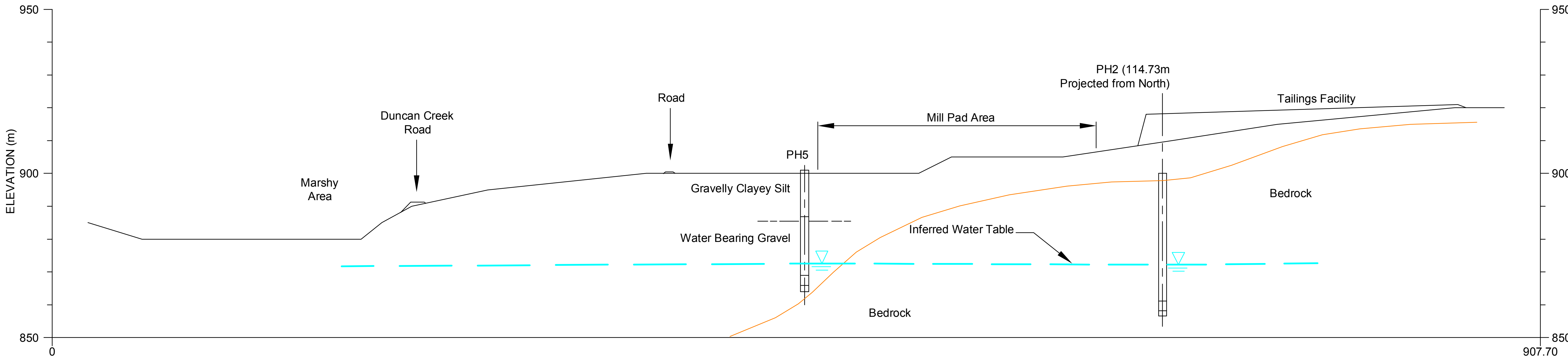
- Flow Direction
- Water Table Contour

NOTES

1. All units in metres
2. Coordinate system is NAD83, UTM Zone 8.
3. Water table contours from Figure 3.

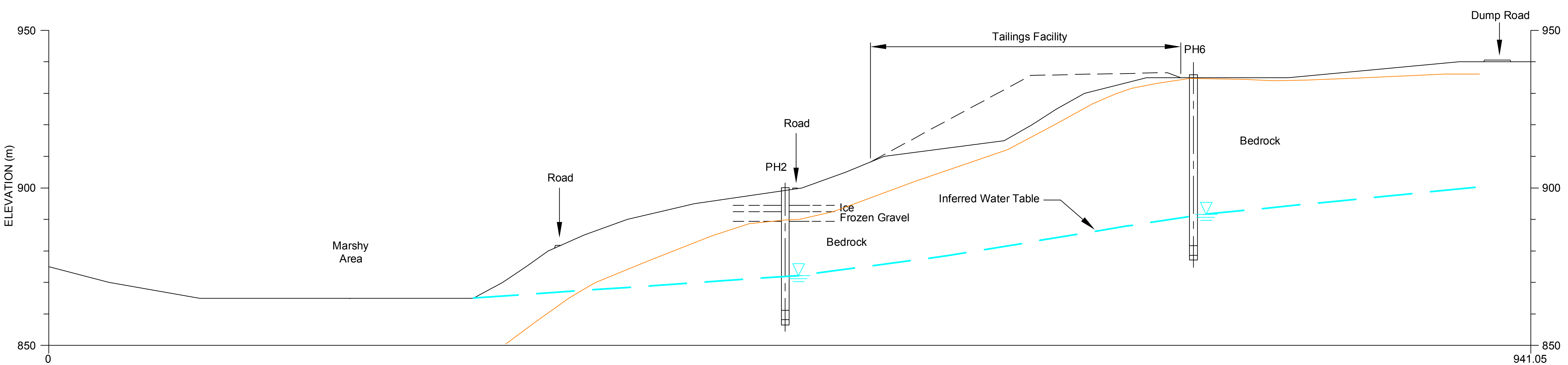
SRK Consulting Engineers and Scientists, Vancouver B.C.	ALEXCO	2010 Bellekeno Groundwater Investigation
SRK JOB NO.: 1CA009.003	Bellekeno Mine Project	Location Map and Cross Section A
FILE NAME: Bellekeno Plan Sec.dwg		DATE: Apr. 2010 · APPROVED: DM · FIGURE: 5

J:\01_SITES\UKHM\ACAD\Acad 2009\Bellekeno Plan Sec.dwg



B 5 **CROSS SECTION B - B'**

Vertical Exaggeration X2



C 5 **CROSS SECTION C - C'**

Vertical Exaggeration X2

NOTES

1. All units in metres
2. Coordinate system is NAD83, UTM Zone 8.

0 20 40 60 80 100

Scale in Metres

SRK Consulting Engineers and Scientists Vancouver B.C.	ALEXCO	2010 Bellekeno Groundwater Investigation
		Cross Section B and C
SRK JOB NO.: 1CA009.003	Bellekeno Mine Project	DATE: Apr. 2010 · APPROVED: DM · FIGURE: 6
FILE NAME: Bellekeno Plan Sec.dwg		

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Appendices

Appendix A1

Firehall Well Log

Department of Environment

Water Resources Section
Yukon Water Well Registry
Box 1703, Whitehorse, Yukon, Y1A 2C6

WATER WELL DRILLING REPORT

Well ID: 213140003

Assigned by Dept. of Environment

The data contained in this report is supplied by the Driller. The Territory disclaims responsibility for its accuracy.
The information contained in this "Water Well Drilling Report" is unverified by YTG Yukon Water Resources Section.
If fields are empty, then no information was provided by the driller.

WELL LOCATION

Well Name: Keno City Firehall Well

The well name is simply an informal name given to a well upon it's completion.

Street Address of Well Location: Lot 48

Town/Village/Area/Lot#: KENO - Keno

UTM Coordinates of Well Location: 484993 m E 7086979 m N

NAD83 Zone 8

Accuracy of Well Location: 5 +/- m

Given that the well location may not be accurate, the above accuracy value represents the approximate error that might be associated with the actual well location.

The well was drilled for the following purpose: Commercial

Date the well was completed: 1987/08/22

The method used to drill the well: Rotary air

Sketch of Well Location

This sketch has been provided by the driller and should be considered as an approximation of well location only.

LOG OF OVERBURDEN AND BEDROCK MATERIALS

The following section describes the geological materials (as recorded by the driller) that were encountered when the well was first drilled.

Depth (m) From	To	General Colour	Most Common Material	Secondary Materials	General Description
0	4.267		SILT	Sand	
4.2672	14.02		SILT	Gravel and Cobbles	
14.021	23.77		SAND	Gravel and Cobbles	
23.774	33.22		SILT		
33.223	38.1		SAND	Gravel and Cobbles	
38.1	55.17		TILL	Cobbles and Boulders	
55.169	92.96		BEDROCK		

While drilling the well, was permafrost encountered? ☐ **If yes, the depth interval was:** from: m to m

WELL CONSTRUCTION

The following section provides information about the well construction details.

Monitor ID: 2131400031

For administrative purposes only

In what geological material (i.e. sand and gravel or bedrock) is the water producing zone of the well completed?

The outside diameter of the well casing: 152.4 cm

The casing material is made out of: Steel

The casing wall thickness is: mm

The casing extends in a depth below ground surface of: 57.3024 m

Other comments that were provided by the driller regarding the casing: Water from 190'; more from 298' to 301' and very loose ground

Surface/Environmental Seal A surface seal provides an impermeable seal between the casing and the ground in the upper 3 metres. This seal helps prevent surface water from leaking downward and into the well water.

Seal Material Type: **Diameter of Seal:** m **Seal Depth from:** m **Seal Depth to:** m

Gravel Pack A gravel pack is sometimes installed by the driller around the well screen. The purpose of a gravel pack could be to reduce sand production in the well water or to increase well yield.

Is there a gravel pack on the well? ☐

Gravel pack details (as provided by the driller):

Well Screen Infromation

Screened Interval from: 57.3024 m **to:** 92.964 m

The outside diameter of the screen is: 152.4 mm

Screen 1 Length: 35.6616 m **Slot Size 1:** thou. inch

The screen is made of:

Screen 2 Length: m **Slot Size 2:** thou. inch

Screen 3 Length: m **Slot Size 3:** thou. inch

The type of screen is: None

There are many types of well screens on the market. Wells with no screens or wells constructed in bedrock are called "OPEN HOLE".

Other useful comments about the screen:

WELL DEVELOPMENT AND STATUS

Following well construction, the well is developed or clean-out until clear groundwater is produced. Depending on the well yield and water quality, the well status is determined (i.e. the well is put into production or the well is abandoned). The following section provides information about Well Development and Status.

The well was developed by: Air surging

Once the well was constructed the following completion or "tie in" was constructed: None

The height of the well casing above ground surface construction (i.e. Well Stick-up) is: 0 m AGS

The static water level (i.e. non pumping condition) below top of casing is: 54.864 m

The estimated yield or production rate of the well is: 1.5154 L/s

After constructing and developing the well, the Well Status was: New, in use for intended purpose

If the well was abandoned, was the well properly filled (i.e. sealed) with bentonite grout? ☐ **If YES, date:**

Method used to estimate the well yield: Air lifting

PUMPING TEST RECORD AND GROUNDWATER QUALITY

Following well construction, the well may have been assessed for quality and/or tested to determine well yield or production rate. The following section provides this information if such assessment was done.

Pumping Test Information

Pumping Test Start Date:

Static Water Level (SWL): m

Pump was set at a depth of: m

Duration of pumping test: min

Final Water Level (FWL) at end of pumping test: m

If the well is flowing naturally under artesian pressure, the flow rate is: L/s

Recommended Pump Depth and Flow Rate

Pump depth: m

Pump rate: L/s

Well Water Level Drawdown Data

Drawdown	
Time (min)	Level (m

Groundwater Quality

Electrical Conductivity: uS pH: Temperature: C

Date Measurements Taken:

Was Bacteria Testing Conducted? ☐ Date Sample Taken Laboratory that conducted analysis:

Was Chemical Analysis Conducted? ☐ Date Sample Taken Laboratory that conducted analysis:

Groundwater Type (i.e. salty, rotten egg smell, iron staining):

Turbidity/sand content after development:

Well Disinfection:

Following well construction the well should be disinfected. Above briefly describes the method of disinfection.

WELL CONTRACTOR

The well contractor that drilled and constructed the well.

Name of Contractor/Drilling Company: Midnight Sun Drilling Company Limited

Name of Driller(s):

CONSULTANT

Consultants that may have been associated with the drilling/well construction.

Company Name:

Company Address:

Report Reference:

Well ID: 213140003

Appendix A2

Firehall Well Water Quality

Keno City Fire Hall Drinking Water Quality
(305' deep well - pump at 298')

Parameter	Units	04-Aug-98	04-Dec-99	24-Oct-00	19-Dec-01	23-Aug-02	16-Sep-03	02-Jul-04	16-Jun-05	20-Jun-06	18-Apr-08	GCDWQ	
Physical Tests													
Colour	CU	< 5	< 5	< 5	< 5	<5	<5	<5	<5	<5	<5	15	1
Conductivity	umhos/cm	411	385	384	358	440	569	559	535	527	562		
Total Dissolved Solids	mg/L	267	238	234	234	331	414	360	356	378	386	500	1
Hardness	mg/L $CaCO_3$	216	202	184	184	206	297	297	288	294	281	-	2
pH		7.69	7.67	7.91	8.06	7.93	8.17	7.85	7.83	8.08	7.72	6.5 - 8.5	1
Turbidity	NTU	0.8	0.4	0.6	<0.1	0.7	0.3	0.28	0.72	2.68	3.5	5	1,4
Dissolved Anions													
Alkalinity - Total	mg/L	122	112	122	111	125	168	166	156	146	147		
Chloride	mg/L	5.9	5	5.2	6.2	6.4	9.1	9.6	7.56	8.38	6.26	250	1
Fluoride	mg/L	0.07	0.09	0.2	0.03	0.04	0.04	0.038	0.053	0.046	<.1	1.5	
Sulphate	mg/L	82	70	70	67	88	136	120	121	123	129	500	1,5
Nutrients													
Nitrate Nitrogen	mg/L	1.9	1.7	1.6	1.67	1.5	1.5	1.68	1.56	1.83	1.61	10	
Nitrite Nitrogen	mg/L	< 0.1	< 0.1	< 0.1	<0.001	<0.1	<0.1	<0.1	<.001	<.001	<.002	1	
Total Metals													
Aluminum	mg/L	< 0.2	< 0.005	< 0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.036		
Antimony	mg/L				<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<.001	0.006	4,5
Arsenic	mg/L	0.0027	0.0051	0.0056	0.003	0.002	0.001	0.003	0.00187	0.00238	0.005	0.01	
Barium	mg/L	0.11	0.144	0.122	0.11	0.12	0.15	0.157	0.139	0.134	0.14	1	
Boron	mg/L	< 0.1	< 0.05	< 0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<.05	5	4
Cadmium	mg/L	0.0007	0.0007	0.0008	0.0007	0.0008	0.0011	0.00099	0.00094	0.00095	0.0009	0.005	
Calcium	mg/L	62.6	59.4	54.8	55.9	58.8	86.7	88	79.8	88.2	80.4		
Chromium	mg/L	< 0.01	< 0.001	< 0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<.001	0.05	
Copper	mg/L	0.02	0.154	1.16[7]	<0.01	<0.01	<0.01	<0.01	0.0043	0.103	0.18	1	1,5
Iron	mg/L	0.11	0.03	0.09	<0.03	0.05	0.17	<0.03	0.071	1.98	0.42	0.3	1
Lead	mg/L	< 0.001	0.010	0.049[7]	<0.001	<0.001	<0.001	<0.001	<0.001	0.0015	<.001	0.01	5,5
Magnesium	mg/L	14.4	13.1	11.4	11.6	14.3	19.5	18.7	17.3	19.1	21.6		
Manganese	mg/L	< 0.005	< 0.001	0.002	0.002	<0.002	0.005	0.0025	0.0036	<0.002	0.004	0.05	1
Mercury	mg/L	< 0.00005	< 0.00005	< 0.00005	< 0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<.02	0.001	
Potassium	mg/L	< 2	0.3	0.24	0.3	0.3	0.3	0.35	0.31	0.32	0.3		
Selenium	mg/L	0.002	0.002	< 0.003	0.002	0.002	0.002	0.0037	0.002	0.002	0.002	0.01	
Sodium	mg/L	2	1.8	1.96	2.1	2	3	2.8	2.3	2.4	2.43	200	1
Uranium	mg/L	0.00462	0.00478	0.00465	0.0037	0.0054	0.0125	0.0116	0.00959	0.00965	0.0087	0.02	4
Zinc	mg/L	0.510	0.159	0.383	0.47	0.28	0.31	0.224	0.135	0.183	0.16	5	1, 5
Dissolved Metals													
Aluminum	mg/L			< 0.005	<0.01								
Antimony	mg/L				<0.0005								
Arsenic	mg/L			0.0052	0.002							0.025	6
Barium	mg/L			0.122	0.11							1	
Boron	mg/L			< 0.05	<0.1							5	6
Cadmium	mg/L			0.0008	0.0007							0.005	
Calcium	mg/L			54.8	54.7								
Chromium	mg/L			< 0.001	<0.002							0.05	
Copper	mg/L			0.905	0.006							1	1,3
Iron	mg/L			0.06	<0.03							0.3	1
Lead	mg/L			0.035[6]	<0.001							0.01	3,7
Magnesium	mg/L			11.4	11.6								
Manganese	mg/L			0.002	<0.002							0.05	1
Mercury	mg/L			< 0.00005	<0.0002							0.001	
Potassium	mg/L			0.28	0.3								
Selenium	mg/L			< 0.003	0.002							0.01	
Sodium	mg/L			1.98	2.1							200	1
Uranium	mg/L			0.00458	0.0037							0.1	
Zinc	mg/L			0.356	0.43							5	1, 3

Notes:
< = less than the detection limit indicated.
GCDWQ = Guidelines for Canadian Drinking Water Quality;
All limits are Maximum Acceptable Concentration (MAC) unless otherwise indicated.
1. Aesthetic Objective (AO) (taste, odour, appearance, etc.)
2. 1 NTU maximum allowed for water entering distribution systems.
3. There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.
4. Interim Maximum Acceptable Concentration (IMAC).
5. First drawn water may be high, flush system before sampling (MAC).
6. At point of consumption.
7. Dec 12/00 resampled: Cu 0.011mg/L, Lead <0.001mg/L. Taken at point of consumption (truck fill point).
Oct. 24/00 sample was collected as an attempt to collect untreated well water - not from a proper sample port.
Suspect the sample location was not properly flushed so that sediment in the pipe caused high levels of lead and copper.

Appendix A3
Review of Firehall Well and Water System

4.5 KENO CITY

4.5.1 GENERAL

Community Status: Unincorporated

Owner of System: Government of the Yukon

Location: The water system is located within the fire hall at the community.

System Description: In general, the system consists of a deep well, which supplies water to a steel storage reservoir in the fire hall where the water is batch-chlorinated. A service pump delivers from the reservoir to a second elevated reservoir located below the ceiling of the truck bay where water gravity discharges into the water truck. Water is delivered to 19 or 20 residents in the community. Some Elsa residents travel to Keno City for water pickup.

A second service pump supplies water to the nearby Community Centre through a buried, insulated water line. The Community Centre houses washrooms, showers and laundry facilities, which are used by local residents and summer visitors.

Contacts:

Owner: Engineering and Development Branch
Government of the Yukon
P. O. Box 2703, Whitehorse, Yukon Y1A 2C6

Ph. (867) 667-5195 Fax (867) 393-6216

Attention: Georgi Pearson, Manager, Community Operations
Dave Albisser, Community Services Officer

Operator: Mike Kokanov
Site 1, Box 22, Keno City, Yukon Y0B 1M0

Ph. (867) 995-2409 (c/o Mike Mancini)

4.5.2 WATER SOURCE

Water is obtained from a deep, drilled well located approximately 15 m from the fire hall. Well information is as follows:

Date of Construction: 1987 (by Midnight Sun Drilling Co. Ltd.)

Depth: 93 m (305 ft.)

Casing: Steel – 203 mm (8 in.) dia. to 36 m (117 ft.) and 152 mm (6 in.) casing into bedrock. Bedrock was located at 55 m (180 ft.).

Screen: No screen in bedrock

Static Level: 55 m (180 ft.)

Pump Location: 91 m (299 ft.)

Pump Specifications: Grundfos 15 SQ15C–290
1.5 hp (estimated)

Capacity: 0.95 to 1.3 L/s (12.5 to 16.7 Igpm.) discharge rate into reservoir

Wellhead Construction: The well casing terminates in an insulated and heated box of PWF construction. The discharge line from the cap extends into an insulated utilidor, which connects to the fire hall (see photos). The pump discharge pipe is heat-traced.

Observations and Comments: The wellhead appears to be fairly well constructed and properly protected from freezing. The box is in good condition and the metal cladding in the lid offers adequate protection from the elements. Past problems with runoff accumulating around the wellhead has resulted in some flooding within the box and around the wellhead. Evidence of this can be seen in the photo of the wellhead box interior. Ditching around the box has alleviated this problem by routing the runoff around and past the box. However, problems may again arise in the future if the ditch fills up with silt and allows water to enter the box again. A more permanent solution may be to install a french drain to collect drainage and carry it to an open discharge point.

The box has no means of locking it from unauthorized entry at present. As such, security should be improved.

The in-ground septic system is located on the opposite side of the fire hall, about 45 to 50 m from the well. As such, it does not meet the current requirement of 60 m separation.

4.5.3 WATER STORAGE, PUMPING AND TREATMENT FACILITIES

The current water supply facilities were constructed with the fire hall in 1988. The key system components include water storage, service pump to an overhead tank for trucked water, and a second service pump, which supplies piped water to the Community Centre. See Fig. 4.5.1 and photos.

4.5.3.1 Water Storage

Water from the well discharges through a 32 mm (1.25 in.) dia. plastic line into the floor-mounted reservoir at the end of the truck bay in the fire hall. The well pump is activated by reservoir float controls.

Primary Tank Description: Plywood reinforced fibreglass, 3.7 m (12 ft.) x 1.9 m (6.3 ft.) x 1.9 m (6.3 ft.) high, complete with access through a 610x610 (24 in. x 24 in.) square opening in the top. The total tank capacity is approximately 13,300 L (2,925 Igal.) and the normal high level volume, at 230 mm (9 in.) below the top, is about 11,700 L (2,574 Igal.).

FLOOR TANK (FINE)

A second storage tank is situated below the ceiling and is filled by the service pump. A valve on the discharge line below the tank is used to fill the water truck by gravity.

Elevated Tank Description: Fibreglass – 5,455 L (1,200 Igal.). Access is provided at the top of the tank.

POTABLE WATER TANK

Observations and Comments: The elevated tank is difficult to access for cleaning and there are reports of past leaks, which have subsequently been repaired, having occurred in the tank.

4.5.3.2 Service Pumps (P–1 and P–2)

The service pump (P–1) draws chlorinated water from the storage tank and fills the elevated tank through a 50 mm (2 in.) dia. line. Pump specifications are as follows:

SAME **Specification:** 1.5 hp Leroy Somer, Model 145JH (Centrifugal)

A similar pump (P–2) supplies water to an elevated tank in the adjacent fire truck bay. These pumps can function as standby pumps for each other, since each of them can serve both the water truck and fire truck tanks through appropriate valving.

4.5.3.3 Service Pump (P–3)

This pump draws chlorinated water from the storage tank and pumps it through a 50 mm (2 in.) dia. P.E. line to the Community Centre. It has the following characteristics:

Specification: 1.5 hp Armstrong 3/4 B (Centrifugal)

SAME

Capacity: 1.5 L/s @ 23 m TDH (24 USgpm @ 75 ft. TDH)

Water is obtained from a deep, drilled well located approximately 15 m from the fire hall. Well information is as follows:

Date of Construction:	1987 (by Midnight Sun Drilling Co. Ltd.)
Depth:	93 m (305 ft.)
Casing:	Steel – 203 mm (8 in.) dia. to 36 m (117 ft.) and 152 mm (6 in.) casing into bedrock. Bedrock was located at 55 m (180 ft.).
Screen:	No screen in bedrock
Static Level:	55 m (180 ft.)
Pump Location:	91 m (299 ft.)
Pump Specifications:	Grundfos 15 SQ15C–290 1.5 hp (estimated)
Capacity:	0.95 to 1.3 L/s (12.5 to 16.7 Igpm.) discharge rate into reservoir
Wellhead Construction:	The well casing terminates in an insulated and heated box of PWF construction. The discharge line from the cap extends into an insulated utilidor, which connects to the fire hall (see photos). The pump discharge pipe is heat-traced.

Observations and Comments:

The wellhead appears to be fairly well constructed and properly protected from freezing. The box is in good condition and the metal cladding in the lid offers adequate protection from the elements. Past problems with runoff accumulating around the wellhead has resulted in some flooding within the box and around the wellhead. Evidence of this can be seen in the photo of the wellhead box interior. Ditching around the box has alleviated this problem by routing the runoff around and past the box. However, problems may again arise in the future if the ditch fills up with silt and allows water to enter the box again. A more permanent solution may be to install a french drain to collect drainage and carry it to an open discharge point.

The box has no means of locking it from unauthorized entry at present. As such, security should be improved.

The in-ground septic system is located on the opposite side of the fire hall, about 45 to 50 m from the well. As such, it does not meet the current requirement of 60 m separation.

Appendix B
2010 Drill Hole Logs

SRK Consulting
Engineers and Scientists

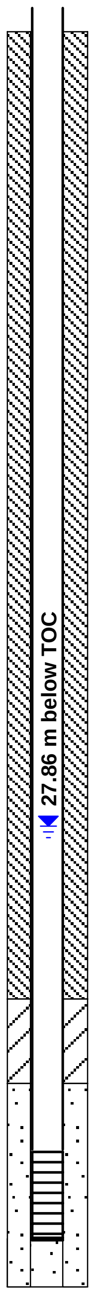
BOREHOLE LOG

SHEET 1 of 1

PROJECT No: 1CA009.003
SITE: Bellekeno
CLIENT: Alexco Resource Corp.

DATE: Feb. 2010
LOGGED BY: Jacek Scibek
DRILL HOLE: PH2

EASTING: 483864
NORTHING: 7086952
ELEVATION: 898.5 masl



DEPTH (m)	ELEV (masl)	WELL	DESCRIPTION	LITHO SYMBOL	DETAILED LITHOGRAPHY	COMMENTS
	898.5				Ground Surface	
0			0.85 m stickup		Gravel	
	895.0				Till some water	
5			2" PVC		Ice	
					Gravel no water, frozen?	
10	890.0				Till dry	
					Bedrock	
15	885.0		bentonite chips to surface			
20	880.0					
25	875.0					
30	870.0					
	865.0		bentonite pellets			
35			sand			
	860.0		screen			
40						39.6 m Producing water up to 20 L/min
	855.0					
45						

NOTES: Coordinates are +/- 5m, they are from a handheld GPS. Elevations are +/- 1m, they are taken from a topo map.

Reviewed By:	FILE

SRK Consulting
Engineers and Scientists

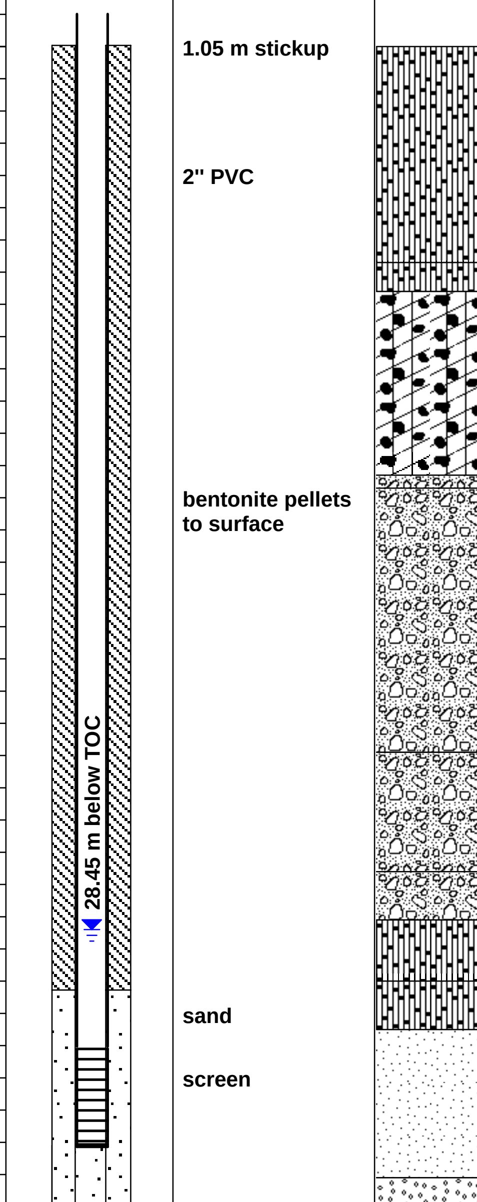
BOREHOLE LOG

PROJECT No: 1CA009.003
SITE: Bellekeno
CLIENT: Alexco Resource Corp.

DATE: Feb. 2010
LOGGED BY: Jacek Scibek
DRILL HOLE: PH5

EASTING: 483836
NORTHING: 7086707
ELEVATION: 900 masl

DEPTH (m)	ELEV (masl)	WELL	DESCRIPTION	LITHO SYMBOL	DETAILED LITHOGRAPHY	COMMENTS
-1	900.0		1.05 m stickup		**Ground Surface**	
					Gravel and Silt (till) dry, fine - coarse ang/sub ang, grey	
4	895.0		2" PVC			
					Silt with fine gravel (till) dark grey moist	
9	890.0				**Silt (clayey) and gravel (till)** dark grey moist	
14	885.0		bentonite pellets to surface		**Boulder** till with cobbles	
					Gravelly till with cobbles dry, then moist at 60 ft	
19	880.0					
24	875.0				**Hard till with gravel layers**	
					Gravel (fine-coarse) dry grey-brown	
					Silt and gravel (till) dark grey moist	
29	870.0		sand		**Gravel with silt (till)** wet	
			screen		**Fine gravel and coarse sand** clean, angular, some Qz, still see sub-round f. gravel	30.5 m to 35.1 m producing water up to 15 L/min
34	865.0				**Clean gravel**	35.1 m to 36.0 m water producing
39	860.0					



NOTES: Coordinates are +/- 5m, they are from a handheld GPS. Elevations are +/- 1m, they are taken from a topo map.

Reviewed By:

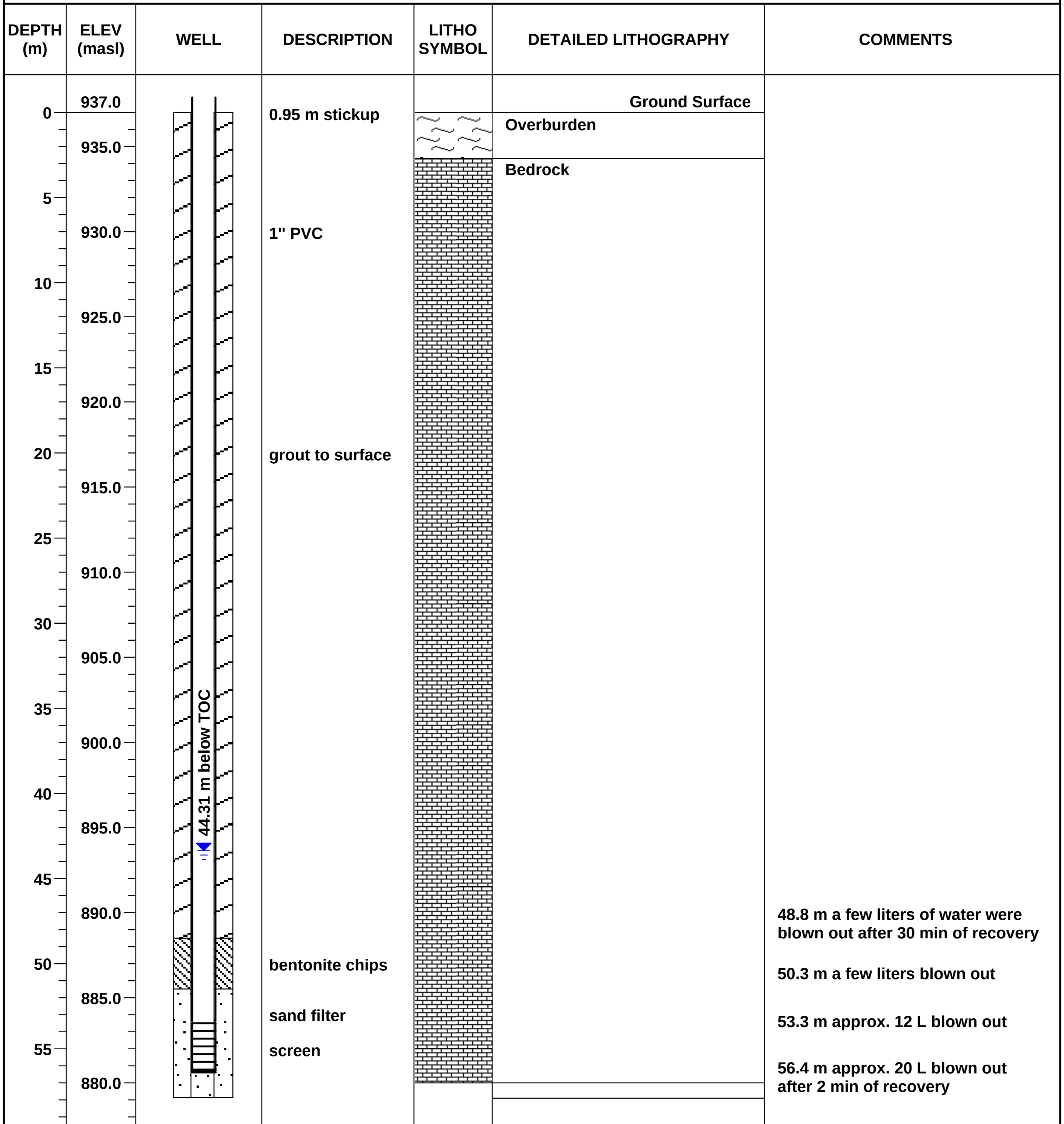
FILE

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

SHEET 1 of 1

PROJECT No: 1CA009.003	**DATE: Feb. 2010**	**EASTING: 484104**
SITE: Bellekeno	**LOGGED BY: Jacek Scibek**	**NORTHING: 7086854**
CLIENT: Alexco Resource Corp.	**DRILL HOLE: PH6**	**ELEVATION: 937.0 masl**



NOTES: Coordinates are +/- 5m, they are from a handheld GPS. Elevations are +/- 1m, they are taken from a topo map.

Reviewed By:

FILE

Appendix C
Vibrating Wire Calibration Sheets

Calibration Record

200 - 2050 Hartley Ave., Coquitlam, British Columbia, Canada V3K 6W5
Tel: 604.540.1100 • Fax: 604.540.1005 • Toll Free: 1.800.665.5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

14

PH5

Vibrating Wire Piezometer

Customer:	ALEXCO RESOURCE CORPORATION	
Model:	VW2100-0.7	
Serial Number:	**VW13099**	
Mfg Number:	0927952	
Range:	700.0 kPa	
Temperature:	24.5 °C	
Barometric Pressure:	999.6 millibars	
W.O. Number:	Q015395	
Cable Length:	60 meters	
Cable Colour Code:	Red / Black (Coil)	Green / White (Thermistor)
Cable Type:	EL380004	
Thermistor Type:	3 Kohms	

Applied Pressure (kPa)	First Reading (B units)	Applied Pressure (kPa)	Second Reading (B units)	Average Pressure (kPa)	Average Readings (B units)	Calculated Linear (kPa)	Linearity F.S. Error (%)	Polynomial Fit (% FS)
0.0	9039	0.0	9040	0.0	9040	1.2	0.17	-0.02
140.0	8279	140.0	8281	140.0	8280	139.9	-0.01	0.03
280.0	7519	280.0	7519	280.0	7519	279.0	-0.15	0.00
420.0	6753	420.0	6753	420.0	6753	418.9	-0.16	-0.01
560.0	5983	560.0	5983	560.0	5983	559.5	-0.07	-0.03
700.0	5206	700.0	5206	700.0	5206	701.5	0.21	0.02
						Max. Error (%):	0.21	0.03

Linear Calibration Factor: C.F.= **0.18267 kPa/B unit**
Regression Zero: At Calibration = **9046.1** B unit
Temperature Correction Factor: Tk = **0.0740 kPa/°C rise**

Polynomial Gage Factors (kPa) **A:** -6.8580E-07 **B:** -0.17290 **C:** 1618.8

Pressure is calculated with the following equations:
Linear, P(kPa) = C.F. X (Li - Lc) - [Tk (Ti - Tc)] + [0.10 (Bi - Bc)]
Polynomial: $P(kPa)=A(Lc)^2+BLc+C+Tk(Tc-Ti)-[0.10(Bc-Bi)]$

	Date (dd/mm/yr)	VW Readout Pos. B (Li)	Temp °C (Ti)	Baro (Bi)
Shipped Zero Readings:	19-Jan-10	9051	19.6	1085.4

Li, Lc = initial (at installation) and current readings
Ti, Tc = initial (at installation) and current temperature, in °C
Bi, Bc = initial (at installation) and current barometric pressure readings, in millibars
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = Hz^2 / 1000 ie: 1700Hz = 2890 B units

Technician: H. Chang Date: 19-Jan-10

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Applied Science Technologists and Technicians of British Columbia 22724 A.C. AL CULLEY ASCT

Document Number.: ELL0130J

MIG0106A

Calibration Record

200 - 2050 Hartley Ave., Coquitlam, British Columbia, Canada V3K 6W5
Tel: 604.540.1100 • Fax: 604.540.1005 • Toll Free: 1.800.665.5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

1ϥ
PH6

Vibrating Wire Piezometer

Customer:	ALEXCO RESOURCE CORPORATION	
Model:	VW2100-0.7	
Serial Number:	**VW13100**	
Mfg Number:	0927953	
Range:	700.0 kPa	
Temperature:	24.5 °C	
Barometric Pressure:	999.6 millibars	
W.O. Number:	Q015395	
Cable Length:	60 meters	
Cable Colour Code:	Red / Black (Coil)	Green / White (Thermistor)
Cable Type:	EL380004	
Thermistor Type:	3 Kohms	

Applied Pressure (kPa)	First Reading (B units)	Applied Pressure (kPa)	Second Reading (B units)	Average Pressure (kPa)	Average Readings (B units)	Calculated Linear (kPa)	Linearity F.S. Error (%)	Polynomial Fit (% FS)
0.0	8878	0.0	8880	0.0	8879	1.1	0.16	-0.01
140.0	8102	140.0	8103	140.0	8103	139.7	-0.04	0.00
280.0	7320	280.0	7321	280.0	7321	279.4	-0.09	0.04
420.0	6539	420.0	6540	420.0	6540	418.8	-0.16	-0.03
560.0	5751	560.0	5751	560.0	5751	559.6	-0.05	-0.02
700.0	4958	700.0	4958	700.0	4958	701.2	0.18	0.01
						Max. Error (%):	0.18	0.04

Linear Calibration Factor:	C.F.=	**0.17857 kPa/B unit**
Regression Zero:	At Calibration =	**8885.1** B unit
Temperature Correction Factor:	Tk =	**0.0542 kPa/°C rise**

Polynomial Gage Factors (kPa) A: -5.6285E-07 B: -0.17078 C: 1560.6

Pressure is calculated with the following equations:
Linear, P(kPa) = C.F. X (Li - Lc) - [Tk (Ti - Tc)] + [0.10 (Bi - Bc)]
Polynomial: $P(kPa)=A(Lc)^2+BLc+C+Tk(Tc-Ti)-[0.10(Bc-Bi)]$

	Date (dd/mm/yr)	VW Readout Pos. B (Li)	Temp °C (Ti)	Baro (Bi)
Shipped Zero Readings:	19-Jan-10	8890	19.6	1085.4

Li, Lc = initial (at installation) and current readings
Ti, Tc = initial (at installation) and current temperature, in °C
Bi, Bc = initial (at installation) and current barometric pressure readings, in millibars
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = Hz^2 / 1000 ie: 1700Hz = 2890 B units

Technician: H. Chang Date: 19-Jan-10

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Applied Science Technologists and Technicians of British Columbia
22724
AL CULLEY
AScT

Document Number.: ELL0130J

MIG0106A

Appendix D
2010 Drill Hole Water Quality

Exova
#104, 19575-55 A Ave.
Surrey, British Columbia
V3S 8P8, Canada

T: +1 (604) 514-3322
F: +1 (604) 514-3323
E: Surrey@exova.com
W: www.exova.com

Report Transmission Cover Page

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

Contact & Affiliation	Address	Delivery Commitments
Scott Keesey Access Mining Consultants Ltd.	151 Industrial Road, # 3 Calcite Business Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-6463 Fax: (867) 667-6680 Email: scott@accessconsulting.ca	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report
Durand Cornett Access Mining Consultants Ltd.	151 Industrial Road, # 3 Calcite Business Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-6463 Fax: (867) 667-6680 Email: durand@accessconsulting.ca	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report
Derek Meneghin Alexco Resource Corp.	1920 - 200 Granville Street Vancouver, British Columbia V6C 1S4 Phone: (604) 633-4888 Fax: null Email: dmeneghin@alexcoresource.com	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report
Tiffany Lunday Access Mining Consultants Ltd.	Suite 1150 - 200 Granville Street, Vancouver Vancouver, British Columbia V6C 1S4 Phone: (604) 633-4888 Fax: (604) 633-4887 Email: tlunday@alexcoresource.com	On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report
Ethan Allen Samplers Account	Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-6463 Fax: null Email: eallen@accessconsulting.ca	On [Report Approval] send (Test Report, COC) by Email - Merge Reports

Notes To Clients:

- Analysis was performed on samples 1-3 that exceeded the recommended holding time for pH, nitrate and nitrite analysis.

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W: www.exova.com

Sample Custody

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

Sample Disposal Date: March 28, 2010

All samples will be stored until this date unless other instructions are received. Please indicate other requirements below and return this form to the address or fax number on the top of this page.

☐ Extend Sample Storage Until ____________________ (MM/DD/YY)

The following charges apply to extended sample storage:

Storage for an additional 30 days	$ 2.50 per sample
Storage for an additional 60 days	$ 5.00 per sample
Storage for an additional 90 days	$ 7.50 per sample

☐ Return Sample, collect, to the address below via:

- ☐ Greyhound
- ☐ DHL
- ☐ Purolator
- ☐ Other (specify) ______________________________

Name ____________________
Company ____________________
Address ____________________
____
Phone ____________________
Fax ____________________

Signature ____________________

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Analytical Report

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

		Reference Number	727339-1	727339-2		
		Sample Date	Feb 14, 2010	Feb 14, 2010		
		Sample Time	NA	NA		
		Sample Location				
		Sample Description	PH6-1	PH5-1		
		Matrix	Water	Water		
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Inorganic Nonmetallic Parameters						
Organic Carbon	Total Nonpurgeable	mg/L	1.4	1.2		0.5
Organic Carbon	Dissolved Nonpurgeable	mg/L	1.0	<0.5		0.5

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Analytical Report

Bill To:	Alexco Resource Corp.	Project:		
Report To:	Access Mining Consultants Ltd.	ID:		
	# 3 Calcite Business Centre	Name:		
	151 Industrial Road	Location:		
	Whitehorse, YT, Canada	LSD:		
	Y1A 2V3	P.O.:		
Attn:	Scott Keesey	Acct code:	ALEXCO 2701	
Sampled By:	Jacek Sciber			
Company:	SRK			

Lot ID:	**727339**
Control Number:	
Date Received:	Feb 18, 2010
Date Reported:	Feb 26, 2010
Report Number:	1298606

		Reference Number	727339-1	727339-2	727339-3	
		Sample Date	Feb 14, 2010	Feb 14, 2010	Feb 14, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	PH6-1	PH5-1	Ph5-2	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Dissolved						
Mercury	Total Dissolved	ug/L	<0.01	<0.01	<0.01	0.01
Aluminum	Dissolved	mg/L	<0.005	<0.005	<0.005	0.005
Antimony	Dissolved	mg/L	0.0407	<0.0002	<0.0002	0.0002
Arsenic	Dissolved	mg/L	0.0192	0.0003	0.0004	0.0002
Barium	Dissolved	mg/L	0.020	0.048	0.048	0.001
Beryllium	Dissolved	mg/L	<0.00004	<0.00004	<0.00004	0.00004
Bismuth	Dissolved	mg/L	<0.001	<0.001	<0.001	0.001
Boron	Dissolved	mg/L	<0.004	<0.004	<0.004	0.004
Cadmium	Dissolved	mg/L	<0.00001	0.00033	0.00035	0.00001
Chromium	Dissolved	mg/L	<0.0004	<0.0004	<0.0004	0.0004
Cobalt	Dissolved	mg/L	0.01890	0.00025	0.00026	0.00002
Copper	Dissolved	mg/L	<0.001	0.001	0.001	0.001
Iron	Dissolved	mg/L	<0.01	<0.01	<0.01	0.01
Lead	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Lithium	Dissolved	mg/L	0.035	0.009	0.01	0.001
Manganese	Dissolved	mg/L	1.090	0.0148	0.0152	0.0002
Molybdenum	Dissolved	mg/L	0.0048	<0.0001	<0.0001	0.0001
Nickel	Dissolved	mg/L	0.078	0.005	0.006	0.001
Selenium	Dissolved	mg/L	<0.0006	0.0006	0.0007	0.0006
Silver	Dissolved	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Strontium	Dissolved	mg/L	1.380	0.246	0.252	0.001
Sulfur	Dissolved	mg/L	318	76.5	78.6	0.2
Thallium	Dissolved	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Thorium	Dissolved	mg/L	<0.0004	<0.0004	<0.0004	0.0004
Tin	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Titanium	Dissolved	mg/L	0.0006	<0.0004	<0.0004	0.0004
Uranium	Dissolved	mg/L	0.1420	0.0031	0.0031	0.0004
Vanadium	Dissolved	mg/L	0.0002	<0.0001	<0.0001	0.0001
Zinc	Dissolved	mg/L	0.064	0.036	0.037	0.001
Zirconium	Dissolved	mg/L	0.0030	<0.0001	<0.0001	0.0001
Metals Total						
Aluminum	Total	mg/L	15.1	0.038	0.035	0.005
Antimony	Total	mg/L	0.024	<0.0002	<0.0002	0.0002
Arsenic	Total	mg/L	0.048	0.0012	0.0012	0.0002
Barium	Total	mg/L	0.10	0.051	0.049	0.001
Beryllium	Total	mg/L	0.0017	<0.00004	<0.00004	0.00004

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Analytical Report

Bill To:	Alexco Resource Corp.	Project:	
Report To:	Access Mining Consultants Ltd.	ID:	
	# 3 Calcite Business Centre	Name:	
	151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Scott Keesey	Acct code:	ALEXCO 2701
Sampled By:	Jacek Sciber		
Company:	SRK		

Lot ID:	**727339**
Control Number:	
Date Received:	Feb 18, 2010
Date Reported:	Feb 26, 2010
Report Number:	1298606

		Reference Number	727339-1	727339-2	727339-3	
		Sample Date	Feb 14, 2010	Feb 14, 2010	Feb 14, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	PH6-1	PH5-1	Ph5-2	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total - Continued						
Bismuth	Total	mg/L	<0.005	<0.001	<0.001	0.001
Boron	Total	mg/L	<0.02	<0.005	<0.005	0.004
Cadmium	Total	mg/L	0.00008	0.00037	0.00038	0.00001
Calcium	Total	mg/L	493	118	117	0.05
Chromium	Total	mg/L	0.0098	<0.0004	<0.0004	0.0004
Cobalt	Total	mg/L	0.0221	0.00032	0.00030	0.00002
Copper	Total	mg/L	0.006	0.002	0.001	0.001
Iron	Total	mg/L	12.4	0.157	0.149	0.01
Lead	Total	mg/L	0.010	0.0005	0.0004	0.0001
Lithium	Total	mg/L	0.04	0.01	0.01	0.001
Magnesium	Total	mg/L	136	32.3	32.0	0.05
Manganese	Total	mg/L	1.39	0.0209	0.0191	0.0002
Molybdenum	Total	mg/L	0.004	<0.0001	<0.0001	0.0001
Nickel	Total	mg/L	0.085	0.005	0.006	0.001
Phosphorus	Total	mg/L	0.10	<0.010	<0.010	0.01
Potassium	Total	mg/L	5.4	0.5	0.6	0.1
Selenium	Total	mg/L	<0.003	<0.0006	<0.0006	0.0006
Silicon	Total	mg/L	35.0	3.39	3.37	0.05
Silver	Total	mg/L	<0.00005	<0.00001	<0.00001	0.00001
Sodium	Total	mg/L	19.5	1.60	1.59	0.02
Strontium	Total	mg/L	1.36	0.256	0.251	0.001
Sulfur	Total	mg/L	404	96.4	99.0	0.1
Tellurium	Total	mg/L	<0.0005	<0.0001	<0.0001	0.0001
Thallium	Total	mg/L	0.00018	<0.00001	<0.00001	0.00001
Thorium	Total	mg/L	0.011	<0.0004	<0.0004	0.0004
Tin	Total	mg/L	<0.0005	<0.0001	<0.0001	0.0001
Uranium	Total	mg/L	0.167	0.0034	0.0034	0.0004
Vanadium	Total	mg/L	0.011	<0.0001	0.0001	0.0001
Zinc	Total	mg/L	0.37	0.042	0.038	0.001
Zirconium	Total	mg/L	0.0098	<0.0001	<0.0001	0.0001
Titanium	Total	mg/L	0.072	<0.001	0.002	0.001
Routine Water						
pH	@ 25 °C		7.10	6.85	6.79	
Electrical Conductivity		µS/cm at 25 C	2280	693	700	1
Calcium	Dissolved	mg/L	425	99.2	99.1	0.1
Magnesium	Dissolved	mg/L	144	27.0	27.0	0.1

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Analytical Report

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

		Reference Number	727339-1	727339-2	727339-3	
		Sample Date	Feb 14, 2010	Feb 14, 2010	Feb 14, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	PH6-1	PH5-1	Ph5-2	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Routine Water - Continued						
Phosphorus	Dissolved	mg/L	<0.01	0.01	<0.01	0.01
Potassium	Dissolved	mg/L	2.1	0.3	0.3	0.1
Silicon	Dissolved	mg/L	3.78	2.68	2.71	0.05
Sodium	Dissolved	mg/L	15.5	1.4	1.4	0.1
Bicarbonate		mg/L	590	100	100	5
Carbonate		mg/L	<6	<6	<6	6
Hydroxide		mg/L	<5	<5	<5	5
P-Alkalinity	as CaCO3	mg/L	<5	<5	<5	5
T-Alkalinity	as CaCO3	mg/L	482	93	93	5
Chloride	Dissolved	mg/L	9.18	0.54	0.58	0.02
Nitrate - N	Dissolved	mg/L	<0.01	0.16	0.15	0.01
Nitrite - N	Dissolved	mg/L	<0.01	<0.01	<0.01	0.01
Sulfate (SO4)	Dissolved	mg/L	953	229	236	0.6
Hardness	as CaCO3	mg/L	1650	359	358	5
Total Dissolved Solids	Calculated Value	mg/L	1850	422	428	1

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Analytical Report

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

Reference Number	727339-4
Sample Date	Feb 15, 2010
Sample Time	NA
Sample Location	
Sample Description	PH2-1
Matrix	Water

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Routine Water						
pH	@ 25 °C		7.28			
Electrical Conductivity		µS/cm at 25 C	1770			1

Approved by: [signature]

Andrew Garrard, BSc, PChem
General Manager

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Methodology and Notes

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alk, pH, EC, Turb in water	APHA	*	Alkalinity - Titration Method, 2320 B	22-Feb-10	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	Conductivity, 2510	22-Feb-10	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	pH - Electrometric Method, 4500-H+ B	22-Feb-10	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	19-Feb-10	Exova Surrey
Carbon Organic (Dissolved) in water (DOC)	APHA		High-Temperature Combustion Method, 5310 B	22-Feb-10	Exova Edmonton
Carbon Organic (Total) in water (TOC)	APHA		High-Temperature Combustion Method, 5310 B	22-Feb-10	Exova Edmonton
Mercury Low Level (Total) in water	EPA	*	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, 245.7	22-Feb-10	Exova Surrey
Metals SemiTrace (Dissolved) in water	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	22-Feb-10	Exova Surrey
Metals SemiTrace (Total) in Water	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	22-Feb-10	Exova Surrey
Trace Metals (dissolved) in Water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	22-Feb-10	Exova Surrey
Trace Metals (dissolved) in Water	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	22-Feb-10	Exova Surrey
Trace Metals (Total) in Water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	22-Feb-10	Exova Surrey
Trace Metals (Total) in Water	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	22-Feb-10	Exova Surrey

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
EPA	Environmental Protection Agency Test Methods - US
US EPA	US Environmental Protection Agency Test Methods

Comments:

- Analysis was performed on samples 1-3 that exceeded the recommended holding time for pH, nitrate and nitrite analysis.

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Methodology and Notes

Bill To:	Alexco Resource Corp.	Project:		Lot ID:	**727339**
Report To:	Access Mining Consultants Ltd.	ID:		Control Number:	
	# 3 Calcite Business Centre	Name:		Date Received:	Feb 18, 2010
	151 Industrial Road	Location:		Date Reported:	Feb 26, 2010
	Whitehorse, YT, Canada	LSD:		Report Number:	1298606
	Y1A 2V3	P.O.:			
Attn:	Scott Keesey	Acct code:	ALEXCO 2701		
Sampled By:	Jacek Sciber				
Company:	SRK				

UPDATED

Lab Copy

Chain-of-Custody Record - Analytical Request Form

From:	
Address:	
Telephone:	
Fax:	
Contact:	
Email:	

Send Samples For Analysis To:	
Address:	
Telephone:	
Fax:	
Contact:	
Email:	

eMail Confirmation and Results To:
dmackie@srk.com
eallen@accessconsulting.ca

Send Original Signed Lab Reports To:
SRK Consulting
Address: 2200 - 1066 West Hastings, Vancouver, BC, V6E 3X2
Phone: (604) 681 4196
Fax: (604) 687 5532
Attn: Dan Mackie
Email: dmackie@srk.com

Send Invoice To:
SRK Consulting
Address: 2200 - 1066 West Hastings, Vancouver, BC, V6E 3X2
Phone: (604) 681 4196
Fax: (604) 687 5532
Attn: Dan Mackie
Email: dmackie@srk.com

FIELD SAMPLE INFORMATION

Fields Notes:

All monitoring wells purged with waterra tubes and hydrolift until field parameters (EC, pH, Temp) stable and water clear, or not clearing any further.

Note: sample PH2-1 was from well not developed completely.

Sampled water was cold, close to 0 C, and stored for short time in +5C in vehicle.

REQUESTED LAB SUITES (see reverse side for details)

	Conductivity & pH	TOC, DOC, Sulphide	Nutrients	Major Ions (incl. Alkalinity)	Physical Parameters (TDS, TSS)	Low Detection Total Metals	Total Metals	Low Detection Dissolved Metals	Dissolved Metals	Oil and Grease	Total Cyanide	Total Ammonia	Dissolved Arsenic by GFAA	Total Arsenic by GFAA	Speciation	Ra226	Total As, Cu, Pb, Ni, Zn	Dissolved As, Cu, Pb, Ni, Zn
√ = Preserved :									√									
√ = Field Filtered :									√									
√ = 1-Day Rush :																		

Sample Control Number	Lab Sample ID	Sample Date (dd-mmm-yy)	Sample Time (hh:mm)	Matrix	Laboratory Comments	Sampler Comments	G = Grab or C = Composite	Number of Containers	Conductivity & pH	TOC, DOC, Sulphide	Nutrients	Major Ions (incl. Alkalinity)	Physical Parameters (TDS, TSS)	Low Detection Total Metals	Total Metals	Low Detection Dissolved Metals	Dissolved Metals	Oil and Grease	Total Cyanide	Total Ammonia	Dissolved Arsenic by GFAA	Total Arsenic by GFAA	Speciation	Ra226	Total As, Cu, Pb, Ni, Zn	Dissolved As, Cu, Pb, Ni, Zn
	PH6-1	14-Feb-10	14:00		Diss Metals sample filtered .45 um filter + preserved with HCl	clear		3	√	√		√			√		√									√
	PH5-1	14-Feb-10	16:45		Diss Metals sample filtered .45 um filter + preserved with HCl	clear		3	√	√		√			√		√									√
	PH5-2	14-Feb-10	16:45		Diss Metals sample filtered .45 um filter + preserved with HCl	clear		2	√						√		√									
	PH2-1	15-Feb-10	10:00			cloudy grey		1	√																	

Relinquished by (Sampler Signature): [signature]	Date/Time: Feb 15, 2010	Company: SRK Consulting	Received by (Signature):	Company:
Relinquished by (Signature):	Date/Time:	Company:	Received by (Signature):	Company:
Sampler (Printed Name): Jacek Scibek	Sample Storage Temperature prior to Shipping (deg. C):			

SAMPLE CONDITION (lab use only)

Sample Receipt Temperature (deg. C):

Samples Received in Good Condition? Yes / No (If no, provide details.)

Lab Copy

Chain-of-Custody Record - Analytical Request Form

From: Alexco Resources

Address: #2 Calcite Business Centre
Telephone:
Fax:
Contact:
Email:

Send Samples For Analysis To:
Address:
Telephone:
Fax:
Contact:
Email:

eMail Confirmation and Results To:
dmackie@srk.com
eallen@accessconsulting.ca

Send Original Signed Lab Reports To:
Access Consulting Group
Address: #3 Calcite Business Centre, 151 Industrial Road, Whitehorse, Yukon Y1A 2V3
Phone: (867) 668-6463
Fax: (867) 667-6680
Attn: Ethan Allen
Email: eallen@accessconsulting.ca

Send Invoice To:
Access Consulting Group
Address: #3 Calcite Business Centre, 151 Industrial Road, Whitehorse, Yukon Y1A 2V3
Phone:
Fax:
Attn:
Email:

RECEIVED FEB 18 2010

FIELD SAMPLE INFORMATION

REQUESTED LAB SUITES (see reverse side for details)

Fields Notes:
All monitoring wells purged with waterra tubes and hydrolift until field parameters (EC, pH, Temp) stable and water clear, or not clearing any further.
Exception is PH2-1, where 160 liters of water was purged due to hydrolift failure. Water was clearing up and field parameters stable.
Sampled water was cold, close to 0 C, and stored for short time in +5C in vehicle.

√ = Preserved :	Dissolved Metals: √
√ = Field Filtered :	Dissolved Metals: √
√ = 1-Day Rush :	

Sample Control Number	Lab Sample ID	Sample Date (dd-mmm-yy)	Sample Time (hh:mm)	Matrix	Laboratory Comments	Sampler Comments	G = Grab or C = Composite	Number of Containers	Conductivity & pH	TOC, DOC, Sulphide	Nutrients	Major Ions	Physical Parameters	Low Detection Total Metals	Total Metals	Low Detection Dissolved Metals	Dissolved Metals	Oil and Grease	Total Cyanide	Total Ammonia	Dissolved Arsenic by GFAA	Total Arsenic by GFAA	Speciation	Ra226	Total As, Cu, Pb, Ni, Zn	Dissolved As, Cu, Pb, Ni, Zn
	PH6-1	14-Feb-10	14:00		Diss Metals sample filtered .45 um filter + preserved with HCl	clear		3	√				√		√		√									
	PH5-1	14-Feb-10	16:45		Diss Metals sample filtered .45 um filter + preserved with HCl	clear		3	√				√		√		√									
	PH5-2	14-Feb-10	16:45		Diss Metals sample filtered .45 um filter + preserved with HCl	clear		3	√				√		√		√									
	~~PH2-1~~	~~15-Feb-10~~	~~9:55~~			~~cloudy; only 160 liters of well purging~~		~~1~~	~~√~~				~~√~~		~~√~~		~~√~~									

Relinquished by (Sampler Signature): Jacek Scibek	Date/Time: Feb 15, 2010	Company: SRK Consulting	Received by (Signature):	Company:
Relinquished by (Signature):	Date/Time:	Company:	Received by (Signature):	Company:
Sampler (Printed Name): Jacek Scibek	Sample Storage Temperature prior to Shipping (deg. C):			

SAMPLE CONDITION (lab use only)
Sample Receipt Temperature (deg. C):
Samples Received in Good Condition? Yes / No (If no, provide details.)

APPENDIX C

SRK CONSULTING

2008 TECHNICAL MEMORANDUM ASSESSMENT OF GROUNDWATER REGIME

AT THE VALLEY TAILINGS FACILITY

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Technical Memorandum

To:	File	**Date:**	February 12, 2008
cc:		**From:**	Ben Green
Subject:	Assessment of Groundwater Regime at the Valley Tailings Facility	**Project #:**	1CE012.000.0H6

1 Introduction

1.1 Background

The former United Keno Hill Mine (UKHM) site, is located in central Yukon Territory, approximately 350 km (220 miles) due north of Whitehorse in the vicinity of the villages of Elsa and Keno City. Mining of the in the area commenced in 1914, and continued to January, 1989. During this period over 5.3 million tons of ore was mined from over 30 open pit and underground operations, with average grades of about 1,370 g/t (40 oz/ton) Ag, 6.6% Pb and 4.1% Zn. The majority of this ore was processed at the Elsa mill.

Tailings from the Elsa mill were deposited downslope in the upper Flat Creek valley over a period of five decades. Three dams were constructed to contain the tailings and to manage surface water discharge from the facility. The dams, tailings, and related diversions and infrastructure are collectively referred to as the Valley Tailings Facility (VTF). Elsa Reclamation and Development Company Ltd. (ERDC) is in the process of preparing a closure plan for the VTF and the various other components of the UKHM property.

In 2007 Alexco contracted SRK Consulting (Canada) Inc. (SRK) to develop a conceptual understanding of the hydrogeology of the VTF, and to develop estimates of the groundwater flux from the facility. This technical memorandum summarizes the 2007 hydrogeological investigations, review, and analysis leading to an estimate of net groundwater flux through the tailings facility.

1.2 Objective

The principal objective of this work was to develop an understanding of the physical hydrogeology of the VTF to enable an estimation of groundwater flux through the facility to be derived. This flux will be used to estimate current contaminant loadings from the VTA to the receiving environment.

1.3 Approach

The study involved a review of available data, followed by the development of a conceptual hydrogeological model for the site. A geotechnical drilling and sampling program was undertaken by SRK in 2007 to provide information on the unconsolidated materials at the project site. Where site specific data were unavailable, a “Best Engineering Judgement” approach was used and assessed with a sensitivity analysis.

1.3.1 Fieldwork & Drilling Programme

SRK undertook a drilling program from October 16th to 25th 2007, consisting of fifteen drill holes at the Valley Tailings Area (VTA), using a percussion drill, to depths of 10 to 20 m below ground level (mbgl). The drill program included six drill holes located along the upstream and downstream crests of Dam 1, Dam 2 and Dam 3, and six drill holes (3 deep drillholes paired with 3 shallow drillholes) were completed within the tailings deposits. Soil stratigraphy, bedrock characterization, geotechnical conditions and permafrost extent and characterization were investigated and samples were collected for laboratory testing. Monitoring wells were installed in the completed drill holes to monitor water level elevations and water chemistry within the VTF, and thermistors were installed in 5 of 6 dam boreholes to monitor thermal conditions within and below the dams. A full account of the hydrogeological drilling programme can be seen in Appendix A. The borehole layout can be seen in Figure 2.1.

The following observations were taken from the VTA drill program:

- The VTA drill program indicates that Dams 1, 2 and 3 were constructed on top of peat and local deposits of tailings.
- Peat underlies the tailings deposits.
- No permafrost was encountered in any of the drill holes completed within the VTF in 2007.
- Permafrost was encountered under the dams by EBA in 1982, although not by SRK in similar locations in the 2007 programme. This indicates that permafrost degradation has occurred, at least in the disturbed areas within the VTF.
- Permafrost was encountered at a depth of 4 m in undisturbed ground downgradient of the VTF to the west of Dam 3, and at 12 m depth to the northwest of Dam 3.

For the purposes of the hydrogeological investigation, cross-sections of the overburden and bedrock interface were established along the centerline of each of the three tailings dams, to coincide with current and previous investigations.

1.4 Data Reviewed

The following references were reviewed for this study:

- Previous site investigation reports, memos and drill logs.
- Grain size analysis data from selected 2007 boreholes.
- Recent (2006) aerial photography of the facility and surrounding area.
- EBA reports (1982, 2006).

2 Conceptual Understanding of Site Hydrogeology

The VTF is situated within a wide glaciated valley in which the extent of tailings disposal is evident (Figure 2.1). Bedrock exposures have been indicated on the map, as well as areas where permafrost has been intersected by boreholes or test pits.

2.1 Geology

The bedrock geology of the Keno Hill area is underlain by Yukon Group metasedimentary rocks. The rocks include various types of argillite, phyllite, slate, schist and quartzite. Conformable greenstone (altered diorite-gabbro) lenses and sills occur in places and few narrow lamprophyre and quartz-feldspar porphyry dykes occur locally. Granitic bodies have intruded the metasedimentary - greenstone package at several places to the north and south of the Keno Hill -Galena Hill area (Watson 1986).

The metasedimentary sequences trend east-west, and dip 20 to 30 degrees to the south. In the Keno Hill area, they form the southern flank of the McQuesten anticline (Watson 1986).

The site is at the western extent of the most recent Cordilleran ice sheet, and thus the surficial geology is dominated by a complex assemblage of glacial and periglacial landforms and deposits. Valley bottoms are broad and overburden covered, commonly boggy and contain thick peat deposits. Permafrost is widespread though discontinuous.

2.2 Structure

A series of faults, striking northeast and dipping steeply southeast, host the silver-lead-zinc lode deposits. These vein faults exhibit left lateral movement, commonly offsetting the surrounding metasedimentary sequences by over 150 m (Watson 1986).

The vein faults are offset in places by two types of unmineralized faults. The first type, known as cross faults, strikes northwest and dips 40 to 60 degrees southwest. These cross faults are typically normal right lateral faults with apparent horizontal movements ranging from 1 to 610 m. The second type of un-mineralized faults are bedding plane thrust faults which exhibit movements ranging from 1 to 30 m. Both cross faults and bedding plane faults show indications of post-ore movement. Several ore zones within the area have been offset by cross faulting. Some limited post-ore movement is also evident within the vein faults (Watson 1986).

2.3 Climate

The climate of the area is typical of continental interior. The mean annual temperature at Mayo is -3°C. Winter temperatures have been recorded to -55°C and summer temperatures to 32°C. There is are only a few hours of daylight in December, and in June there is no true darkness due to the latitude of about 64°N. The average annual precipitation is 285 mm. The area of the property is underlain by widespread discontinuous permafrost.

2.4 Tailings & Water Management

2.4.1 Deposition of Tailings

The tailings from past milling activities were deposited in the upper Flat Creek valley below the Elsa mill site. The main accumulation of tailings is in a swampy area formerly drained by North Fork Flat Creek. Porcupine Creek passes through the southwest portion of the tailings area, with the lower portion of the creek confined to a diversion ditch excavated in 1979. A lesser volume of older tailings is perched on the hillside on both sides of Porcupine Creek, from just below the highway to the valley bottom. The areal extent of tailings is relatively well delineated from recent air photography (Figure 2.1). The total surface area of the impoundment is approximately 75 ha.

Considerable drilling was done in the tailings area by UKHM in a number of campaigns to assess the remaining economic metal content of the tailings. Prior to the construction of Dam 1, tailings were discharged on the hillside directly into Porcupine Creek, and tailings accumulated from the discharge point down the hillside and north across the valley. After Dam 1 was constructed, the tailings discharge was relocated to the hillside at the southeast corner of the VTF and the more recent mass of tailings is distributed along an arcuate path from this discharge point to Dam 1. An isolated area of old tailings occurs in terraces just below the highway to the west of Porcupine Creek.

Dam 2 and Dam 3 were constructed in the 1970s to form polishing ponds intended to increase the residence time of tailings pond water prior to discharge. The soils under all three dams have thawed since construction, resulting in an unknown amount of subsidence of the dams. Addition of mine rock to the low points has been required every few years to compensate for the subsidence.

Results of inspections of the dams can be found in a series of reports by EBA Engineering, the most recent of which was prepared in 2007. These inspection reports note ongoing subsidence of the structures during the 1980s and 1990s, with little evidence of subsidence observed in recent years. The tailings behind Dam 1, where wet, have developed a vegetative cover, but the dry, sandy, upper portions of the tailings deposit is barren. The exposed tailings are subject to wind erosion from time to time.

2.4.2 Water Management

The diversion of Porcupine Creek around the tailings is a complicating factor for closure, in that there is thought to be a significant amount of leakage from the diversion towards Pond 3. Above the diversion, Porcupine Creek cuts through the south edge of the tailings deposit for a distance of about 400 m, and there has historically been erosion of the tailings both prior to and following construction of the diversion.

It is understood that there are diversions on the hillside immediately southeast of the VTF that are intended to intercept shallow flows upgradient of the VTF and convey this water from the VTF catchment into the No Cash Creek catchment to the east. These diversions likely exert little influence on the VTF groundwater regime and are not discussed further.

Incident precipitation and runoff from the local catchment are retained by Dam 1 and form Pond 1 immediately upstream. This water decants to Pond 2 and continues through the Dam 2 decant to Pond 3. A decant through Dam 3 discharges Pond 3 water to the downgradient wetland, with the water ultimately reporting to Flat Creek via surface or shallow subsurface pathways.

2.5 Hydrogeological interpretation

The following interpretations can be taken from the information above:

- The area was originally drained from the east to west by Flat Creek, Brefalt Creek, Porcupine Creek and North Fork Flat Creek.
- Dams have been constructed to hold back tailings and to manage water; these dams have impeded the flows of North Fork Flat Creek. A diversion channel was contracted to divert flows from Porcupine Creek, Brefalt Creek, and Flat Creek around Dam 3. However, seepage from this diversion towards Pond 3 has been recorded.
- The bedrock is likely to have low primary permeability with a relatively high secondary permeability as a result of local fractures and faulting.
- Alluvial and glacial deposits are present above the bedrock units. Groundwater is assumed to flow predominantly through higher permeability zones of these unconsolidated units. The glacial deposits appear to consist of a complex of glacial sediments dominated by a poorly sorted ablation till with high silt content.
- Topography is moderate, with flows channelled within a wide glacial valley. Hydraulic gradients are considered low.
- Runoff from the upgradient catchments is expected to be high due to sparse vegetation, bedrock outcrops and discontinuous permafrost.
- Peat was recorded across the site prior to tailings deposition. Depending on the maturity of the peat, its thickness and compression (from the overlying tailings), hydraulic conductivity values in the range of 10^{-5}m/s to 10^{-6}m/s could be expected. This is significant when considering possible vertical seepage into underlying soils.

3 Assessment of Groundwater Flux

3.1 Methodology

3.1.1 Groundwater Flux Through Dams

Based on the distribution of boreholes across the site, three section lines were selected to coincide with the alignment of Dam 1 (A-A'), Dam 2 (B-B'), and Dam 3 (C-C') as seen in Figure 4.1. Flow lines were constructed through the site from survey and monitoring data. These are also illustrated in Figure 4.1. Hydrogeological interpretations were made based on the information available. The borehole logs and hydrogeological cross sections can be viewed in Figures 4.2 and 4.3.

Permeability data for the materials was estimated using grain size distributions. Hydraulic conductivity (K) values were assigned to the respective unconsolidated sediments logged in the 2007 boreholes. The distribution of the sediments was then interpreted across each of the dam sections. The cross sectional area of the sediments was estimated and then a weighted average for the hydraulic conductivity of that material was derived to produce a net hydraulic conductivity for each section.

A hydraulic gradient was calculated for each of the dams. A Darcy approach was taken to estimate the flow through the unconsolidated cross-section beneath each of the dams.

3.1.2 Estimate of Seepage from Porcupine Creek Diversion Channel

Seepage has been recorded from a section of the Porcupine Diversion into the adjacent tailings south of Pond 3. The channel is located approximately 500m to the south of Pond 3, and extends 800m in an east to west direction. Seepage flows from the channel were estimated by assuming a constant hydraulic head in the ditch, flowing through a shallow permeable material to the surface water in Pond 3.

3.2 Grain Size Analysis

Samples of subsurface materials were collected from the 2007 hydrogeological drilling program. Select samples of representative sediments from each of the dam foundations were sent to the EBA soils laboratory in Whitehorse for grain size analysis. The results of the grain size testwork can be seen in Appendix C.

The results were analysed to estimate a hydraulic conductivity using two methods. The Hazen formula is commonly used to estimate saturated hydraulic conductivity from grain size curves; however, this method assumes a sandy material with the effective grain size D_{10} line (percent passing <10%) lies between the 0.1 mm and 3 mm particle size. These assumptions are not valid for the materials in question. The Hazen formula was therefore considered inappropriate.

The method for estimating hydraulic conductivity that was adopted for this study was to make use of the RETC (version 6) software package developed by van Genuchten et al. (1985) to quantify the hydraulic functions of unsaturated soils using the theoretical pore-size distribution models of Mualem (1953) and Burdine (1986). These models predict the unsaturated hydraulic conductivity function from observed soil water retention data. This method is more appropriate for the fine grained soils underlying the VTF.

The results with the selected analysis method are displayed in Table 3.1. A range of hydraulic conductivity values is given to illustrate the level of confidence in the results.

3.3 Limitations of Data

Percussion drilling creates a grain size bias towards the coarse soil fractions. Even with the highest level of care, the finer fractions can be lost by flushing with water encountered or with the circulating air. This loss of fines can greatly effect the interpretation of grain size analysis results to estimate hydraulic conductivity. During the drilling process, the inspector noted that significant fines were flushed from the samples. These flushed fines represent an unknown proportion of the true silt or clay component of the samples.

A best engineering judgement (BEJ) approach was therefore used to propose a hydraulic conductivity (K) value for each of the samples, to ascertain their probable in-situ permeability. Field observations during the drilling program indicated that a high proportion of silt had been washed from the sample by water. Consequently the BEJ approach was to take the geometric mean of the *lower* K range for each sample, to account for the loss of silt fractions, so that a single hydraulic conductivity for that sediment group could be derived. The results are seen in Table 3.2.

The BEJ hydraulic conductivities were then weighted with respect to the cross sectional area for each of the material. The results can be seen below in Table 3.3. The resulting weighted hydraulic conductivity values are considered reasonable for an in-situ ablation till material.

Table 3.1: Details and Results of Grain Size Analysis

Dam	Borehole Number	Sample Number	Depth (m)	Description	Hydraulic Conductivity (m/s)		Analysis Method
					From	To	
Dam 3	GT12	GS-5	8	Gravel	6.7 E-06	6.7 E-04	RETC
Dam 3	H2	GS-2-5	6 - 8	Silty- sandy gravel	6.6 E-07	6.6 E-05	RETC
Dam 1	GT7	GS-7	14	Silty- sandy gravel	6.3 E-07	6.3 E-05	RETC
Dam 2	GT8	GS-6	16-18	Silty- sandy gravel	8.7 E-07	8.7 E-05	RETC
Dam 3	GT12	GS-9	14	Silty- sandy gravel	6.6 E-07	6.6 E-05	RETC
Dam 2	GT8	GS-6	8	Sandy Gravel	6.4 E-06	6.4 E-04	RETC
Dam 3	GT12	GS-6	10	Sandy Gravel	1.8 E-06	1.8 E-04	RETC
Dam 1	GT7	GS-6	12	Sandy Gravel	7.5 E-06	7.5 E-04	RETC
Dam 3	H11	GS-4	8	Sandy Gravel	2.9 E-06	2.9 E-04	RETC
Dam 3	GT10	GS-4	8	Sandy Gravel	6.7 E-06	6.7 E-04	RETC
Dam 2	GT9	GS-7	11	Sand	7.8 E-06	7.8 E-04	RETC
Dam 3	H2	GS-8	10	Silty sand	1.3 E-06	1.3 E-04	RETC

Table 3.2: Hydraulic Conductivities of Overburden Materials Derived from Grain Size Analysis

Material Type Description (Lab)	Hydraulic Conductivity (K) range (m/s)		BEJ Hydraulic Conductivity (K) range (m/s)	Comments
	Lower	Upper		
Gravel	6.7 E-5	6.7 E -3	6.7 E-5	Geometric mean of lower K value used as BEJ to account for fines loss
Sandy Gravel	1.8 E-6	7.5 E-4	4.0 E-6	Geometric mean of lower K value used as BEJ to account for fines loss
Sandy Silty Gravel	6.3 E-7	8.7 E-5	7.0-07	Geometric mean of lower K value used as BEJ to account for fines loss

Table 3.3: Weighted Average Hydraulic Conductivities Calculated for Overburden Cross-Sections beneath VTF Dams

	Material Type	VTA Dam		
		Dam 1	**Dam 2**	**Dam 3**
Gravel	Area in section (m^2)	1,003	4,959	600
	Hydraulic Conductivity [m/s] (weighted)	6.7 E-06	6.7 E-05	6.7 E-05
Sandy Gravel	Area in section (m^2)	1,369	1,257	5,120
	Hydraulic Conductivity [m/s] (weighted)	4.9 E-06	4.9 E-06	4.9 E-06
Silty Sandy Gravel	Area in section (m^2)	10,377	8,238	17,205
	Hydraulic Conductivity [m/s] (weighted)	7.0 E-07	7.0 E-07	7.0 E-07
Weighted Average Hydraulic Conductivity (m/s)		**8.4 E-07**	**1.2 E-06**	**9.0 E-07**

3.4 Groundwater Flux Calculation

3.4.1 VTA Dams

To derive a groundwater flux (Q), a Darcy approach was taken (Equation 3.1). The main components of this equation are summarised below:

Equation 3.1: Darcy Equation

$$Q = -K \times A \times \frac{dh}{dx}$$

Where:

Q = Groundwater flux or discharge (m^3/day

K = Hydraulic Conductivity (m/day)

A = Area through cross section (m^2)

$\frac{dh}{dx}$ = Hydraulic gradient

A flux for each of the dams was calculated using the Darcy Equation and the properties of the respective cross-sections from Table 3.3.

Hydraulic gradients were calculated for each of the sites using various surface water and groundwater level elevations. An arithmetic mean of the gradients was used to derive an overall hydraulic gradient for each dam site.

The Darcy equation was then used to calculate a groundwater flux through for each Dam. The results are tabulated in Table 3.4.

3.4.2 Diversion Channel

The Porcupine Creek diversion channel is understood to lose water via a groundwater pathway via a zone of old tailings material between the diversion and Pond 3 (Figure 4.1). A section was produced across the estimated seepage face along the diversion channel. From the findings from Borehole H4D, the depth to bedrock is in the region of 5m. A similar Darcy approach to estimating groundwater flux through the dams was taken to derive a seepage flux from the diversion channel. This flux, of approximately 4 m^3/day is likely to enter the system upstream of Dam 3. It is likely that a component of this will feed into Pond 3.

From this analysis, a net groundwater flux in the region of 18 m^3/day could be expected through the base of Dam 3.

3.4.3 Sensitivity Analysis

A sensitivity analysis was carried out to determine what input parameters were sensitive to the outcome of the model. The following were investigated, with the degree of confidence noted for each parameter:

- Hydraulic Conductivity (low- moderate, 2 orders magnitude);
- Area of material in cross section (high, +/- 10%); and
- Hydraulic gradient (moderate to high +/-20%);

The results of the sensitivity analysis indicate that the main uncertainty in the estimate of flux from the VTF stems result from the adopted values of hydraulic conductivity. Table 3.4 lists the minimum, maximum and BEJ seepage flux estimates for the area, based on the ranges of hydraulic conductivity area and gradient. The flux used in the study was derived based on the best engineering judgement (BEJ).

Table 3.4: Seepage Flux Estimates at Select Locations in the VTF

Dam	Area (m^2)	Hydraulic Conductivity (m/sec)	Hydraulic Gradient	Min Flux Q (m^3/day)	Max Flux Q (m^3/day)	BEJ Flux Q (m^3/day)
Dam 1	12,749	8.4 E-07	0.02	0.1	2075.6	**15.6**
Dam 2	14,454	1.2 E-06	0.01	0.1	2066.2	**15.6**
Dam 3	22,925	9.0 E-07	0.01	0.1	2354.7	**17.8**

4 Conclusions

This study used grain size data for samples collected during hydrogeological investigations at the Valley Tailings Facility to estimate hydraulic characteristics of the unconsolidated materials beneath the tailings and the dams. Using these data, a groundwater flux was calculated through the unconsolidated sediments beneath each of the dams. A net flux of **18 m^3/day** was estimated to leave the VTF via groundwater flow beneath Dam 3.

The flux was estimated using data that was not collected under ideal conditions for a hydrogeological investigation, and was analysed using methods that are suitable for scoping level assessments. The sensitivity analysis indicates that the resulting flux is sensitive to changes in hydraulic conductivity. Although a full hydrogeological study is not warranted, further information should be collected from the site to increase the hydrogeological understanding.

4.1 Discussion and Recommendations

The sampling methodology (using a percussion drill) was not a recommended one for collection of representative samples for grain size analysis. This limitation was recognized in advance and was accepted as a reasonable trade-off for procuring drilling services on short notice. The loss of a portion of the sample due to the percussive nature of the drilling method results in an under representation of the finer fractions, which in turn results in a systematic bias towards a higher estimate of hydraulic conductivity. In this study, to partially overcome this bias, the lower value in the range of hydraulic conductivities estimated for each soil type was used.

The following actions are recommendations to increase the confidence in the conclusions of the analyses presented in this memorandum. It is hoped that these can be undertaken and, with field observations, the results can be used to continuously modify and update the model.

- Refinement of the site water balance to allow better estimates of seepage losses from the Porcupine Diversion.
- Slug testing in the existing wells to attempt to derive a better estimate of hydraulic conductivity in the overburden soils beneath the VTF.

Prepared by

Ben Green
Senior Hydrogeologist

Reviewed by

Michael Royle
Principal Consultant

5 References

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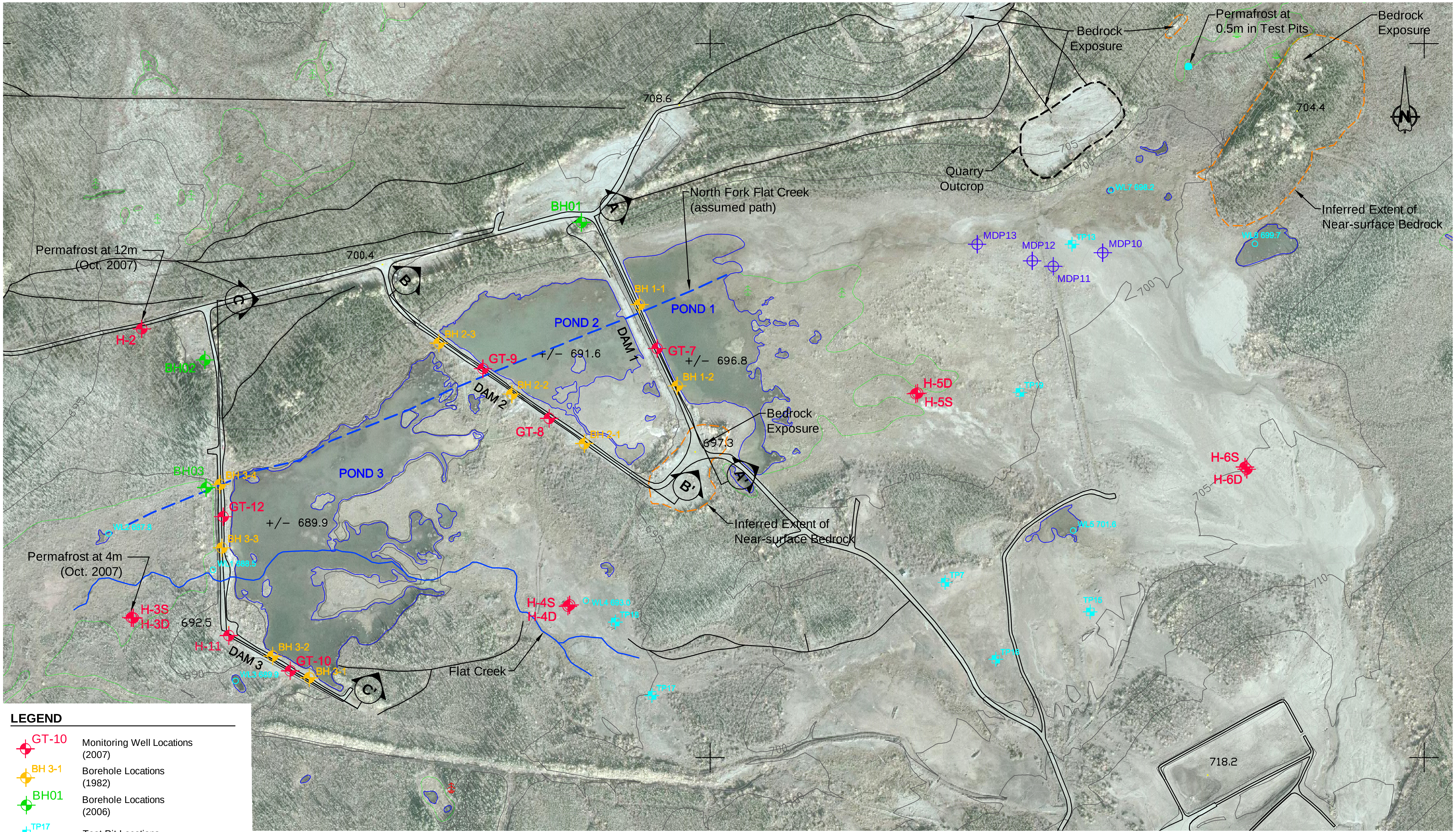
Figures



LEGEND

GT-10	Monitoring Well Locations (2007)
BH 3-1	Borehole Locations (1982)
BH01	Borehole Locations (2006)
TP17	Test Pit Locations
MDP10	Manual Drive Points

Note:
GT-* locations also contain Thermistor Strings
H-* locations are Monitoring Wells only

NOTES

1. Base drawing and orthophoto provided by ERDC. Orthophoto prepared by AeroGeometric, from photos flown September 2006 by Geodesy Remote Sensing Inc, Calgary, Ab.
2. Coordinate projection is NAD83, UTM projection.
3. Contour interval is 1 metre.

0 50 100 150 200 250
Scale in Metres

SRK Consulting
Engineers and Scientists

ERDC

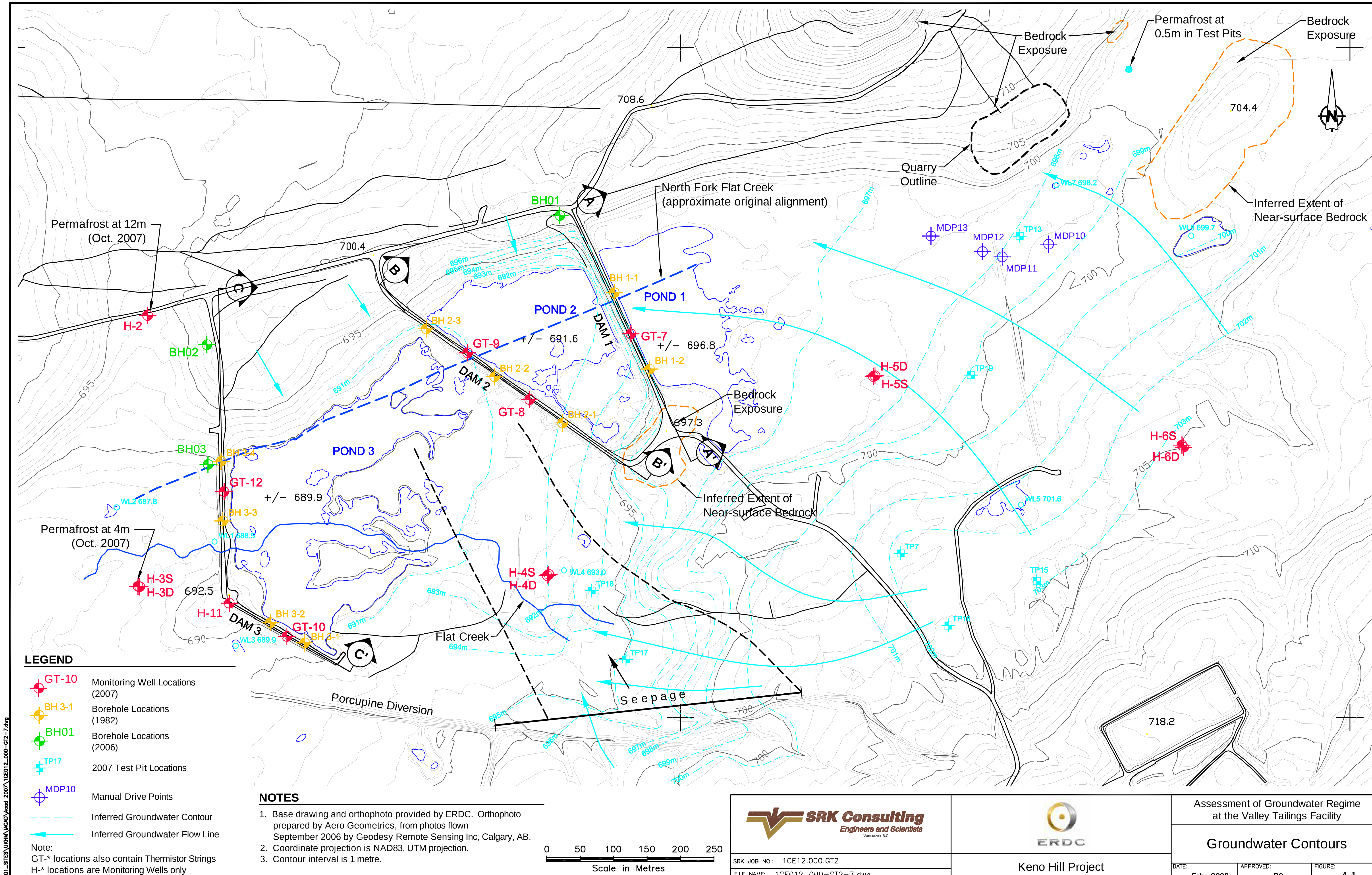
SRK JOB NO.: 1CE12.000.GT2
FILE NAME: 1CE012_000-GT2-7.dwg

Keno Hill Project

Assessment of Groundwater Regime at the Valley Tailings Facility

Drillhole Locations

DATE: Feb. 2008
APPROVED: BG
FIGURE: 2.1



NOTES

1. Base drawing and orthophoto provided by ERDC. Orthophoto prepared by Aero Geometrics, from photos flown September 2006 by Geodesy Remote Sensing Inc, Calgary, AB.
2. Coordinate projection is NAD83, UTM projection.
3. Contour interval is 1 metre.

0 50 100 150 200 250
Scale in Metres

SRK Consulting
Engineers and Scientists

ERDC

Keno Hill Project

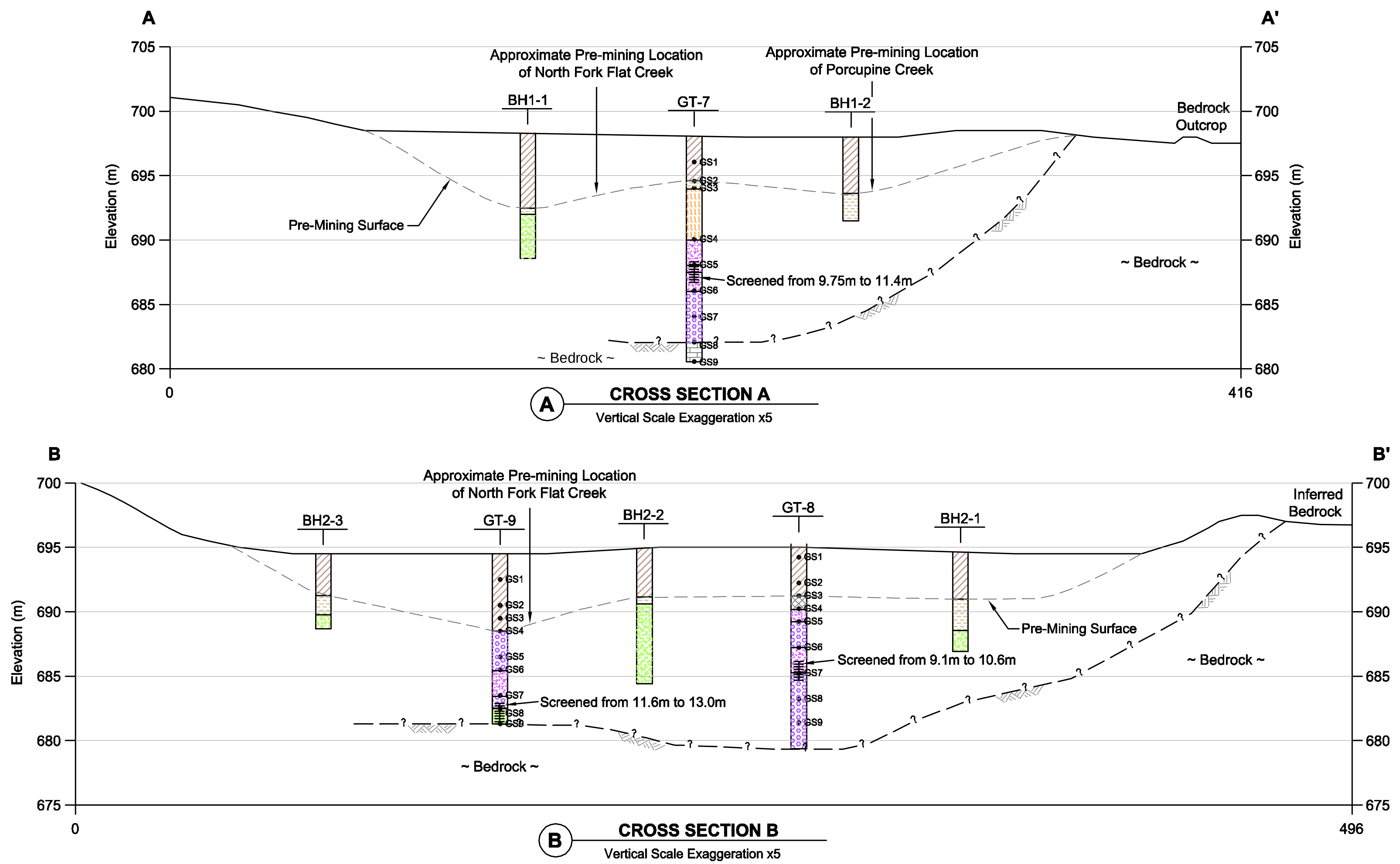
Assessment of Groundwater Regime at the Valley Tailings Facility

Groundwater Contours

SRK JOB NO.: 1CE12.000.GT2
FILE NAME: 1CE012_000-GT2-7.dwg

DATE: Feb. 2008 | APPROVED: BG | FIGURE: 4.1

J:\01_SITES\UKHM\ACAD\Acad 2007\1CE012_000-GT2-7.dwg



LEGEND

- Dam Fill
- Peat / Tailing
- Sand with few Gravels or Pebbles
- Fine-grained silty Till with few gravel
- Silty/clay Till with few gravel
- Peat and Organic Silt
- Bedrock (Br)
- Peat (Pt)
- Gravel with coarse sand
- Gravel with silt
- Gravel with silt/clay
- Well-graded Gravel
- Poorly Graded Gravel
- Till Permafrost
- Inferred Stratigraphy Contact
- Drill Hole Screen Interval
- GS1 Grab Sample Location

0 20 40 60 80 100
Scale in Metres

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Vancouver B.C.

ERDC

Assessment of Groundwater Regime at the Valley Tailings Facility

Sections A and B

Keno Hill Project

SRK JOB NO.: 1CE12.000.H3
FILE NAME: 1CE012_000-GT2-7.dwg

DATE: Feb. 08
APPROVED: BG
FIGURE: 4.2

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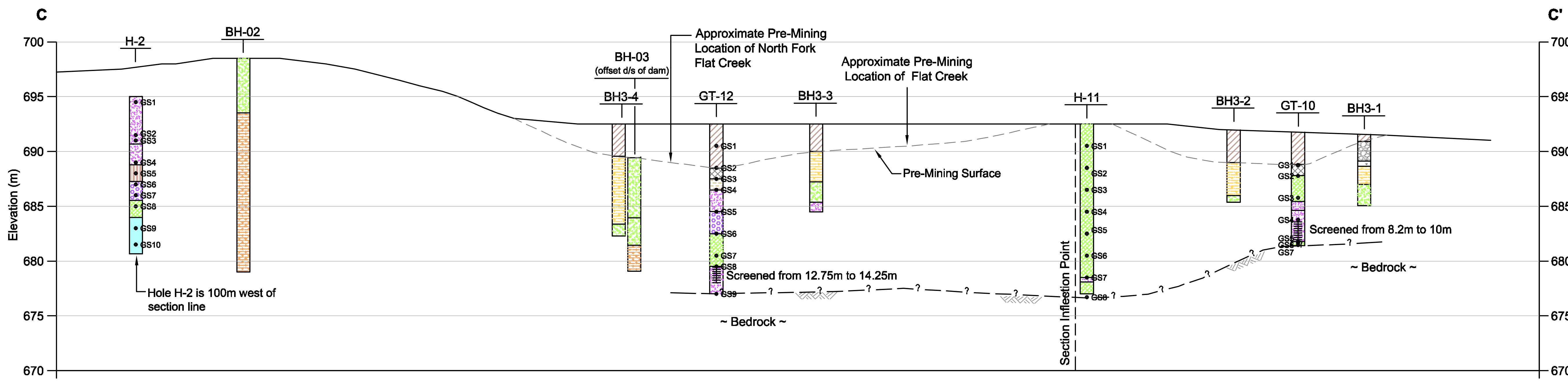

C CROSS SECTION C

Vertical Scale Exaggeration x5

LEGEND

- Dam Fill
- Peat / Tailing
- Sand with few Gravels or Pebbles
- Fine-grained silty Till with few gravel
- Silty/clay Till with few gravel
- Peat and Organic Silt
- Bedrock (Br)
- Peat (Pt)
- Gravel with coarse sand
- Gravel with silt
- Gravel with silt/clay
- Well-graded Gravel
- Poorly Graded Gravel
- Till Permafrost
- Inferred Stratigraphy Contact
- Drill Hole Screen Interval
- • GS1 Grab Sample Location

0 20 40 60 80 100

Scale in Metres

SRK Consulting Engineers and Scientists Vancouver B.C.

ERDC

Assessment of Groundwater Regime at the Valley Tailings Facility

Section C

SRK JOB NO.: 1CE12.000.H3

FILE NAME: 1CE012_000-GT2-7.dwg

Keno Hill Project

DATE: Feb. 08 | APPROVED: BG | FIGURE: 4.3

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Appendix A
2007 Hydrogeological Field Investigation

SRK Consulting
Engineers and Scientists

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Vancouver, B.C. V6E 3X2
Canada

vancouver@srk.com
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Tel: 604.681.4196
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Technical Memorandum

To:	File	**Date:**	March 31, 2008
cc:		**From:**	Lowell Wade
Subject:	2007 Hydrogeological Field Investigation, Keno Hill, YT	**Project #:**	1CE012.000.0H6

1 Drilling

All boreholes were drilled using a Becker Hammer Drill mounted on a Komatsu MST-2600 rubber track platform. All boreholes were vertical and were completed using double-walled drill steel with compressed air return in a manner that is very similar to a reverse circulation drill. Specifically, air is pumped down the double-walled drill steel, and the air and any drill cuttings return to a cyclone at surface via the interior of the drill steel. The internal and external diameter of the rods was 76.2 mm and 139.7 mm, respectively. Samples were collected in a 20 L pail placed under the cyclone at defined intervals and stratigraphic changes. Drilling was carried out by Glacier Dredge Drilling from Whitehorse, using a single 2-person crew, working 10-hour shifts.

For unconsolidated and loosely consolidated silts and clays, the drill rods were allowed to fall under their own weight while clearing the bit with compressed air. The soft ground conditions did not provide sufficient resistance to create compression in the hammer cylinder to cycle the hammer for the next blow. The cold temperatures required the use of an ether injector to cycle the hammer. Very poor sample recovery was obtained in unconsolidated and loosely consolidated soils. Once consolidated sediments were encountered the hammer was started with moderate air pressure. Excellent sample recovery was achieved. Refusal was usually in bedrock or permafrost.

SRK engineer Mr. Lowell Wade, E.I.T. supervised the drill, logged the recovered material, and collected representative soil samples for geotechnical testing. Mr. Dave Desmarais of Access Consulting Group assisted with the drill program. Samples were shipped to EBA Engineering's soil testing laboratory in Whitehorse. All remaining soil was discarded next to the respective borehole.

The borehole locations were initially marked set out according to co-ordinates provided by SRK, but final locations were adjusted to suit field conditions. The surveyed coordinates, depth and orientation of the completed boreholes are provided in Table 1.

Table 1: Borehole Coordinates

Hole ID	Northing[1]	Easting[1]	Collar Elevation (m)	Depth (m)	Inclination[2]
H2	7088602.338	474202.234	696.851	13.52	-90°
H3 Deep	7088197.266	474190.402	690.512	4.59	-90°
H3 Shallow	7088197.862	474187.827	690.383	2.48	-90°
H4 Deep	7088213.765	474799.317	694.810	6.71	-90°
H4 Shallow	7088215.632	474801.615	694.840	3.00	-90°
H5 Deep	7088512.259	475289.087	700.002	12.46	-90°
H5 Shallow	7088511.299	475286.450	699.992	5.00	-90°
H6 Deep	7088405.545	475750.178	706.714	5.55	-90°
H6 Shallow	7088408.575	475747.520	706.601	2.00	-90°
H11	7088170.765	474325.887	692.893	15.80	-90°

1. UTM Projection NAD 83 Zone 8.
2. Relative to the horizontal plane.

2 Summary of Borehole Profiles

A complete log of the completed hydrogeological boreholes and the installation details for the slotted monitoring wells are provided in Appendix A. The following sections summarize the results of the hydrogeological drilling program.

2.1 H2

Borehole H2 was drilled to refusal in a topographic low northwest of Dam #3 (Figure 1) to a depth of 13.52 m to establish a background monitoring station. Sample recovery from H2 was excellent over the entire length of the borehole with permafrost encountered at 13.5 m and the hole was dry at the bottom. Refusal was in gravel. The permafrost was classified as well bonded with 5% excess ice (NRC, 1963). A monitoring well was installed in this borehole to evaluate background water quality and water levels.

2.2 H3D and H3S

Boreholes H3D and H3S were drilled downstream of Dam #3 adjacent to the Flat Creek floodplain (Figure 1). These two boreholes were drilled to install monitoring wells down gradient of Dam #3. A pair of wells was installed in an effort to monitor the vertical pressure profile at this location to allow an evaluation of whether an upward gradient existed within the ground water downstream of the dam. H3D was drilled to refusal at a depth of 4.59 m. Sample recovery from H3D was excellent over the entire length of the borehole and the hole was dry at the bottom. Refusal was in gravel. The permafrost appears to be well bonded with 5% excess ice. H3S was drilled ~2 m to the southeast of H3D. This borehole, which was 2.48 m deep, intersected the same stratigraphy as H3D.

2.3 H4D and H4S

Boreholes H4D and H4S were drilled in the old subaerial tailings south of Pond #3, as shown on Figure 1. A pair of monitoring wells was installed to monitor water level elevations and porewater chemistry both in the tailings and in the overburden immediately beneath the tailings at this location. H4D was drilled to refusal at a depth of 6.71 m. Sample recovery from H4D was excellent except for poor recovery of the tailings just above the water table. Recovered overburden was unfrozen and no permafrost features were observed. Refusal was on bedrock, although no bedrock sample was recovered. A monitoring well was installed to evaluate groundwater elevation beneath the tailings. H4S was drilled approximately 2 m to the west of H4D to a depth of 3.0 m and was equipped with a monitoring well.

2.4 H5D and H5S

Boreholes H5D and H5S were drilled upstream of Dam #1, east of the south abutment, as shown on Figure 1. A pair of monitoring wells was installed to monitor water level elevations and porewater chemistry both in the tailings and in the overburden immediately beneath the tailings at this location. H3D was drilled to refusal at a depth of 12.46 m. Sample recovery from H5D was poor in the tailings but was excellent for the remainder of the borehole, with refusal in bedrock. Recovered overburden was unfrozen and no permafrost features were observed. H5S was drilled approximately 2 m to the west of H5D.

2.5 H6D and H6S

Boreholes H6D and H6S were drilled upstream of Dam #1 near the south-eastern margin of the VTF (Figure 1). A pair of monitoring wells was installed to monitor water level elevations and porewater chemistry both in the tailings and in the overburden immediately beneath the tailings at this location. H6D was drilled to refusal at a depth of 5.55 m. Sample recovery from H5D was good, with refusal in bedrock. Recovered overburden was unfrozen and no permafrost features were observed. H6S was drilled to a depth of 2.0 m approximately 2 m to the west of H6D.

2.6 H11

Borehole H11 was drilled to refusal at 15.8 m on the gravel knob on the downstream side of the elbow in Dam #3 (Figure 1). Sample recovery from H11 was generally good. Recovered overburden was unfrozen and refusal was in bedrock. The bottom of the borehole was wet at completion. No monitoring well or thermistor string was installed at this location.

3 Reference

Pihlainen, J.A.; Johnston, G.H. 1963. Guide to a Field Description of Permafrost for Engineering Purposes. NRCC Tech. Memo. 79. 21 pp

Appendix B
2007 Borehole Logs and Hydrogeological Cross-Sections

BOREHOLE LOG LEGEND

Ice lens [Vs]

Gravel, grey, well graded, trace fines [GW].

Gravel, light brown, well graded, trace fines, some organics (~10%) [GW]

Gravel, grey, well graded, trace fines, wet [GW]

Peat, black, fibrous [Pt]

Peat, black, fibrous with wood fragments, wet [Pt]

Bedrock, greenstone

Sand, coarse, light grey, some gravel [SP]

Silty sand, grey [SM]

Silty sand, brown, compact [SM]

Sand, grey, well graded, wet [SW]

Tailings, silty sand, brown [SM]

No recovery [assumed tailings and peat, SM/Pt]

No recovery, water returned
[assumed tailings and peat, SM/Pt]

Tailings, silty sand, brown, very loose, wet [SM]

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Vancouver B.C.

ERDC

SRK JOB NO.: 1CE12.000.GT2	Keno Hill	2007 Geotechnical Report and Hydrogeological Field Investigation
FILE NAME: DrillLogLegend.dwg		Borehole Log Legend
		DATE: Feb. 08 / APPROVED: LW / FIGURE: -

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Adjacent to access road NW of VTF, NW of Dam #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-18 **TO** 2007-10-19
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088600.52 N 474203.79 E **DATUM:** NAD83

BOREHOLE: H2
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

ELEVATION - m / DEPTH - m	DESCRIPTION
695.01 / 0.00	Organic root mat, black [Pt]
694.51 / 0.50	Sand, coarse, light grey, minor fines, gravels [SW]
688.01 / 7.00	Sand, coarse, light grey, some gravel [SP]
687.01 / 8.00	Sand, coarse, light grey, trace gravel and ice fragments [SP]
686.01 / 9.00	Gravel, grey, trace fines, some coarse sand [GP]
684.66 / 10.35	Silty gravel, grey, well graded, with fines. [GM] Encountered water at 10.35 m
684.01 / 11.00	Silty gravel, grey, well graded with fines [GM]
683.01 / 12.00	Silty gravel, grey, well graded with fines [GM]. Permafrost [Nbe (5%)]
681.49 / 13.52	Refusal in silty gravel

SAMPLE TYPE AND NUMBER	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
GS-1			
GS-2			20 drill blows between 1.7 - 2.0 m
GS-3			
GS-4			
GS-5	0	0	38 drill blows between 6.5 - 6.8 m
GS-6			
GS-7			
GS-8			
GS-9			
GS-10			

WELL DETAILS & WATER LEVEL - m: 13.33m depth on 2007-10-19

Temperature (°C): -2 0 2 4 6 8
WATER CONTENT and LIMITS (%): W_P W W_L — 20 40 60 80 100 120

DEPTH - ft: 5 10 15 20 25 30 35 40 45 50 55 60 65
DEPTH - m: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Downstream of Dam #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-24 **TO** 2007-10-25
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088195.45 N 474191.96 E **DATUM:** NAD83

BOREHOLE: H3 DEEP
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

ELEVATION - m / DEPTH - m	DESCRIPTION	SAMPLES TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
688.67 / 0.00	Gravel, light brown, well graded, trace fines, some organics (~10%) [GW]	GS-1	Remoulded			
686.92 / 1.75	Gravel, grey, well graded, trace fines, encountered water [GW]	GS-2	Remoulded			
686.77 / 1.90	Ice lens [Vs], crushed by Becker Hammer					
686.67 / 2.00	Gravel, grey, well graded, trace fines [GW]	GS-3	Remoulded			
684.67 / 4.00	Gravel, grey, well graded, trace fines [GW]. Frozen till thawed by warm air from Becker Drill [Nbe assumed]	GS-4	Remoulded			
		GS-5	Remoulded			430 drill blows between 4.5 - 4.8 m
683.87 / 4.80	Refusal in gravel					

Columns: DEPTH - ft (5–65); DEPTH - m (1–19); WELL DETAILS & WATER LEVEL - m; SYMBOL; Temperature (°C) -2 0 2 4 6 8; WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: ~2m southeast of H3 Deep
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-25 **TO** 2007-10-25
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088196.04 N 474189.38 E **DATUM:** NAD83

BOREHOLE: H3 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION	TYPE OF SAMPLER	LABORATORY AND IN SITU TESTS	
Remoulded	DC Diamond core barrel	C Consolidation	Ku Thermal conductivity Unfrozen (W / m°C)
Undisturbed	GS Grab sample	D Bulk density (kg/m3)	Kf Thermal conductivity Frozen (W / m°C)
Lost	SS Split spoon	Dr Specific gravity	PS Particle size analysis
Core		Ksat Saturated hydraulic cond. (cm/s)	

ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
688.54 / 0.00	Gravel, light brown, well graded, trace fines, some organics (~10%) [GW]						
686.79 / 1.75	Gravel, grey, well graded, trace fines, encountered water [GW]						
686.64 / 1.90	Ice lens [Vs], crushed by Becker Hammer						
686.54 / 2.00	Gravel, grey, well graded, trace fines [GW]						
686.06 / 2.48	End of hole						

WELL DETAILS & WATER LEVEL - m

Temperature (°C): -2 0 2 4 6 8

WATER CONTENT and LIMITS (%): W_P W W_L; 20 40 60 80 100 120

DEPTH - ft: 5 10 15 20 25 30 35 40 45 50 55 60 65

DEPTH - m: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Old tailings South of Pond #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088211.95 N 474800.87 E **DATUM:** NAD83

BOREHOLE: H4 DEEP
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION	TYPE OF SAMPLER	LABORATORY AND IN SITU TESTS	
Remoulded	DC Diamond core barrel	C Consolidation	Ku Thermal conductivity Unfrozen (W / m°C)
Undisturbed	GS Grab sample	D Bulk density (kg/m3)	Kf Thermal conductivity Frozen (W / m°C)
Lost	SS Split spoon	Dr Specific gravity	PS Particle size analysis
Core		Ksat Saturated hydraulic cond. (cm/s)	

ELEVATION - m / DEPTH - m	DESCRIPTION	SAMPLE TYPE AND NUMBER	LABORATORY and IN SITU TESTS
692.97 / 0.00	Tailings, silty sand, brown [SM], water encountered at 1.75 m	GS-1	w = 7.5%
		GS-2	w = 6.7%
		GS-3	w = 23.3%
689.97 / 3.00	Peat, black, fibrous with wood fragments, wet [Pt]	GS-4	
688.97 / 4.00	Peat, black, fibrous [Pt]	GS-5	
		GS-6	
686.97 / 6.00	Silty gravel, grey, well graded, compact [GM]	GS-7	w = 6.1%
686.26 / 6.70	Silty sand, grey [SM]	GS-8	
686.26 / 6.71	Refusal - no sample collected [assumed bedrock based on drill response]	GS-9	

Columns: DEPTH - ft (5–65); DEPTH - m (1–19); WELL DETAILS & WATER LEVEL - m; STRATIGRAPHY (ELEVATION - m / DEPTH - m, DESCRIPTION, SYMBOL); SAMPLES (TYPE AND NUMBER, CONDITION, RECOVERY %, N or RQD); LABORATORY and IN SITU TESTS; Temperature (°C) -2 0 2 4 6 8; WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Old tailings South of Pond #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088213.81 N 474803.17 E **DATUM:** NAD83

BOREHOLE: H4 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

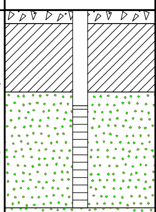
SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	Temperature (°C) -2 0 2 4 6 8 / WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120
			693.00 / 0.00	Tailings, brown, silty sand [SM], water encountered at 1.75 m							
			690.00 / 3.00	End of hole							



Depth scale: ft 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65; m 1–19

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BOREHOLE LOG

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PROJECT: Keno Hill		**BOREHOLE:** H5 DEEP	
LOCATION: Subaerial tailings East of Dam #1		**PAGE:** 1 **OF** 1	
FILE No: UNITED KENO HILL (1CE012.000)		**DRILL TYPE:** Air Return	
BORING DATE: 2007-10-22 **TO** 2007-10-22		**DRILL:** Becker Hammer	
DIP: 90.00 **AZIMUTH:**		**CASING:** Double Walled	
COORDINATES: 7088510.44 N 475290.64 E **DATUM:** NAD83			

SAMPLE CONDITION	TYPE OF SAMPLER	LABORATORY AND IN SITU TESTS	
Remoulded	DC Diamond core barrel	C Consolidation	Ku Thermal conductivity Unfrozen (W / m°C)
Undisturbed	GS Grab sample	D Bulk density (kg/m3)	Kf Thermal conductivity Frozen (W / m°C)
Lost	SS Split spoon	Dr Specific gravity	PS Particle size analysis
Core		Ksat Saturated hydraulic cond. (cm/s)	

Well details & water level - m: 0.89m depth on 2007-10-22

Ground surface elevation: 698.16

Elevation - m / Depth - m	Description	Sample type and number	Laboratory and in situ tests
698.16 / 0.00	Tailings, silty sand, brown, compact, organic fragments (~10%) [SM]	GS-1	
697.16 / 1.00	Tailings, silty sand, light brown, very loose, wet [SM]	GS-2	
696.66 / 1.50	Tailings, silty sand, brown, compact [SM]	GS-3	
696.16 / 2.00	Tailings, silty sand, brown, very loose, wet [SM]	GS-4	
693.16 / 5.00	Peat, brown grey, fine fibrous grading to amorphous granular [Pt]	GS-5, GS-6, GS-7	w = 67%
691.16 / 7.00	Gravel, grey, well graded, wet [GW]	GS-8	
690.86 / 7.30	Silty/Clayey sand, grey, well graded, water encountered at 7.3 m [SM/SC]	GS-9	w = 19.8%
689.16 / 9.00	Silty/Clayey gravel, grey, well graded, finessuspended in water [GM/GC]	GS-10	w = 3.9%
687.16 / 11.00	Bedrock, black, graphitic schist, strong sulphide odor	GS-11	
686.16 / 12.00	Bedrock, black, graphitic schist, trace (~1%) pyrite	GS-12	
685.70 / 12.46	Refusal in bedrock		

Temperature (°C): -2 0 2 4 6 8

WATER CONTENT and LIMITS (%): W_P W W_L — 20 40 60 80 100 120

BOREHOLE LOG

SRK Consulting — Engineers and Scientists

PROJECT: Keno Hill
LOCATION: Subaerial tailings East of Dam #1
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-22 **TO** 2007-10-22
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088509.48 N 475288.00 E **DATUM:** NAD83

BOREHOLE: H5 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		

ELEVATION - m / DEPTH - m	DESCRIPTION (STRATIGRAPHY)	SAMPLES: TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
698.15 / 0.00	Tailings, silty sand, brown, compact, organic fragments (~10%) [SM]					
697.15 / 1.00	Tailings, silty sand, light brown, very loose, wet [SM]					
696.65 / 1.50	Tailings, silty sand, brown, compact [SM]					
696.15 / 2.00	Tailings, silty sand, brown, very loose, wet [SM]					
693.15 / 5.00	End of hole					

DEPTH - ft: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65
DEPTH - m: 1 to 19

WELL DETAILS & WATER LEVEL - m

Temperature (°C): -2 0 2 4 6 8

WATER CONTENT and LIMITS (%): W_P W W_L — 20 40 60 80 100 120

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Subaerial tailings near SE margin of VTF
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088403.73 N 475751.73 E **DATUM:** NAD83

BOREHOLE: H6 DEEP
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION	TYPE OF SAMPLER	LABORATORY AND IN SITU TESTS	
Remoulded	DC Diamond core barrel	C Consolidation	Ku Thermal conductivity Unfrozen (W / m°C)
Undisturbed	GS Grab sample	D Bulk density (kg/m3)	Kf Thermal conductivity Frozen (W / m°C)
Lost	SS Split spoon	Dr Specific gravity	PS Particle size analysis
Core		Ksat Saturated hydraulic cond. (cm/s)	

ELEVATION - m / DEPTH - m	DESCRIPTION	SAMPLES TYPE AND NUMBER	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
704.87 / 0.00	Tailings, silty sand, brown (from 0.0 to 1.0 m), grey (from 1.0 to 1.5 m), loose [SM]	GS-1, GS-2		
703.37 / 1.50	Peat, brown, fine fibrous, [Pt]	GS-3		
702.87 / 2.00	Gravel, light brown/grey, well graded, moist [GW]	GS-4	w = 5.6%	⊙
701.87 / 3.00	Sand, dark grey, well graded. Encountered water at 3.0 m [SM/SC]	GS-5		
699.87 / 5.00	Bedrock, black, graphitic schist, trace (~1%) pyrite	GS-6, GS-7		
699.27 / 5.60	Refusal in bedrock			

Column headings: DEPTH - ft; DEPTH - m; WELL DETAILS & WATER LEVEL - m; STRATIGRAPHY (ELEVATION - m / DEPTH - m; DESCRIPTION; SYMBOL); SAMPLES (TYPE AND NUMBER; CONDITION; RECOVERY %; N or RQD); LABORATORY and IN SITU TESTS; Temperature (°C) -2 0 2 4 6 8; WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120

Depth scale (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65
Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

C:\Geotec742\SRK templates\loglog SRK m23 Kino.sty PLOTTED: 2008-02-08 14:44hrs

BOREHOLE LOG

SRK Consulting — Engineers and Scientists

PROJECT: Keno Hill		**BOREHOLE:** H6 SHALLOW	
LOCATION: Subaerial tailings near SE margin of VTF		**PAGE:** 1 **OF** 1	
FILE No: UNITED KENO HILL (1CE012.000)		**DRILL TYPE:** Air Return	
BORING DATE: 2007-10-23 **TO** 2007-10-23		**DRILL:** Becker Hammer	
DIP: 90.00 **AZIMUTH:**		**CASING:** Double Walled	
COORDINATES: 7088406.76 N 475749.08 E **DATUM:** NAD83			

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	Temperature (°C) / WATER CONTENT and LIMITS (%)
704.76 / 0.00	Tailings, silty sand, brown (from 0.0 to 1.0 m), grey (from 1.0 to 1.5 m),loose [SM]							
703.26 / 1.50	Peat, brown, fine fibrous, [Pt]							
702.76 / 2.00	End of hole							

Depth scales: DEPTH - ft 5–65; DEPTH - m 1–19. WELL DETAILS & WATER LEVEL - m. Temperature (°C) scale -2 0 2 4 6 8; Water content scale W_P W W_L 20 40 60 80 100 120.

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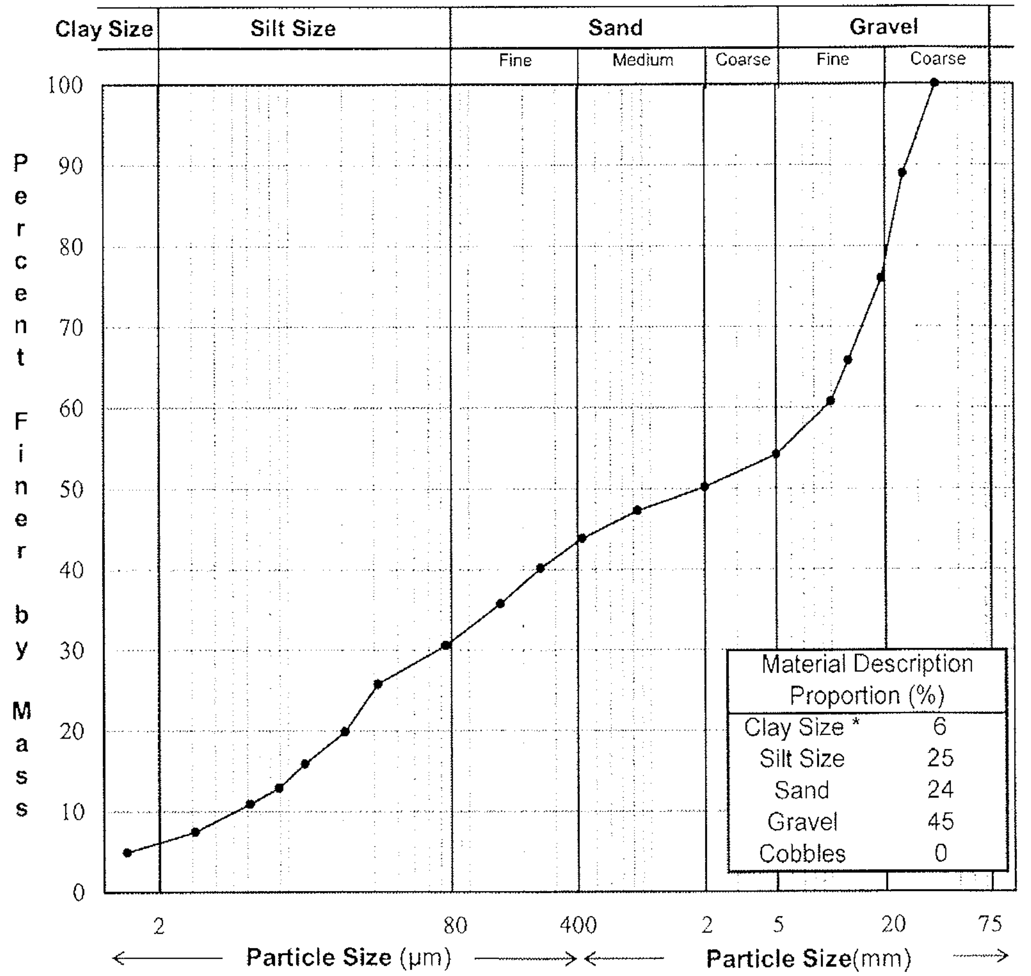
Appendix C
Laboratory Analyses of Grain Size Distributions

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mine		
Sample No.:	H2 (GS 2-5)		
Depth:	6.0 m & 8.0 m (combined)		
Description**:	GRAVEL - silty, sandy, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	89
19 mm	76
13 mm	66
10 mm	61
5 mm	54
2 mm	50
850 μm	47
425 μm	44
250 μm	40
150 μm	36
75 μm	31
31 μm	26
21 μm	20
12 μm	16
9 μm	13
6 μm	11
3 μm	7
1 μm	5



Material Description	Proportion (%)
Clay Size *	6
Silt Size	25
Sand	24
Gravel	45
Cobbles	0

Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By: ________

EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project: **SRK Soil Testing** Date Tested: 2008/01/20

Client: SRK Consulting Inc.

Project No.: W14101104

Location: United Keno Hill Mines

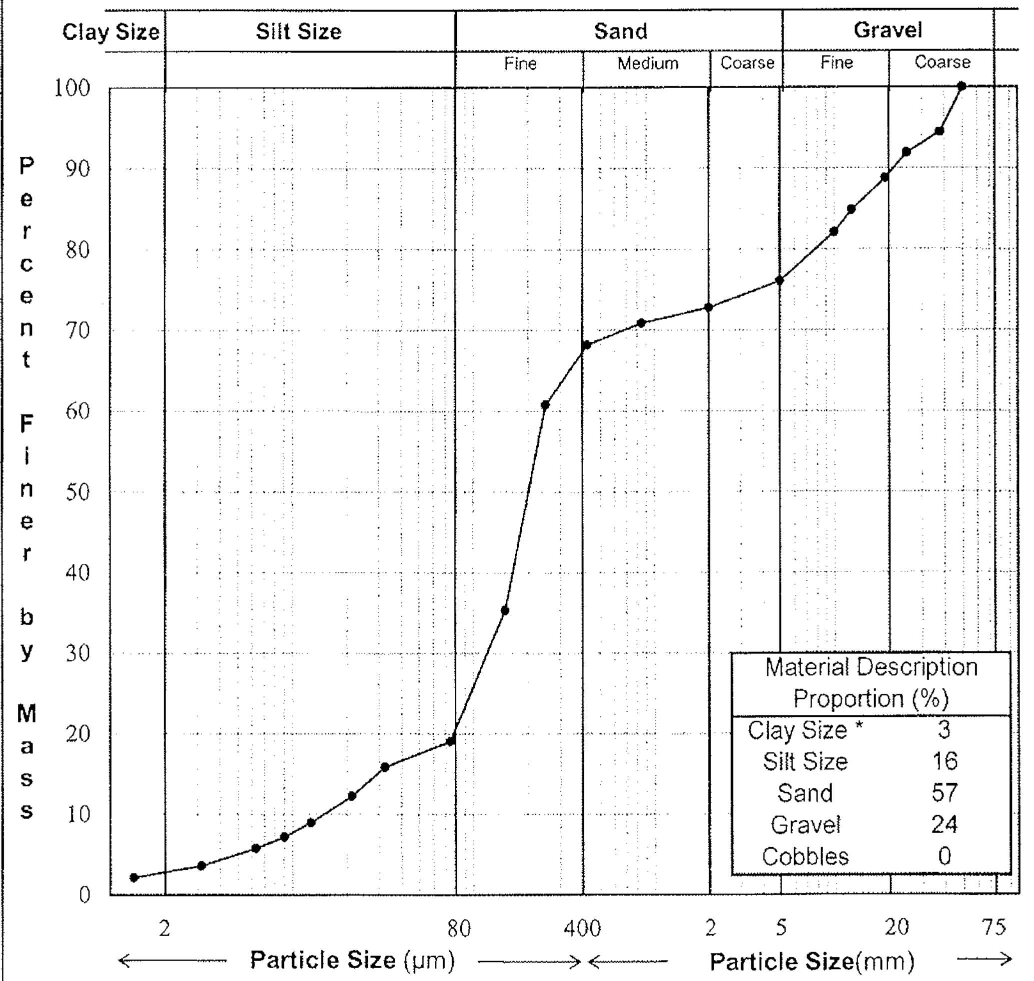
Sample No.: H2 (GS 8)

Depth: 10.0 m

Description**: SAND - some gravel, some silt, trace clay

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	94
25 mm	92
19 mm	89
13 mm	85
10 mm	82
5 mm	76
2 mm	73
850 μm	71
425 μm	68
250 μm	61
150 μm	35
75 μm	19
32 μm	16
21 μm	12
13 μm	9
9 μm	7
6 μm	6
3 μm	4
1 μm	2

GRAVEL | SAND | SILT | CLAY



Material Description Proportion (%)	
Clay Size *	3
Silt Size	16
Sand	57
Gravel	24
Cobbles	0

Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering Consultants Ltd.

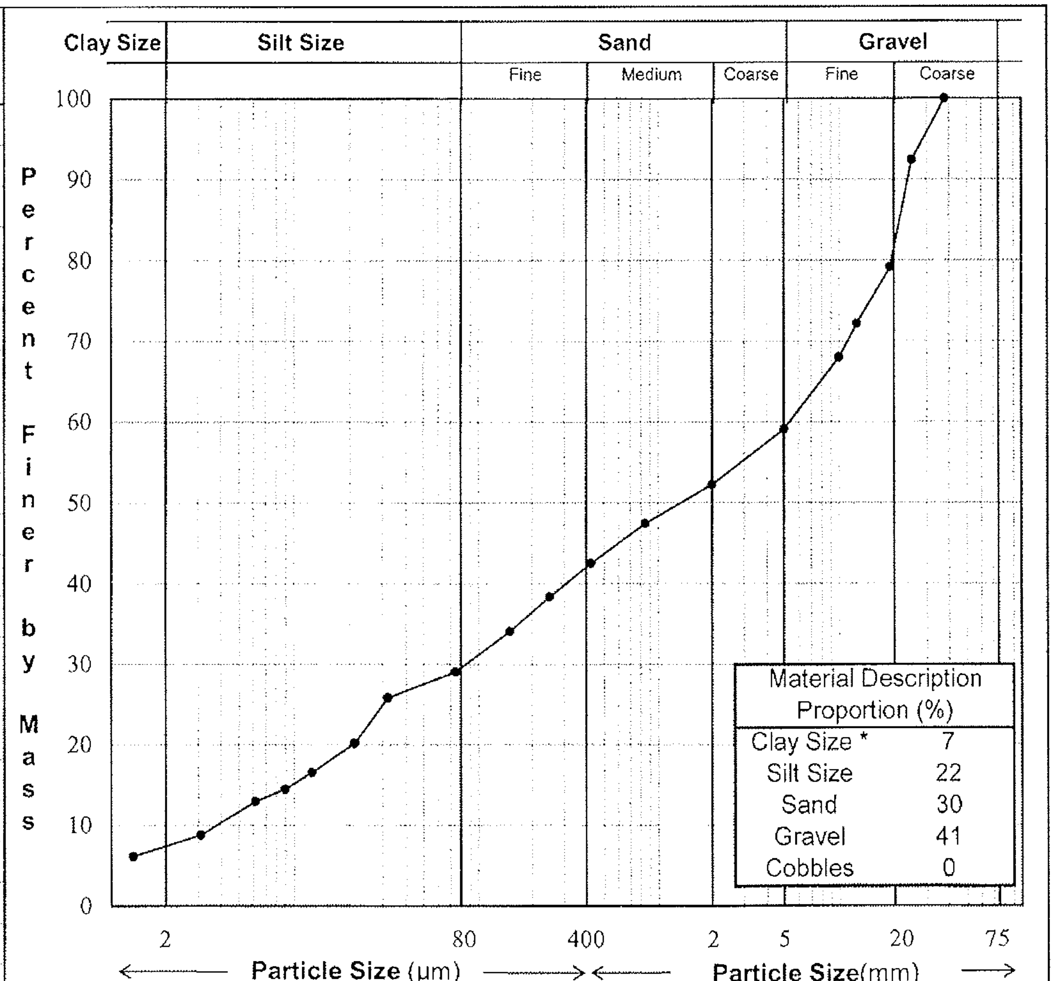
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project: **SRK Soil Testing** Date Tested: 2008/01/20
Client: SRK Consulting Inc.
Project No.: W14101104
Location: United Keno Hill Mines
Sample No.: GT 7 (GT 7)
Depth: 14.0 m
Description**: GRAVEL - sandy, silty, trace clay

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	92
19 mm	79
13 mm	72
10 mm	68
5 mm	59
2 mm	52
850 μm	47
425 μm	43
250 μm	38
150 μm	34
75 μm	29
32 μm	26
21 μm	20
13 μm	17
9 μm	14
6 μm	13
3 μm	9
1 μm	6

GRAVEL | SAND | SILT | CLAY



Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By: [signature]

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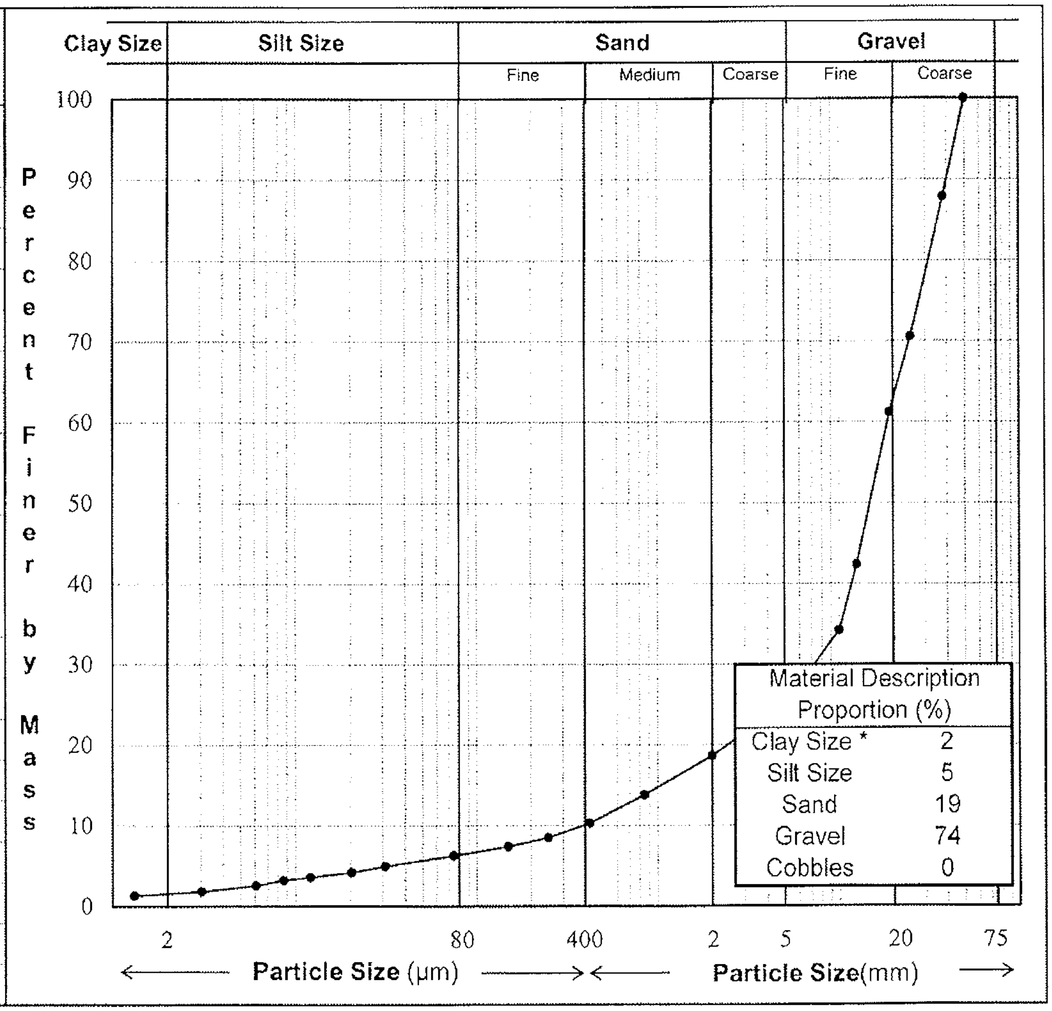
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 8 (GS6)		
Depth:	8.0 m		
Description**:	GRAVEL - some sand, trace silt, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	88
25 mm	71
19 mm	61
13 mm	42
10 mm	34
5 mm	25
2 mm	19
850 μm	14
425 μm	10
250 μm	9
150 μm	7
75 μm	6
31 μm	5
20 μm	4
12 μm	4
9 μm	3
6 μm	3
3 μm	2
1 μm	1

GRAVEL | SAND | SILT



Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

*** Sample appears to be segregated - may not be representative

Reviewed By: ______

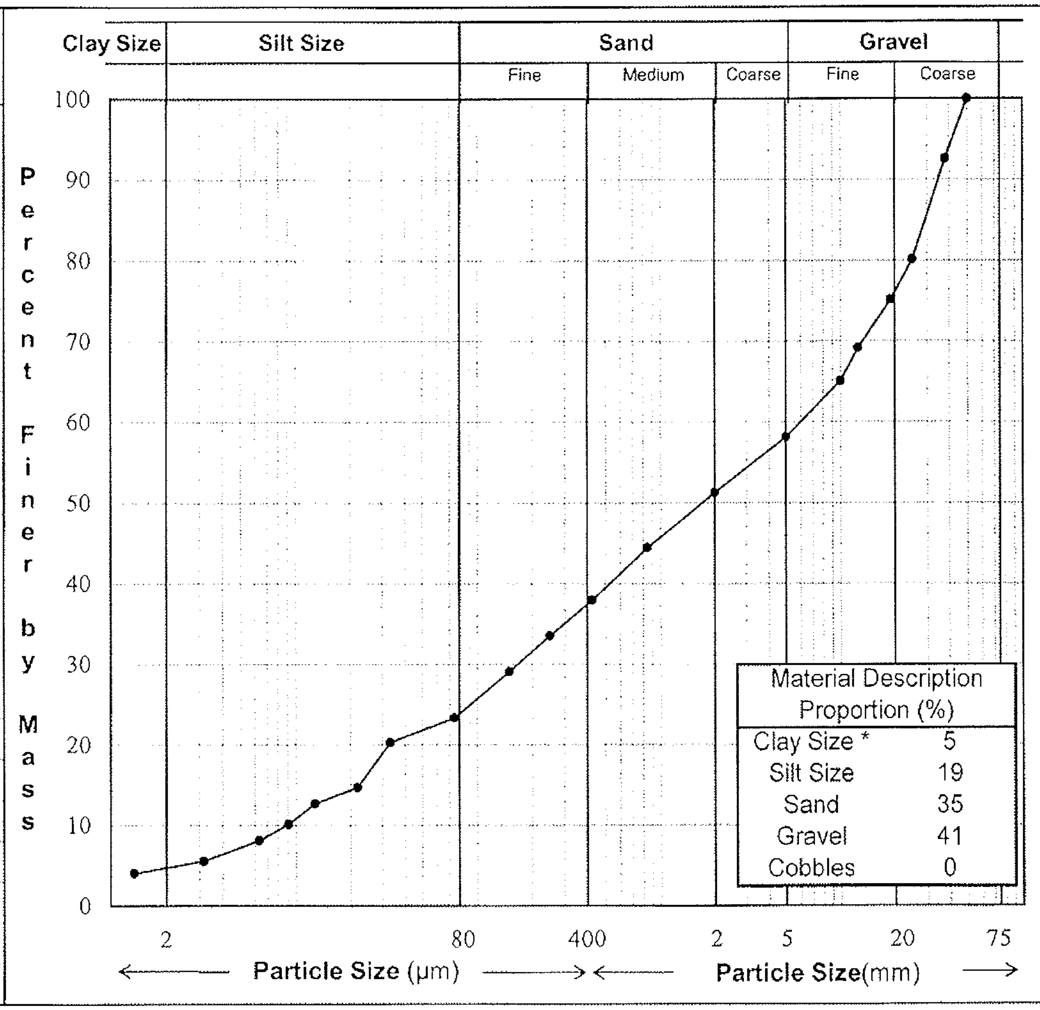
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 8 (GS 6)		
Depth:	16.0 m & 18.3 m (Combined)		
Description**:	GRAVEL AND SAND - some silt, trace clay		

	Particle Size	Percent Passing
	100 mm	
	75 mm	
GRAVEL	50 mm	100
	38 mm	93
	25 mm	80
	19 mm	75
	13 mm	69
	10 mm	65
	5 mm	58
SAND	2 mm	51
	850 μm	44
	425 μm	38
	250 μm	34
	150 μm	29
SILT	75 μm	23
	33 μm	20
	22 μm	15
	13 μm	13
	9 μm	10
	6 μm	8
CLAY	3 μm	6
	1 μm	4



Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By: [signature]

EBA Engineering Consultants Ltd.

PARTICLE SIZE DISTRIBUTION

ASTM C136 & D422

Project: **SRK Soil Testing**

United Keno Hill Mines

Project Number: W14101104

Date Tested: 11/17/2007

Borehole Number: GT 10 (GS 4)

Depth: 8 m

Soil Description: GRAVEL - sandy, trace of silt

Cu:

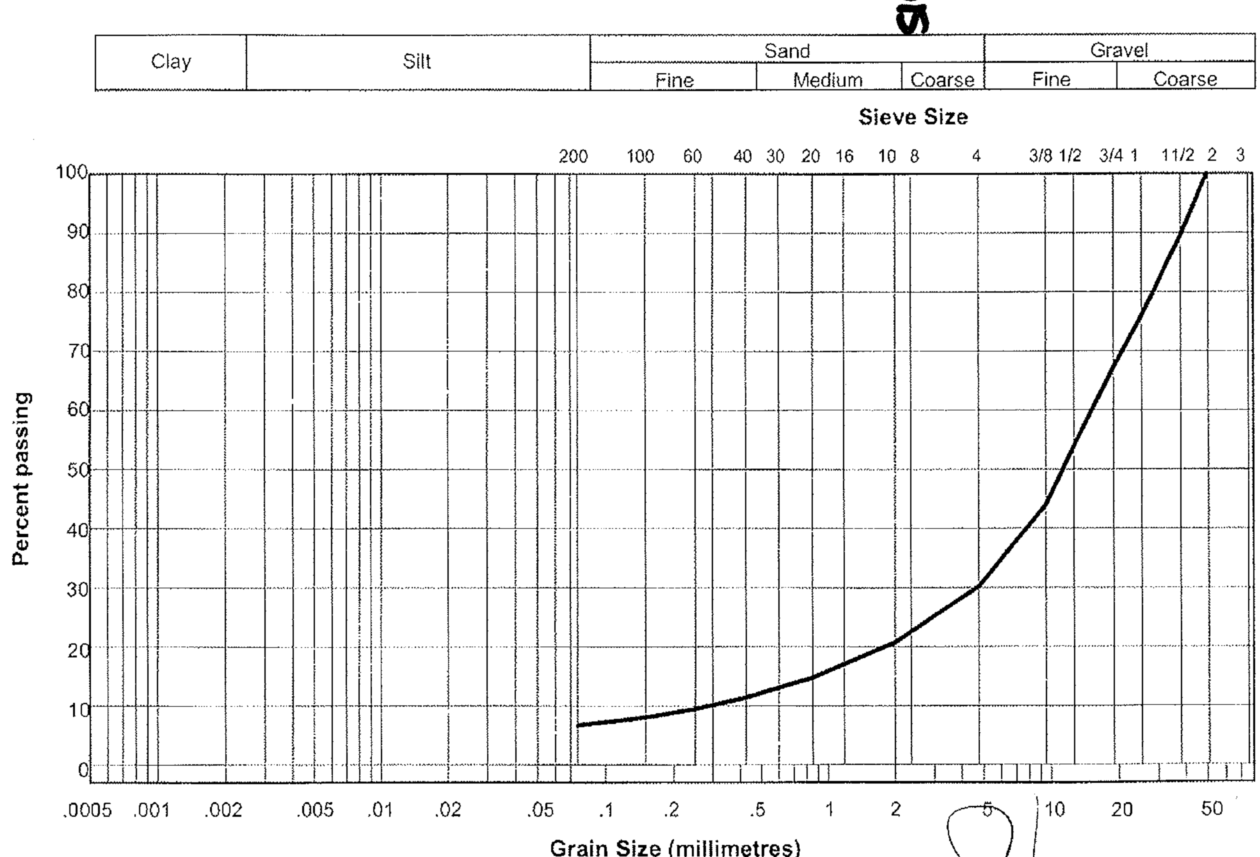
Cc:

Natural Moisture Content: 6.1%

Remarks:

Sieve Size	Percent Passing
50.000	100
37.500	89
25.000	75
19.000	67
12.500	53
9.500	44
4.750	30
2.000	21
0.850	15
0.425	11
0.250	9
0.150	8
0.075	6.7

GRAVEL | SAND | SILT



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EBA Engineering Consultants Ltd.

PARTICLE SIZE DISTRIBUTION

ASTM C136 & D422

Project: **SRK Soil Testing**

United Keno Hill Mines

Project Number: W14101104

Date Tested: 1/20/2008

Borehole Number: GT 9 (GS 7)

Depth: 11 m

Soil Description: SAND - some gravel, trace of silt

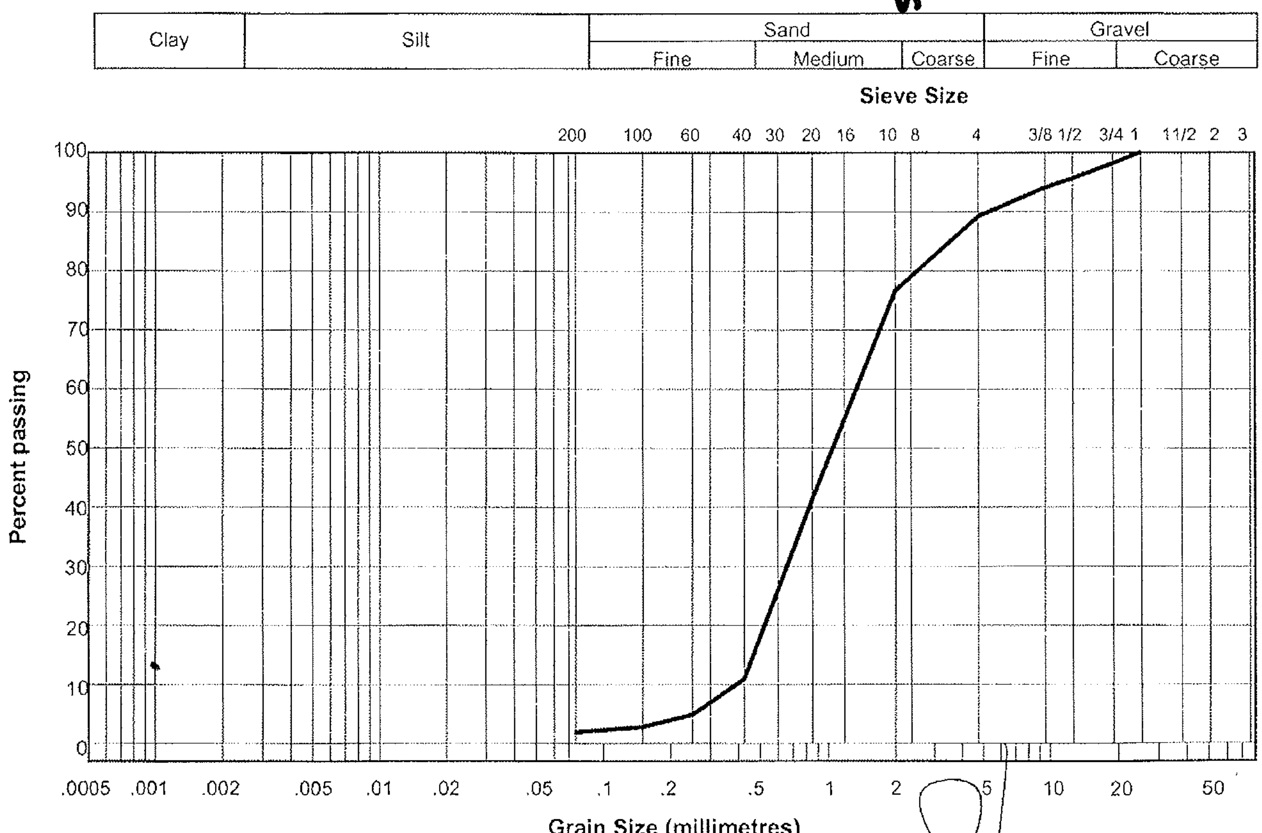
Cu:

Cc:

Natural Moisture Content: 12.0%

Remarks:

	Sieve Size	Percent Passing
GRAVEL	50.000	#N/A
	37.500	#N/A
	25.000	100
	19.000	98
	12.500	96
	9.500	94
SAND	4.750	89
	2.000	77
	0.850	41
	0.425	11
	0.250	5
	0.150	3
SILT	0.075	2.0



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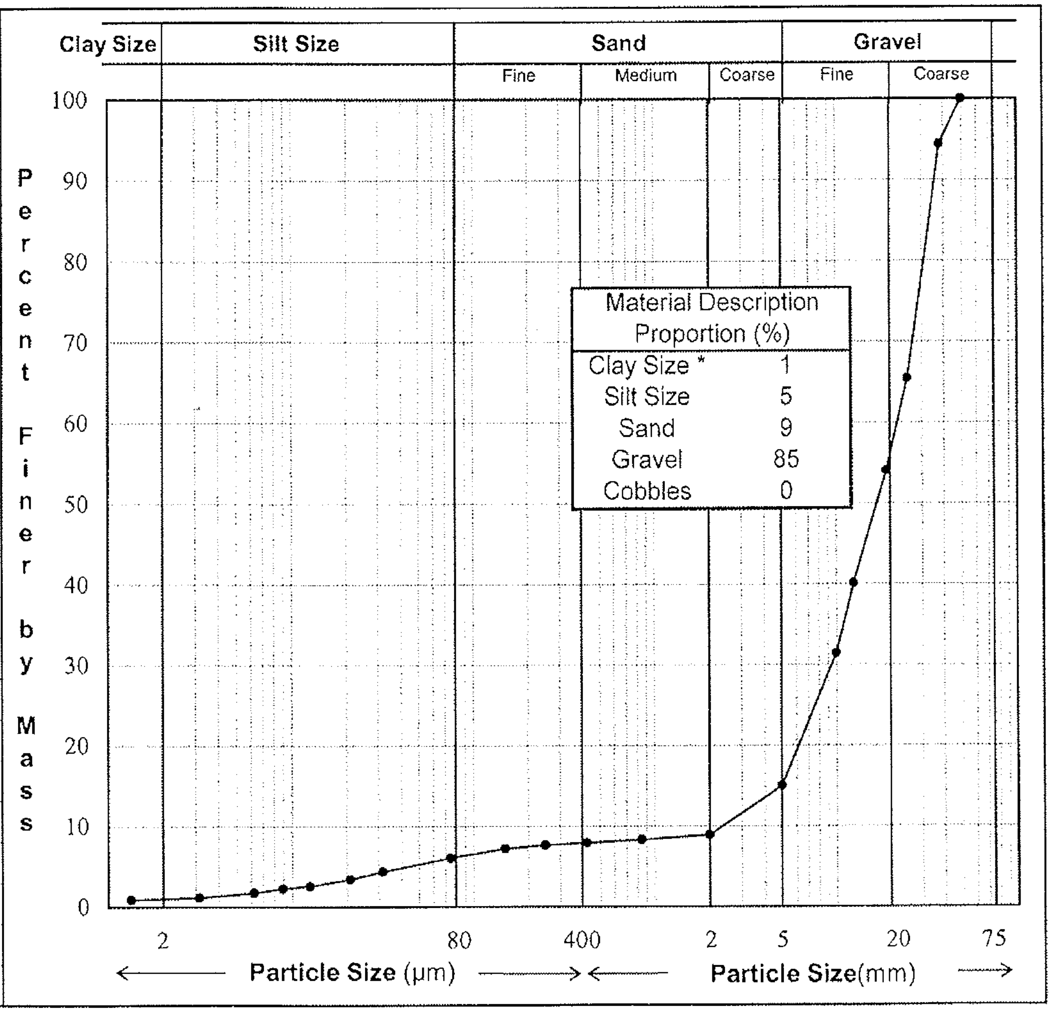
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 12 (GS 5)		
Depth:	8.0 m		
Description**:	GRAVEL - trace sand, trace silt, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	94
25 mm	65
19 mm	54
13 mm	40
10 mm	31
5 mm	15
2 mm	9
850 μm	8
425 μm	8
250 μm	8
150 μm	7
75 μm	6
32 μm	4
21 μm	3
13 μm	3
9 μm	2
6 μm	2
3 μm	1
1 μm	1

GRAVEL | SAND | SILT | CLAY



Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

***Sample appears segregated - may not be representative

Reviewed By: [signature]

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PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project: **SRK Soil Testing**

Date Tested: 2008/01/20

Client: SRK Consulting Inc.

Project No.: W14101104

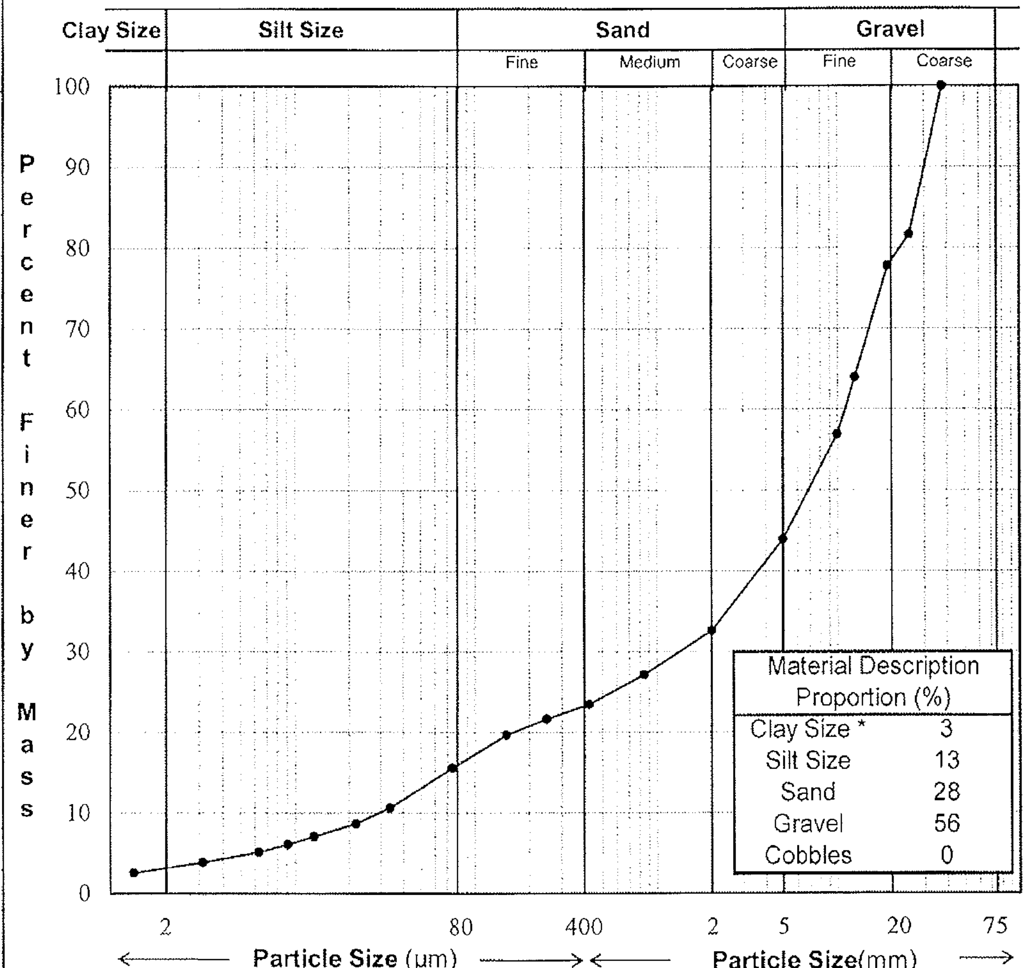
Location: United Keno Hill Mines

Sample No.: GT12 (GT 6)

Depth: 10.0 m

Description**: GRAVEL - sandy, some silt, trace clay

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	82
19 mm	78
13 mm	64
10 mm	57
5 mm	44
2 mm	33
850 µm	27
425 µm	24
250 µm	22
150 µm	20
75 µm	16
34 µm	11
22 µm	9
13 µm	7
9 µm	6
6 µm	5
3 µm	4
1 µm	3



GRAVEL | SAND | SILT | CLAY

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

Reviewed By:

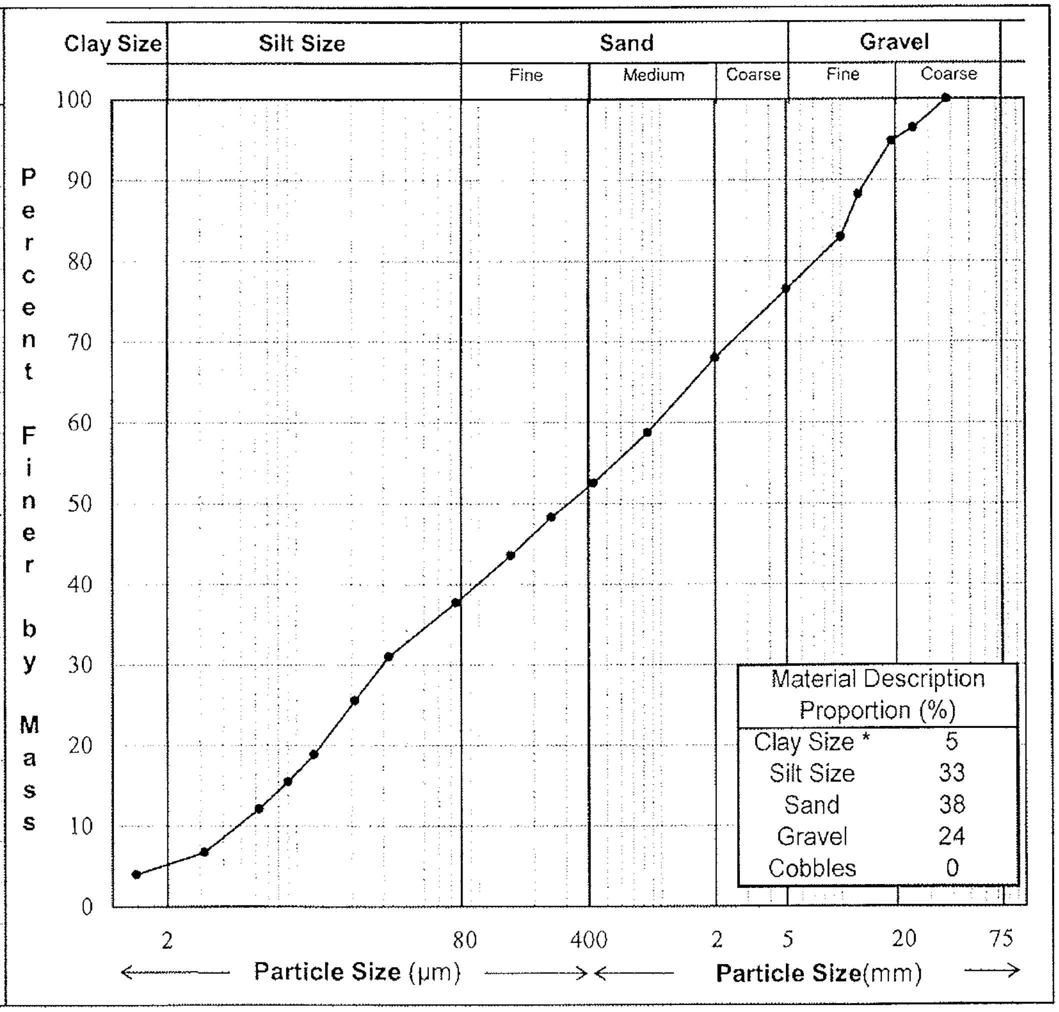
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 12 (439)		
Depth:	14.0 m		
Description**:	SAND - silty, gravelly, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	96
19 mm	95
13 mm	88
10 mm	83
5 mm	77
2 mm	68
850 μm	59
425 μm	53
250 μm	48
150 μm	44
75 μm	38
32 μm	31
21 μm	26
13 μm	19
9 μm	15
6 μm	12
3 μm	7
1 μm	4



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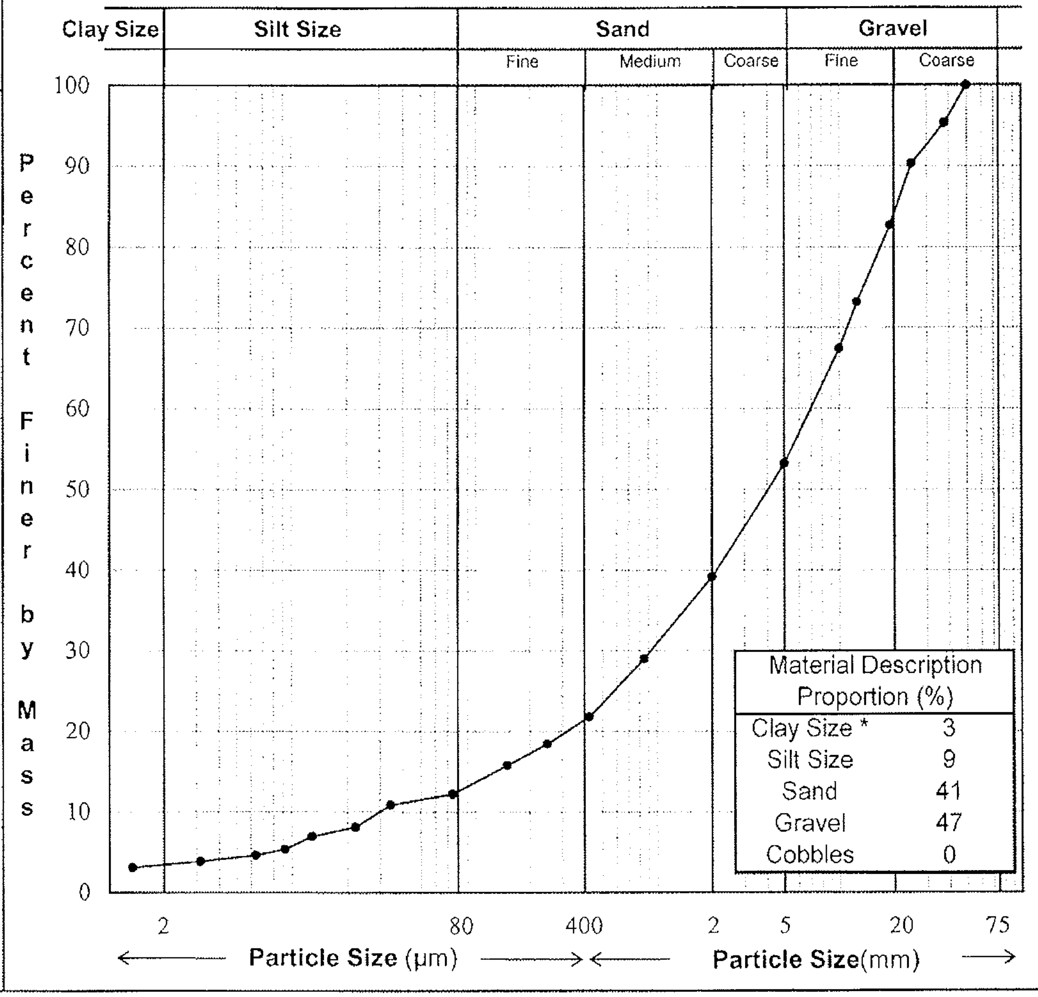
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	H 11 (GS 4)		
Depth:	8.0 m		
Description**:	GRAVEL AND SAND - trace silt, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	95
25 mm	90
19 mm	83
13 mm	73
10 mm	67
5 mm	53
2 mm	39
850 µm	29
425 µm	22
250 µm	18
150 µm	16
75 µm	12
34 µm	11
22 µm	8
13 µm	7
9 µm	5
6 µm	5
3 µm	4
1 µm	3

GRAVEL / SAND / SILT / CLAY



Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

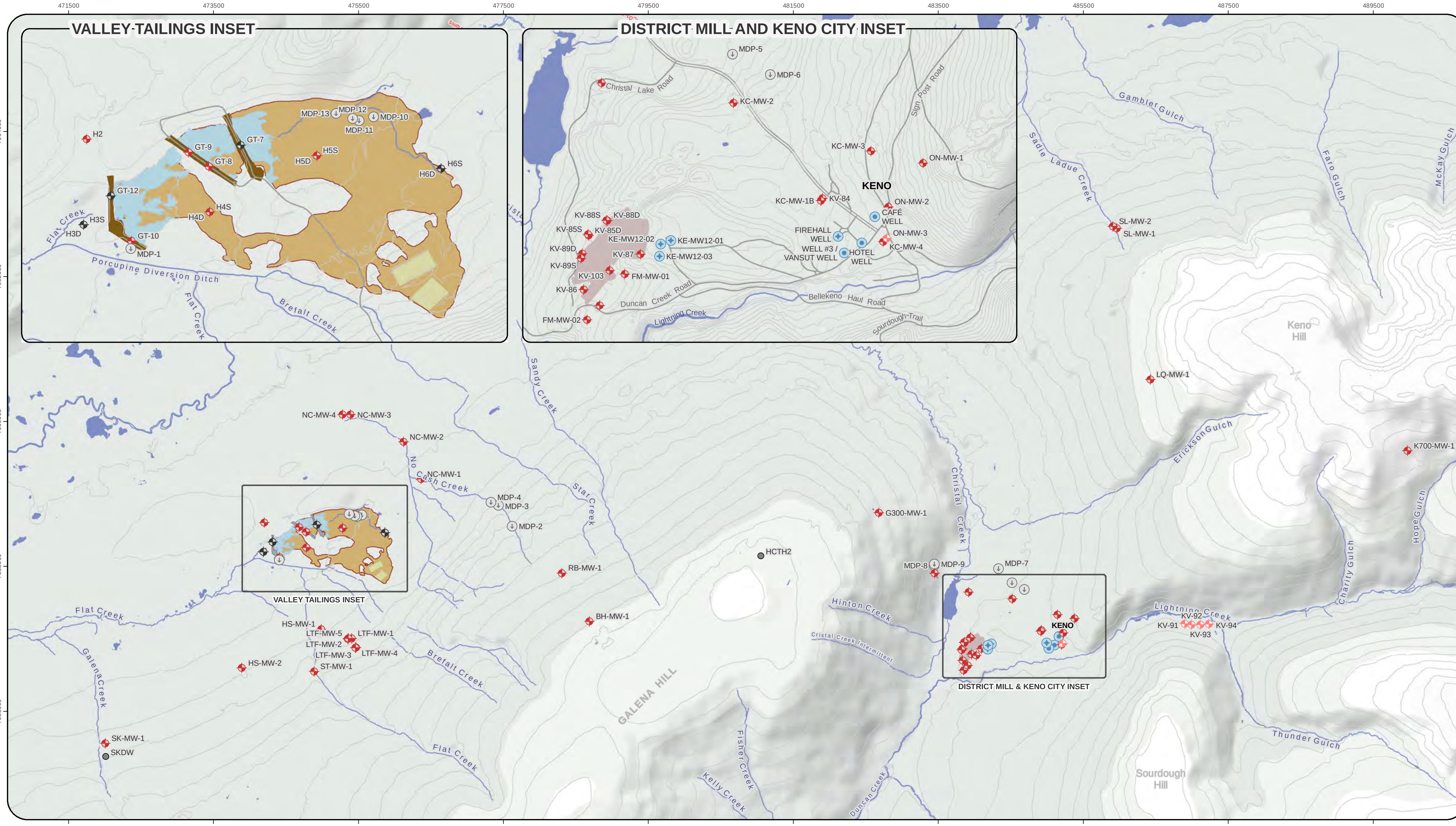
Reviewed By: [signature]

EBA Engineering Consultants Ltd.

Appendix D

Figure 1

Map of Keno Basin Groundwater Monitoring Station Locations



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Datum: NAD 83; Map Projection: UTM Zone 8N

Monitoring Well
Pending Monitoring Well
Decommissioned Monitoring Well
Private Drilled Well
Public Drilled Well
Water Supply Well
Manual Drive Point
Decommissioned Manual Drive Point
Drill Hole
Highway
Secondary Road
Contours (50m intervals)
District Mill Site
Valley Tailings
Valley Tailings Sludge
Valley Tailings Dam
Valley Tailings Ponds

* S = shallow well, D = deep well; usually these wells are right next to each other and appear as one single point on the map

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ELSA RECLAMATION AND DEVELOPMENT COMPANY
CLOSURE OPTIONS REPORT

FIGURE 1
GROUNDWATER MONITORING STATION LOCATIONS

NOVEMBER 2013

I:\ALEX-05-01\gis\mxd\UKHM\Overview_Maps\WQ\01-GROUNDWATER\GWMonitoring_MASTER_20131022.mxd
(Last edited by: jpan; 11/15/2013/12:14 PM)

WERNECKE TAILINGS INVESTIGATION

[OFF CLAIM]

November 2013

Prepared for:

ELSA RECLAMATION AND DEVELOPMENT COMPANY LTD.

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Report reviewed by:

Kai Woloshyn
Alexco Resource Corp.

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1 INTRODUCTION

There are three areas in the Keno Hill Silver District that contain mine tailings material that has been reworked and migrated downstream of the original deposit area: the dispersed tailings in Flat Creek downstream of the Valley Tailings Facility, those downstream of the Mackeno tailings in Christal Creek, and those downstream of the Wernecke tailings in Sadie Ladue Creek (Wernecke dispersed tailings) on Keno Hill (Figure 1).

This report describes results of a dispersed tailings investigation in Sadie Ladue Creek, Wernecke Lake and Gambler Lake, focusing on the Wernecke dispersed tailings beyond the UKHM claims boundary. An investigation (Interralogic, 2012a) was conducted in 2012 which focussed on the dispersed Wernecke Tailings, however off-claim tailings were outside the scope of the study and were only minimally evaluated.

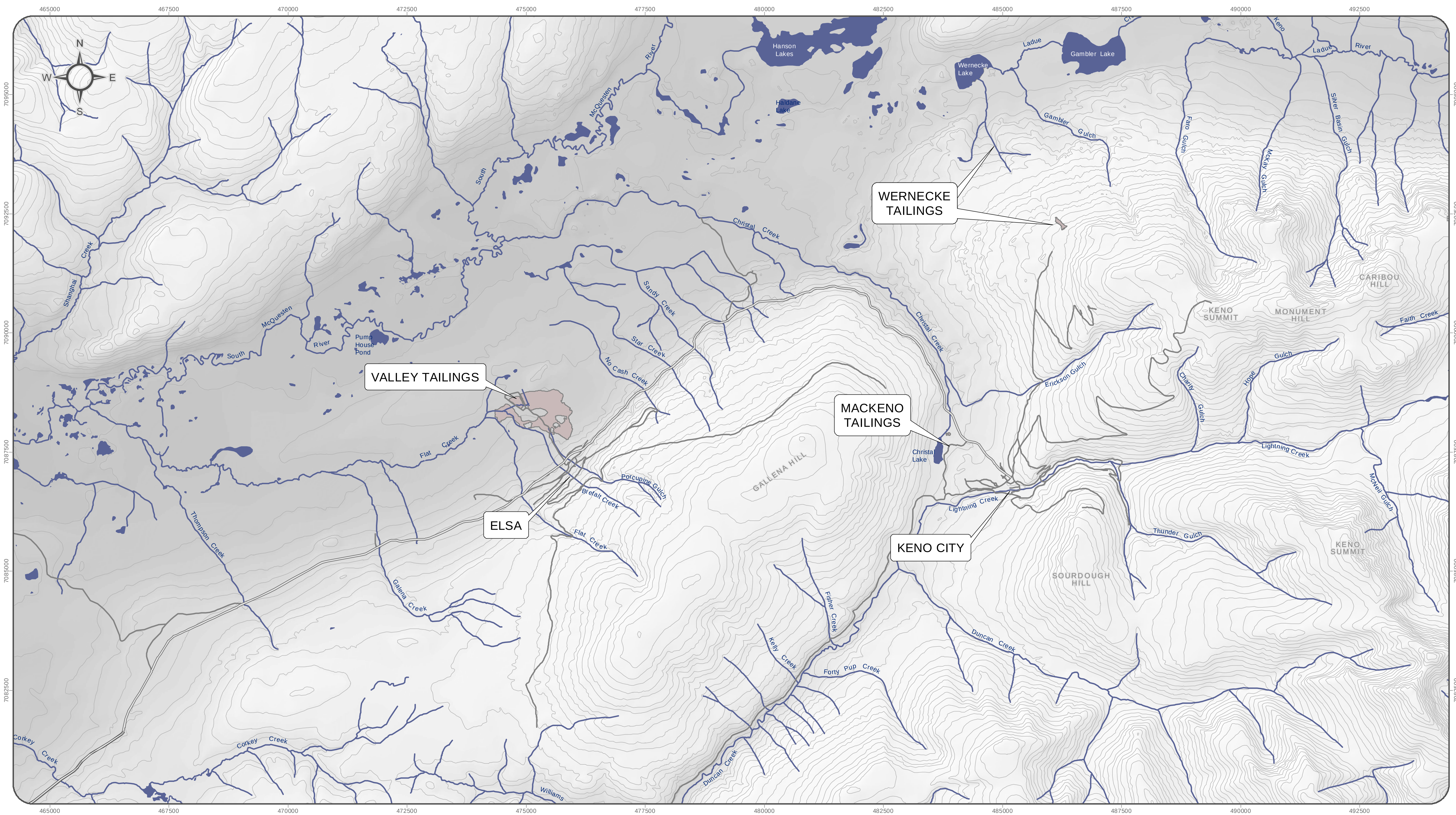
The objectives of this investigation were to:

- Identify the presence of dispersed tailings along Sadie Ladue Creek, in Wernecke (previously "Unnamed") Lake, Ladue Creek between Wernecke and Gambler Lakes, and in Gambler Lake itself;
- Identify and delineate possible deposits of dispersed tailings that may be adversely impacting Sadie Ladue Creek;
- Collect water samples from Sadie Ladue Creek, Wernecke Lake, Ladue Creek between Wernecke Lake and Gambler Lake, and within Gambler Lake (at different depths);
- Measure the depth of Wernecke Lake to develop a basic bathymetric map;
- Collect soil samples from tailings and soils in the Wernecke Lake shore area;
- Collect stream and lake sediments from Wernecke Lake, Gambler Lake, and Ladue Creek; and
- Install a staff gauge in Wernecke Lake;

The Wernecke area is shown in Figure 2. A series of transects were sampled over the lower portion of Sadie Ladue Creek, and across Wernecke Lake from the tailings delta to the opposite shore. Water samples and flow measurements were collected in Sadie Ladue and Ladue Creeks, Gambler Gulch and in Wernecke and Gambler Lakes. The soil samples were evaluated for metals and total organic carbon, with a selected set also sampled for leachability and acid base accounting. The data were evaluated to characterize the distribution, and to determine the physical and geochemical stability of dispersed tailings beyond the UKHM claim boundary and to develop conceptual closure options.

While this investigation was focussed on off-claim areas, there was an on-claim area, previously unidentified, that contains dispersed tailings. Results from this area were included in this investigation and report.

The field work presented in this report was conducted by field staff from by Access Consulting Group and Interralogic Inc. between September 25 and September 28, 2013. The work conducted followed the work plan that had been previously developed to guide the site investigation activities (ERDC, 2013).



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Quartz claim boundaries current as of February 24th, 2011. Ownership data current as of December 20th, 2010. Data source: http://geomaticsyukon.ca.

Datum: NAD 83; Map Projection: UTM Zone 8N

1:75,000 (when printed on 11 x17 inch paper)

0 0.5 1 2 3 4 5 Kilometers

Highway
Secondary Road
Contours (100 ft)
Watercourse
Tailings
Waterbody

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WERNECKE TAILING INVESTIGATION

FIGURE 1

DISPERSED TAILINGS AREAS OVERVIEW

I:\ALEX-05-01\gis\mxd\UKHM\Overview_Maps\SiteSpecific\Property_Overview_Simple_NoClaims_with_Tailings_20131113.mxd
(*13/11/2013/10:27 AM*)

2 BACKGROUND

Sadie Ladue Creek and Wernecke Lake have been influenced by the effects of historical mining activities since the 1920s. A discussion of this history is provided in Interralogic (2012a). A mill at the Wernecke site operated from 1925 to 1932, processing ore from Sadie Ladue and the Lucky Queen mines. Tailings from the mill were originally contained, but later allowed to flow down the drainage to Wernecke Lake. Dispersed and re-worked tailings are present along Sadie Ladue Creek over the 2.5 km distance from the mill to the lake. Several tailings pods are present in and away from the main incised channel where dispersed tailings have accumulated. Fluvial transport has resulted in the development of an alluvial fan in Wernecke Lake, composed primarily of tailings material. The Sadie Ladue 600 level adit, driven in 1923 for dewatering when the mine was flooded with excess water, and now collapsed, drains water from the mine workings and open pits above.

Previous characterizations date back to 1993 (an unpublished environmental site investigation by the Department of Indian and Northern Development in 1993; Access Mining Consultants, 1996a; Access Mining Consultants, 1996b; Norecol, 1997; Public Works and Government Services Canada, 2000; Interralogic 2012a; Interralogic, 2012b).

The Interralogic (2012a) investigation confirmed that tailings dispersion has occurred along the full length of the Sadie Ladue drainage, with relatively large deposits at the base of the drainage. The Interralogic (2012b) study of natural attenuation potential in the Sadie Ladue drainage found elevated zinc, manganese, iron and aluminum concentrations in sediment samples along the drainage. In addition, water samples showed negligible decreases in zinc and cadmium concentrations down the flow path and sporadic increases of major metals such as aluminum and iron at downstream locations. The study concluded that natural attenuation of zinc and other metals from the draining Sadie Ladue adit may be occurring along the Sadie Ladue drainage, however the result are currently being masked by dispersed tailings and inflows of potentially impacted water from tributaries.

Work to date has focused on the extent of Wernecke dispersed tailings on UKHM claims, with limited consideration of the tailings that had migrated off the claims. Given the considerable amount of dispersed tailings beyond the claim boundary, the current study was initiated to better define the distribution, physical and geochemical stability of the dispersed tailings in the Sadie Ladue drainage, Wernecke Lake and Gambler Lake and determine potential closure options.

3 STUDY AREA SETTING

The Sadie-Ladue mine site is located on the northwest slope of Keno Hill at an elevation of roughly 1,260 m (Figure 1). The mine workings spread over more than 700 m northeast-southwest in what has now become known as the Wernecke Camp. The Sadie Ladue drainage slopes moderately at roughly 7° to the northwest. Wernecke Lake (previously "Unnamed Lake") sits in the valley bottom on the north side of Keno Hill, receiving drainage from the Sadie Ladue watershed (Plate 1). Water from Wernecke Lake discharges into Ladue Creek, which flows into Gambler Lake (Plate 2) before continuing downstream.

Plate 1: Aerial view looking down the Sadie Ladue Creek Drainage to Wernecke Lake

Plate 2: Aerial view above Wernecke Lake looking east toward Gambler Lake

Soils are poorly developed in the immediate area of the Wernecke camp and the Sadie Ladue 600 adit, as they are in others areas of the District, consisting of discontinuous deposits of decomposed, weathered bedrock and glacial till. The area of the Wernecke camp itself is highly disturbed from many years of mining (Interralogic, 2012a).

The gully above the 600 level adit, is dry, showing signs of drainage only during freshet. What little surface water there is during the summer and autumn is limited to seeps and stagnant, ponded groundwater discharge, including several road cut seeps which collect and run west along the Wernecke Road ditch (PWGSC, 2000). All mine water is free-draining from the workings out the 600 level, which is located approximately 800 m north of the Wernecke camp at an elevation of 1100 m.

Drainage from the Sadie Ladue 600 adit forms the year-round headwaters of the watershed, flowing just over 3 km down the Sadie Ladue drainage to Wernecke Lake at the head of Ladue Creek in the valley bottom. The valley bottom resides at an elevation of roughly 750 m. The nearest drainage is Gambler Gulch, located more than 650 m west of the Wernecke camp. Permafrost is reported to a depth of 80 m in the area (McTaggart, 1960).

Wernecke Lake is currently approximately 27 hectares, while the tailings fan is roughly 9.7 hectares (Plate 3). It has been estimated that the Wernecke tailings fills roughly a quarter of the lake, and the entire lake bottom (PWGSC, 2000). Gambler Lake is 1400 m from Wernecke Lake, and is just over 83 hectares in surface area.

Bioclimatic zones, and hence floristic composition range from Subalpine (1100m-1450m) in the vicinity of the Sadie-Ladue mine site to Boreal Low (200m-500m) at the valley bottom and to Boreal High (500m-1100m) in between (ELC, 2012). Vegetation in the Subalpine zone consists of an open canopy dominated by *Abies lasiocarpa* (subalpine fir) followed by *Picea glauca* (white spruce) which increases in density as elevation decreases down to the Boreal High zone. The shrub layer found in this area and down slope to the tailings delta consists of *Salix* (willow), *Betula Glandulosa* (scrub birch) and *Ledum* (Labrador tea) while the herb layer consists of *Vaccinium vitis idea* (cranberry), *Vaccinium uligonosum* (blueberry) *Oxycoccus microcarpus* (bog cranberry) and *Epilobium Angustifolium* (fireweed) with an understory consisting of *Hylocomium splendens* (step moss), *Pleurozium schreberi* (red stemmed feather moss) and lichens.

Early pioneering species such as salix, alnus, carex, fire moss and biological soil crusts radiate several metres from the forest edge and are colonizing the delta. Biological soil crusts (BSCs), consisting of a combination of primarily cyanobacteria, algae, mosses and lichen are established on the tailings interspersed with carex which, in several areas appears to be heavily browsed. BSCs also dominate dispersed tailings located along the Sadie Ladue Creek drainage. The shorelines of Wernecke Lake, Ladue Creek and Gambler Lake are dominated by carex, juncus and other emergents.

Plate 3: Aerial view of Wernecke Lake and Tailings Delta

4 METALS IN THE NATURAL ENVIRONMENT

Naturally-mineralized areas like the KHSD often have metals and other chemical constituents that naturally exceed water quality guidelines for the protection of aquatic life as well as having elevated levels in soils relative to other areas. However, within the KHSD, true background concentrations are not available for several streams, including Sadie Ladue and Ladue Creeks, and Gambler Gulch, as a result of the region's long mining history and the position of those streams relative to mine discharges. Because of this, background concentration estimates for a host of relevant parameters were developed by Minnow (2013) from six stations in the KHSD representing non-mining-impacted conditions. The Minnow (2013) concentrations, as well as the Canadian Council of the Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life (FAL) are used here to evaluate water quality data collected for the Wernecke Tailings Investigation. Tailings and sediment samples were compared with crustal abundance and CCME sediment quality guidelines for the protection of freshwater aquatic life.

5 METHODS

A variety of field methods were used in the investigation, including soil and sediment sampling along transects on land and in Wernecke Lake, water quality sampling in Sadie Ladue and Ladue Creeks, Gambler Gulch, and Wernecke and Gambler Lakes, bathymetric measurements, and the installation of a staff gauge on Wernecke Lake. Methods are described briefly below and Figure 2 shows the location of the various sample types collected.

5.1 SOIL AND SEDIMENT SAMPLING

A survey of the Sadie Ladue drainage beyond the UKHM boundary was planned and carried out, focusing on the final, low energy stream reach terminating in Wernecke Lake, the tailings delta in the lake, and the lake bottom. The objectives of the survey were to identify the extent of tailings dispersion, estimate the amount of tailings present, and determine the physical and geochemical stability of the tailings. Soil and sediment samples were gathered along transects and in points of interest in the Sadie Ladue drainage and in Wernecke Lake on September 25, 26, 27 and 28, 2013. Sediment samples were collected in Gambler Lake on September 27, 2013.

5.1.1 Sampling Transects

Seven transects were defined along the Sadie Ladue drainage and in Wernecke Lake. Three transects (WT1, WT2 and WT3) were sampled perpendicular to Sadie Ladue Creek, each incorporating 1 soil pit in the incised creek bed, and 2 or 3 soil pits on each side at roughly equally spaced intervals. The transects were 75, 250 and 500 m from the intersection of the tailings delta and the surrounding forest for WT3, WT2 and WT1 respectively. Four transects established across the tailings delta and lake (UL1, UL2, UL3, and UL4) began from UL1-X, a common point located where Sadie Ladue Creek flows into the Wernecke Lake tailings delta, and radiated outward toward the opposite shore in equivalent intervals.

5.1.2 Pods and Additional Areas of Interest

Accumulations of exposed tailings, called tailings pods, along the Sadie Ladue drainage were delineated within and beyond the UKHM claim boundary. The largest pods extended from within the UKHM claims to just down gradient of the UKHM claim boundary, with smaller pods dispersed down the drainage. A GPS tracking function was used to walk around the pod and record the edges, providing the area of each pod. Samples were collected in pods and other areas of interest, including the outflow channel from Wernecke Lake, using the soil and sediment sampling techniques described below.

5.1.3 Soil Pits

Soil pits were dug with shovels, as deep as conditions allowed, ranging from 30-80 cm. No borings were conducted, and the total depth of tailings was not realized by shovel. Soil horizons were measured, described and photographed. Samples were collected from 1 or more horizons of interest. If relevant, depth to water was recorded. Sediment samples were collected within the top 10 cm of the lake bottom sediment, using a shovel for shallower depths and an Eckman Dredge sampler for deeper sections of the lake.

5.1.4 Vegetation Density

The vegetation density was observed in the areas around sampling locations. It was recorded and given a rating from 1 to 5, as follows:

- 0: No vegetation;
- 1: Minimal vegetation: soil crusts, mosses and lichens;
- 2: Partial cover: grasses and sedges;
- 3: Willows and shrubs less than a metre;
- 4: Conifers greater than 2 metres; and
- 5: Undisturbed.

An N modifier was used if the environment was deemed to be in its natural undisturbed state, despite being rated 3 or 4 (i.e. in a wetland).

5.1.5 Laboratory Analytical Methods

All 88 soil and sediment samples were analyzed for total metals via inductively coupled plasma (ICP) and total carbon by ALS Minerals. A subset of 24 samples (suspected to contain dispersed tailings) were also sampled for leachability (24 hour shake flask extraction) and acid base accounting (ABA) by ALS Environmental.

ABA samples were tested using the standard Sobek method with a siderite correction (using the hydrogen peroxide method of Skoussen, 1978). Sulphate was measured on an HCl digested sample and sulphide sulphur was determined by calculation, as the difference between total sulphur (via Leco) and sulphate sulfur. Total inorganic carbon was measured via coulometer and paste pH was measured at a 1:1 solid to water ratio. A standard 24-hour shake flask extraction test was conducted using a 3:1 liquid to solid ratio using deionized water as the extracting fluid. ICP trace ultra-metals analysis for 41 elements was conducted using an aqua regia digestion and combined inductively coupled plasma - atomic emission spectroscopy (ICP-AES) and mass spectrometry (ICP-MS) finish.

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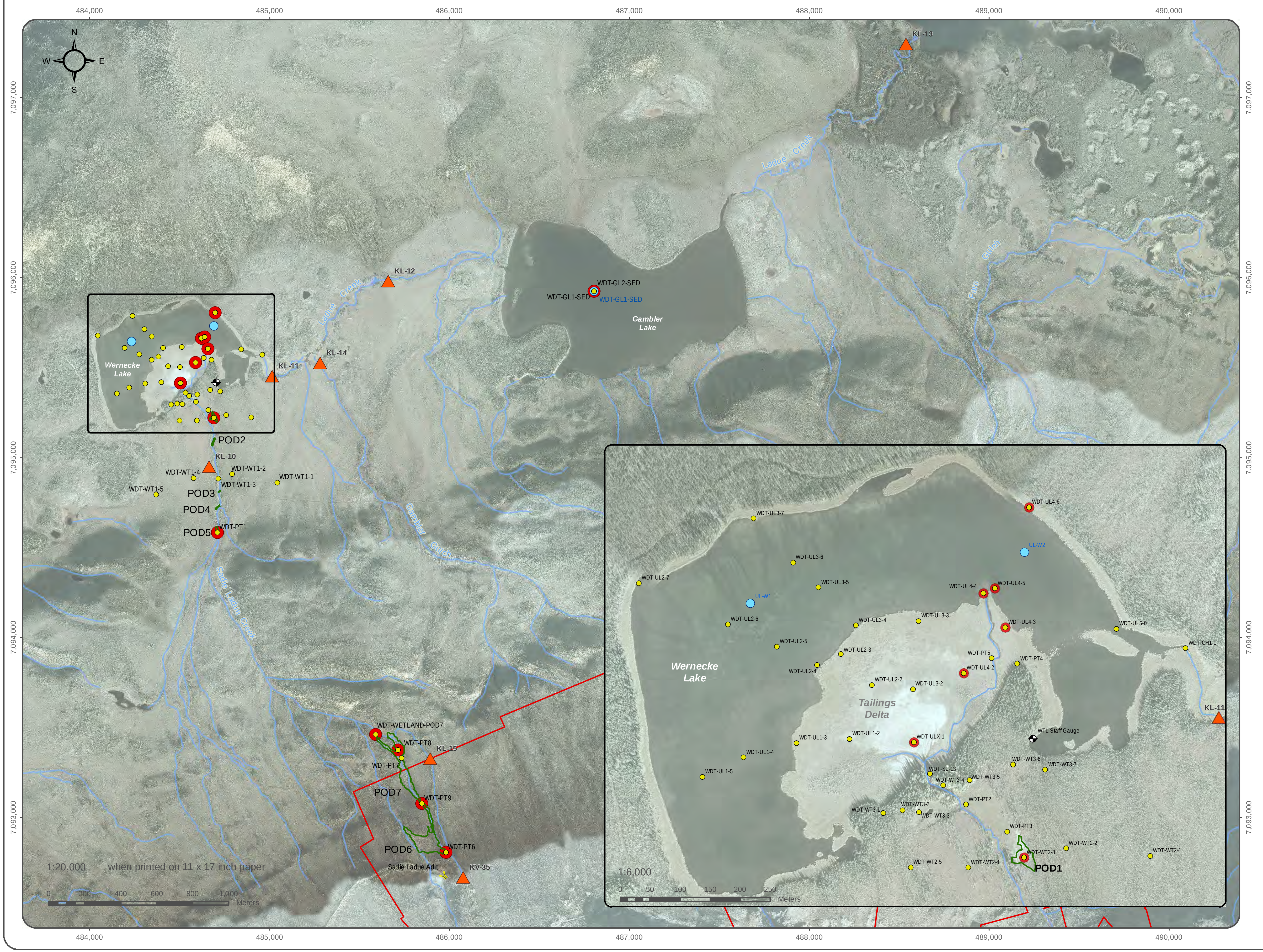
FIGURE 2

SADIE LADUE CREEK, WERNECKE AND GAMBLER LAKE SAMPLE LOCATIONS



- Adit
- Staff Gauge
- Lake Water Samples
- Soil/Sediment Samples - Metals Only
- Soil/Sediment Samples - Geochemistry
- Keno Ladue Surface Water Quality Monitoring Station
- Tailings Pods
- ERDC Quartz Claim Boundary
- Watercourse

Aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Imagery acquired September 13th and 14th 2006.

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Map Projection: UTM Zone 8N

ACCESS

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(*Last edited by: mducharme;13/11/2013/10:34 AM*)

5.2 WATER SAMPLING

On September 27, 2013, surface water quality samples were collected from 8 locations along the Ladue Drainage for laboratory analysis. Flow was measured in concurrence with the 4 stream measurements, while depth was recorded for the 4 lake measurements. Samples were collected for the analysis of dissolved and total metals and carbon, as well as general solute chemistry. Field measurements of pH, conductivity, oxidation reduction potential, dissolved oxygen and temperature were also conducted during stream sampling. Sample locations are noted on Figure 2. Sample collection, custody and QA/QC was undertaken according to Access Consulting Group's *Standard Protocols for the Collection of Surface Water*, including the collection and analysis of 1 field duplicate. All data was entered into the EQWin water quality database.

5.2.1 Stream Sampling

Stream water quality samples were collected on Sadie Ladue Creek (KL-10), Ladue Creek (KL-11 and KL-12) and Gambler Gulch (KL-14). A flow measurement was calculated for each stream using the velocity-area method and a Marsh McBirney flowmeter. Temperature, pH, conductivity, oxidation reduction potential, and dissolved oxygen were recorded in situ using a YSI sampler. Plate 4 shows KL-12 on Ladue Creek looking toward the inflow into Gambler Lake.

Plate 4: Ladue Creek looking to the inflow into Gambler Lake at KL-12

5.2.2 Lake Sampling

Lake water quality samples were collected on Wernecke and Gambler Lakes. A Kemmerer water column profile sampler was used to collect samples mid-column. Two samples were collected on Wernecke Lake (UL-W1 and UL-W2) at different locations, while two samples were collected in Gambler Lake at the same location, at different depths (1 and 3 m, GL-1-1m and GL-1-3m respectively). Water was also collected to later record quasi-in situ measurements of pH and conductivity using a YSI sampler.

5.2.3 Staff Gauge Installation

A staff gauge was installed in Wernecke Lake, to the southeast of the tailings delta, in a bay on the southeast side of the lake (Plate 5). Angle iron was pounded into the lake sediment, and a ruled staff was installed and surveyed. The water level of the lake was 0.700m on September 26, 2013 at 15:10, and can now be recorded for future quarterly sampling trips in the Ladue watershed.

Plate 5: Staff gauge installed in Wernecke Lake

5.2.4 Lab Analysis

Water samples were analyzed by ALS Environmental for dissolved and total metals, dissolved and total carbon, as well as general solute chemistry. Results were entered into the Keno EQWin database and linked to ongoing quarterly sampling in the Ladue watershed. This allowed a time series of water quality to be analyzed and compared to the CCME-FAL.

5.3 BATHYMETRY

A nine-foot inflatable boat was used to collect bathymetric measurements of Wernecke Lake. Depth was measured along the four lake transects described in section 5.1.1 Transects (UL1, UL2, UL3, and UL4). In total, 65 depth measurements were taken and 12 visual estimates during travel through the southeast bay where made. These 77 depths were utilized to create a model of the lake bathymetry using ESRI Spatial Analyst software. The same tools and methods were used to infer the lake bathymetry prior to the deposition of the Wernecke dispersed tailings, in this instance using some of the current depth measurements and depth values created based on the current depth measurements, using the hypothesis that prior to tailings deposition the lake was deepest in the center. Using the current lake volume estimate and the volume estimate of the lake prior to the tailings deposition, an estimation of the volume of tailings in the lake was made and is described in section 6.4.

6 RESULTS

6.1 SOIL & SEDIMENT SAMPLING

For the Wernecke dispersed tailings, of primary concern was visually identifying the spatial extent of dispersed tailings and using the geochemical sampling results to confirm the visual assessment recorded at the time of sampling. Because tailings are not always recognizable due to their similarity to natural fine grained sediment, elevated metals contents may provide a good indicator of samples which contain tailings, assuming native sediment did not contain elevated metal contents.

Constituents of potential concern (COPCs) include metals commonly associated with mined materials and wastes (tailings) in the District. Historical and regional geochemical and water quality assessment work within the Keno Hill district provide context and guidance with respect to constituents which are elevated compared with crustal abundance averages, guidelines, regulatory standards, and other thresholds which have been used (i.e. “impacted” vs. “unimpacted” contained metal soil thresholds, Interralogic, 2012a). COPCs identified as being elevated within geological materials (e.g. ACG 2012) and/or within waters in the Keno Hill District (e.g. Minnow, 2013) include Zn, Cd, Pb, As, Se, Al, Fe, Ag, and Cu. COPCs which are described in additional detail within the study were selected with reference to these district studies. Analysis of results utilized comparisons between contained trace metals and crustal abundance and sediment quality guidelines, while leachable metals via shake flask extraction test results were compared with water quality guidelines and background concentrations derived by Minnow (2013). These comparisons were used to facilitate evaluation of the potential of the Wernecke dispersed tailings for dissolved metal release.

Summary tables showing the soil and sediment information are presented below. Table 1 presents information about the sample transects which were conducted laterally across Ladue Creek above Wernecke Lake. Table 2 presents information and description of samples collected from transects which radiated out from WDT-UL-X on the tailings delta in Wernecke Lake. Table 3 presents information and sample description for samples collected from tailings pods along Ladue Creek above Wernecke Lake, and Table 4 presents the list of samples collected from Wernecke and Gambler Lakes.

Table 1: Soil Sample Transects Information

Sample ID	Sample Description	Sample Type	Sample Depth (cm)
WDT-WT1-1-15CM	Dense organic clay & silt, roots and grass stems	Transect 1	15
WDT-WT1-1-25CM	Lean clay with some silt, dark gray, ice at bottom	Transect 1	25
WDT-WT1-2-15CM	Silty clay, lean dark gray	Transect 1	15
WDT-WT1-2-45CM	Sandy silt with some clay. Sand is fine to coarse dark gray natural soil, alluvial	Transect 1	45
WDT-WT1-3-10CM	Coarse sand with silt, gray to dark gray	Transect 1	10
WDT-WT1-3-25CM	Organic black soil, slit, clay and organic matter	Transect 1	25
WDT-WT1-3-40CM	Interbedded sand, silt and clay	Transect 1	40
WDT-WT1-4-30CM	Clay, slate gray with some silt	Transect 1	30
WDT-WT1-4-45CM	Silty gravel and sand	Transect 1	45
WDT-WT1-5-35CM	Clayey silt, dark gray with root fragments	Transect 1	35
WDT-WT2-1-35CM	Silty sand, glaying with rootlets	Transect 2	35
WDT-WT2-2-38CM	Black organic silt, dark gray	Transect 2	38
WDT-WT2-3-5CM	Organic soil/peat	Transect 2	5
WDT-WT2-3-15CM	Black organic dark brown soil	Transect 2	15
WDT-WT2-3-25CM	Alternating silt/sand	Transect 2	25
WDT-WT2-3-60CM	Alternating silt/sand	Transect 2	60
WDT-WT2-4-40CM	Fluvial coarse gravel and sandy gravel	Transect 2	40
WDT-WT2-5-35CM	Dark gray silt	Transect 2	35
WDT-WT3-1-25CM	Dark gray silt, sulphur smell	Transect 3	25
WDT-WT3-2-40CM	organic material and decomposed materials	Transect 3	40
WDT-WT3-3-15CM	Brown/red peat	Transect 3	15
WDT-WT3-3-40CM	Coarse dark gray sand with trace organics	Transect 3	40
WDT-WT3-3-55CM	Dark gray silt	Transect 3	55
WDT-WT3-4-15CM	Organic rich original ground with smothered dead vegetation	Transect 3	15
WDT-WT3-4-35CM	White/light gray sand with rusty oxidation around rootlets. Black mottling.	Transect 3	35
WDT-WT3-5-35CM	Organic rich dark gray silt	Transect 3	35
WDT-WT3-6-15CM	Silty clay	Transect 3	15
WDT-WT3-6-25CM	Sandy clay with some silt	Transect 3	25
WDT-WT3-7-30CM	Dark gray silt	Transect 3	30

Table 2: Soil Sample Tailings Delta Transects Information

Sample ID	Sample Description	Sample Type	Sample Depth (cm)
WDT-UL1-2-5CM	Tan colored & red colored sand	Tailings Delta1	5
WDT-UL1-2-30CM	Gray sand - light gray with alternating tan and gray lines within - bedding?	Tailings Delta1	30
WDT-UL1-2-80CM	Gray sand - light gray with alternating tan and gray lines within - bedding?	Tailings Delta1	80
WDT-UL1-3-10CM	Dark gray tailings	Tailings Delta1	10
WDT-UL1-3-25CM	Dark gray tailings	Tailings Delta1	25
WDT-UL2-2-5CM	Oxidized reddish brown tailings (sand)	Tailings Delta2	5
WDT-UL2-2-20CM	Gray tailings	Tailings Delta2	20
WDT-UL2-2-45CM	Coarse gray silt-brownish gray	Tailings Delta2	45
WDT-UL2-3-20CM	Gray silt/tailings	Tailings Delta2	20
WDT-UL3-2-5CM	Mottled (glaying) gray and oxidized medium sand tailings	Tailings Delta3	5
WDT-UL3-2-50CM	Gray medium sand tailings	Tailings Delta3	50
WDT-UL3-3-15CM	Reddish brown fine sand with rootlets	Tailings Delta3	15
WDT-UL4-2-10CM	Rust colored to brown fine to medium sand with some silt	Tailings Delta4	10
WDT-UL4-2-20CM	Gray fine to medium sand	Tailings Delta4	20
WDT-UL4-2-35CM	Gray fine to medium sand	Tailings Delta4	35
WDT-UL4-3-10CM	Organic rich, gray to brown silt with fine sand	Tailings Delta4	10
WDT-UL4-3-25CM	Dark gray silt with fine sand	Tailings Delta4	25
WDT-ULX-1-53CM	Lightly layered gray unoxidized tailings	Tailings DeltaX	53
WDT-ULX-1-5CM	Oxidized reddish brown tailings (sand)	Tailings DeltaX	5
WDT-PT4-45CM	Organic rich silt gray to black	Tailings Delta	45
WDT-PT5-15CM	Brown silty fine sand	Tailings Delta	15

Table 3: Soil Sample Ladue Creek/Pod Information

Sample ID	Sample Description	Sample Type	Sample Depth (cm)
WDT-PT1-5CM	Light tan fine sand with some silt - tailings?	Creek/Pod	5
WDT-PT1-20CM	Black organic silt with trace fine sand, roots, black to brown (natural ground?)	Creek/Pod	20
WDT-PT2-15CM	Silt, fine sand and clay, abundant grasses and root fragments throughout, dark gray	Creek/Pod	15
WDT-PT2-25CM	Slimy fine sand with silt and grass, siltier than higher layer	Creek/Pod	25
WDT-PT3-15CM	Sandy layer, silt and fine sand - tan colored	Creek/Pod	15
WDT-PT3-25CM	Fine sand and silt with roots and grass	Creek/Pod	25
WDT-PT6-10CM	Gray mixed tailings	Creek/Pod	10
WDT-PT6-22CM	Mixed fine sandy tailings	Creek/Pod	22
WDT-PT6-35CM	Fine sandy gray tailings	Creek/Pod	35
WDT-PT7-8CM	Humus layer	Creek/Pod	8
WDT-WETLAND-POD7-7CM	Brown gray fine sand	Creek/Pod	7
WDT-WETLAND-POD7-18CM	Red oxide and white gray & brown gray fine sand	Creek/Pod	18
WDT-PT8-4CM	Dark brown fluvial type deposit	Creek/Pod	4
WDT-PT8-10CM	Light gray/brown	Creek/Pod	10
WDT-PT8-30CM	Red oxides mixed with gray	Creek/Pod	30
WDT-PT9-4CM	Gray tailings	Creek/Pod	4
WDT-PT9-12CM	Oxide red and gray tailings	Creek/Pod	12
WDT-PT9-34CM	Dark gray brown	Creek/Pod	34
WDT-SL-13	Sediment mixed with organics	Creek/Pod	15

Table 4: Wernecke and Gambler Lake Sediment Sample Summary

Sample ID	Sample Type
WDT-UL1-4-SED	Wernecke Lake Sediment
WDT-UL1-5-SED	Wernecke Lake Sediment
WDT-UL2-4-SED	Wernecke Lake Sediment
WDT-UL2-5-SED	Wernecke Lake Sediment
WDT-UL2-6-SED	Wernecke Lake Sediment
WDT-UL2-7-SED	Wernecke Lake Sediment
WDT-UL3-4-SED	Wernecke Lake Sediment
WDT-UL3-5-SED	Wernecke Lake Sediment
WDT-UL3-6-SED	Wernecke Lake Sediment
WDT-UL3-7-SED	Wernecke Lake Sediment
WDT-UL4-4-SED	Wernecke Lake Sediment
WDT-UL4-5-SED	Wernecke Lake Sediment
WDT-UL4-6-SED	Wernecke Lake Sediment
WDT-UL5-0-SED	Wernecke Lake Sediment
WDT-CH1-0-SED	Wernecke Lake Sediment
WDT-GL1-SED	Gambler Lake Sediment
WDT-GL2-SED	Gambler Lake Sediment

6.1.1 Spatial Distribution and Conditions of Dispersed Tailings

Seven tailings pods were delineated along the Sadie Ladue drainage, and are shown in Figure 2. The material in the pods ranged from medium to fine sand in the upper pods to alternating fine sand and silt in the lower pods. All pods are characterized by a general lack of revegetation, with undisturbed areas adjacent to the pod, as shown in Plate 6. The pods are generally in low gradient areas where the tailings have settled out, except for pods 6 and 7 (Plate 6). Table 12 in Section 6.4.1 indicates the average slope of each pod. Pod 1 (Plate 7) is 210 m from the edge of the tailings delta and upgradient from a wetland. Pods 2, 3, 4, and 5 are within the Sadie Ladue drainage, adjacent to the incised channel. Pods 6 and 7 are approximately 700 m downslope and to the east of the tailings impoundment, in steep terrain. Pod 7 extends 625 m down the slope, flattening out into a wetland.

The tailings delta in Wernecke Lake covers an area of 97,257 m^2. Early pioneering plant species are colonizing outward from the edge of undisturbed forest several meters into the delta (Plate 8). Species include white spruce, scrub birch, alder, willow, gramminoids and sedge. Biological soil crusts (made up of a combination of cyanobacteria, lichens, mosses, microfungi and bacteria) dominate the delta where sedges are absent.

Sedge tussocks are found in wetted areas of the delta, i.e. along the defined Sadie Ladue channel, and where the delta edged is partially submerged in water. The material in the delta is light grey, with reddish oxidized mottling near the surface, ranging from silt with fine sand to fine to medium sand with some silt. Tailings are also present in the outlet of the Sadie Ladue creek channel.

Wernecke Lake sediments appeared rich with organic material, however, elevated metals concentrations throughout the lake as described in Section 6.1.2.1 indicate that tailings have probably been dispersed throughout.

An estimate of the volume of tailings pods, of the tailings delta, and submerged in Wernecke Lake is provided in section 6.4.

Plate 6: Tailings Pod 7 in the Wernecke Creek drainage below Sadie Ladue Adit

Plate 7: Tailings Pod 1 above Wernecke Lake

Plate 8: Wernecke Lake tailings delta showing vegetative regrowth along the margins

6.1.2 Geochemical Characteristics

6.1.2.1 Contained Trace Metals

Trace metals analysis via ICP was conducted on all 85 Wernecke dispersed tailings samples including all sediment and soil samples (Appendix A1). Results for total organic carbon (TOC) are also reported in Appendix A1. Metal results were compared with CCME Sediment Quality Guidelines for the Protection of Aquatic Life for all elements for which CCME guidelines exist, including As, Cd, Cu, Pb, Hg, and Zn. The Interim Sediment Quality Guideline (ISQG) was used rather than the Probable Effects Level (PEL). In addition, a number of additional elements for which SFE testing (Section 6.1.2.3) showed some exceedances of Canadian water quality guidelines, including Al, Cr, Co, Fe, Mo, Ni, Se and Ag were compared with 10x crustal abundance for a point of reference. Table 5 summarizes this comparison.

Table 5: ICP Trace Metals Results Comparison with CCME Sediment Quality Guidelines and 10x Crustal Abundance

Element	Al	As	Cd	Cr	Co	Cu	Fe
Number of Samples ≥ CCME	-	83	85	-	-	79	-
Number of Samples ≥ 10x Crustal	81	74	79	0	0	0	0
% of Samples ≥ CCME	-	98%	100%	-	-	93%	-
% of Samples ≥ 10x Crustal	0%	87%	93%	0%	0%	0%	0%
CCME Sediment Quality Guideline[a] (ppm)	-	5.9	0.6	-	-	35.7	-
10x Crustal Abundance[b](ppm)	823000	18	1.5	1020	250	600	563000
Element	**Pb**	**Hg**	**Mo**	**Ni**	**Se**	**Ag**	**Zn**
Number of Samples ≥ CCME	69	61	-	-	-	-	83
Number of Samples ≥ 10x Crustal	63	38	0	0	85	81	64
% of Samples ≥ CCME	81%	72%	-	-	-	-	98%
% of Samples ≥ 10x Crustal	74%	45%	0%	0%	100%	95%	75%
CCME Sediment Quality Guideline (ppm)	35	0.17	-	-	-	-	123
10x Crustal Abundance (ppm)	140	0.85	12	840	0.5	0.75	700

a – Sediment Quality Guidelines for the Protection of Aquatic Life (ISQG)
b – 10x Crustal Abundance - Wikipedia

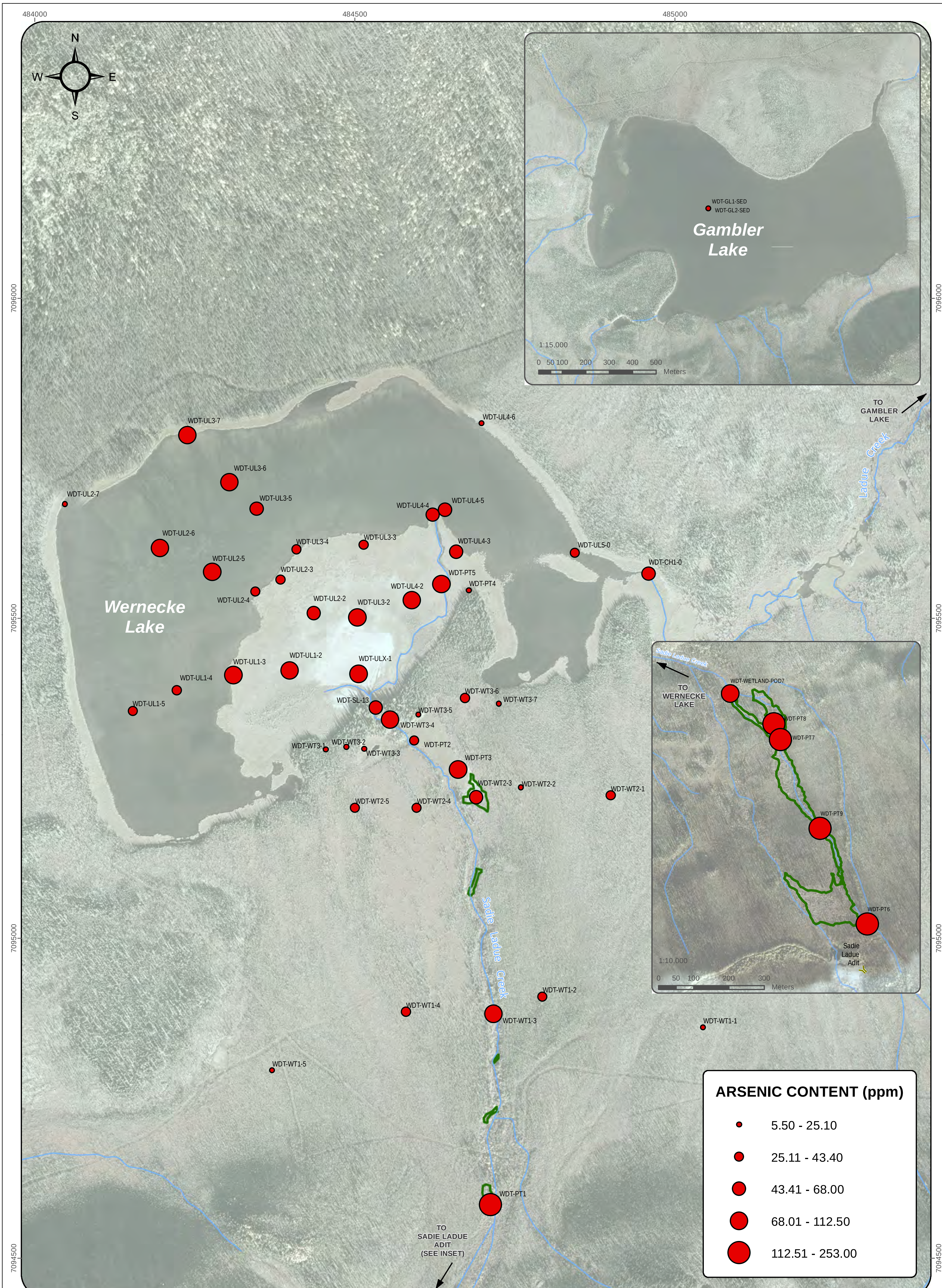
Interralogic (2012a) compared sediment samples from Flat Creek with a control group of sediment samples from the Keno area and determined that the probability of a pre-mine sediment sample having zinc concentration higher than 626 mg/kg was less than 5%. Interralogic then applied this number (626 mg/kg, which is very similar to 10x crustal abundance) as a cut-off for sediment sample results indicating samples higher than 626 mg/kg as being unlikely to have been naturally occurring.

Table 5 shows that all of the elements for which CCME Sediment Quality Guidelines exist, at least 72% of samples exceeded the guideline. Comparison with 10x crustal abundance shows that in addition to the elements which frequently exceed the CCME Sediment Quality Guidelines, the concentration of Se and Ag are also elevated in 100% and 95% of the Wernecke sediment/soil samples, respectively.

It should be noted that for three elements, including Zn, Pb, and As, a significant number of samples exceeded the method detection limit (MDL) of 10,000 ppm (for Zn and Pb) and 100 ppm for As, respectively. For the data analysis, the MDL was used even though the actual (unknown) concentration is higher. Ore grade over-limits assays were conducted for Ag, Zn and Pb for a number of samples. Of these samples, the maximum contained zinc was 6.97% (69,700 ppm) and the maximum contained lead was 4.21% (42,100 ppm).

Spatial Distribution of COPC Elements

Figures 3 through 9 illustrate the concentration of selected COPC metals including As, Ag, Cd Cu, Pb, Se and Zn according to their location on the base map. The size of the symbols represent constituent concentrations. Where multiple samples were collected from a test pit, the sample with the highest concentration is shown. Natural Breaks (Jenks) method was used to determine bin sizes and breaks. These elements were chosen for plotting based on their known association with Keno Hill Silver District mineralization and based on their elevated concentrations compared with reference values (10x crustal abundance, and CCME Sediment Quality Guidelines).



Talings Pods

Watercourse

1:5,500 *(when printed on 11 x 17 paper)*

0 50 100 200 300 400

Meters

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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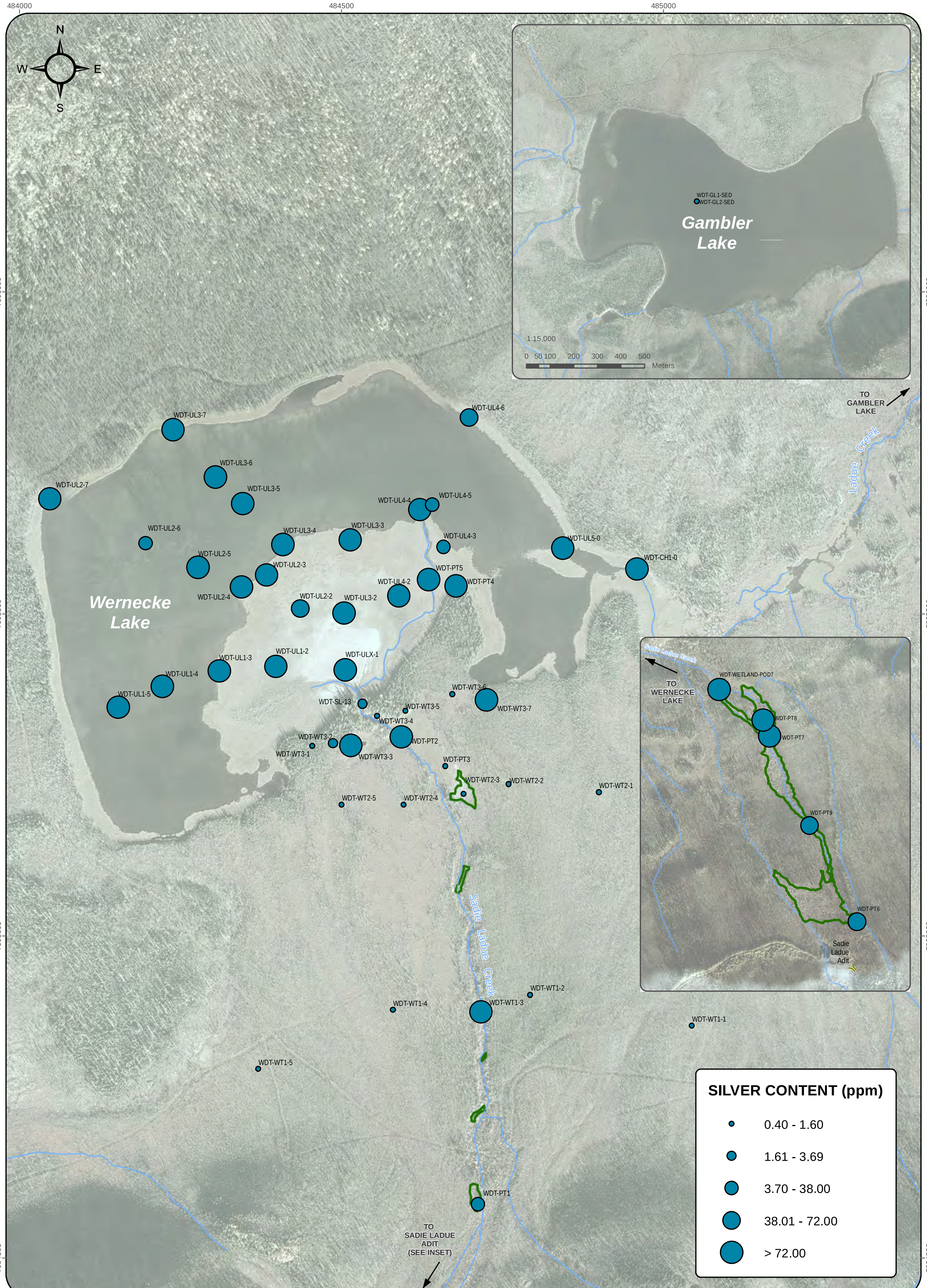
FIGURE 3

SEDIMENT METAL CONCENTRATIONS

ARSENIC (As)

NOVEMBER 2013

I:\ALEX-05-01\gis\mxd\UKHM\Studies\WerneckeTailings-SadieLadue\Fall_2013_MetalConcentrations\SedimentMetalConcentrations_As_20131106.mxd
(Last edited by: jpan;2013-11-07/16:27 PM)



Talings Pods

Watercourse

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0 50 100 200 300 400

Meters

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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FIGURE 4

SEDIMENT METAL CONCENTRATIONS

SILVER (Ag)

NOVEMBER 2013

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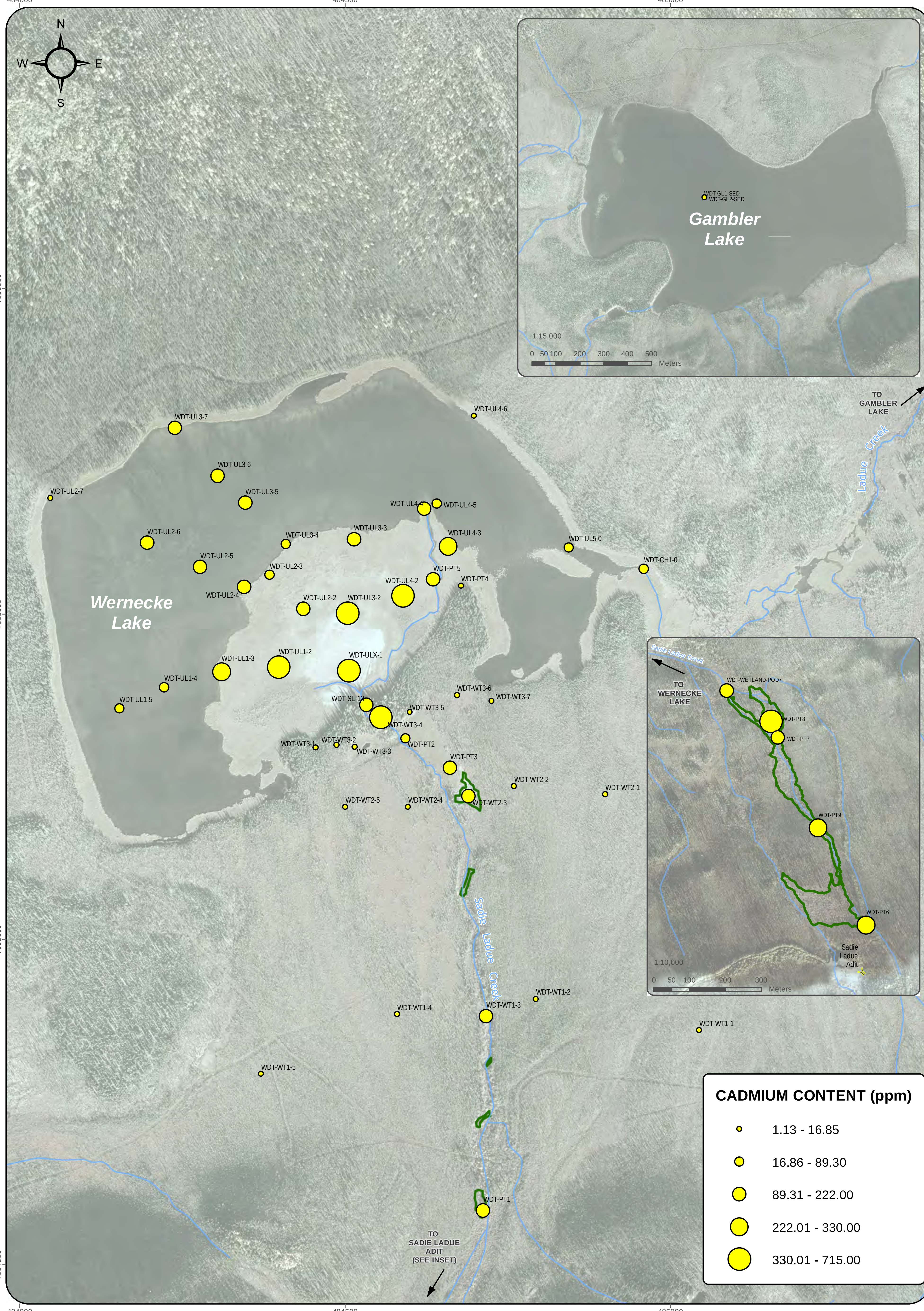

Talings Pods
Watercourse

1:5,500 *(when printed on 11 x 17 paper)*

0 50 100 200 300 400
Meters

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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FIGURE 5

SEDIMENT METAL CONCENTRATIONS

CADMIUM (Cd)

NOVEMBER 2013

I:\ALEX-05-01\gis\mxd\UKHM\Studies\WerneckeTailings-SadieLadue\Fall_2013_MetalConcentrations\SedimentMetalConcentrations_Cd_20131107.mxd
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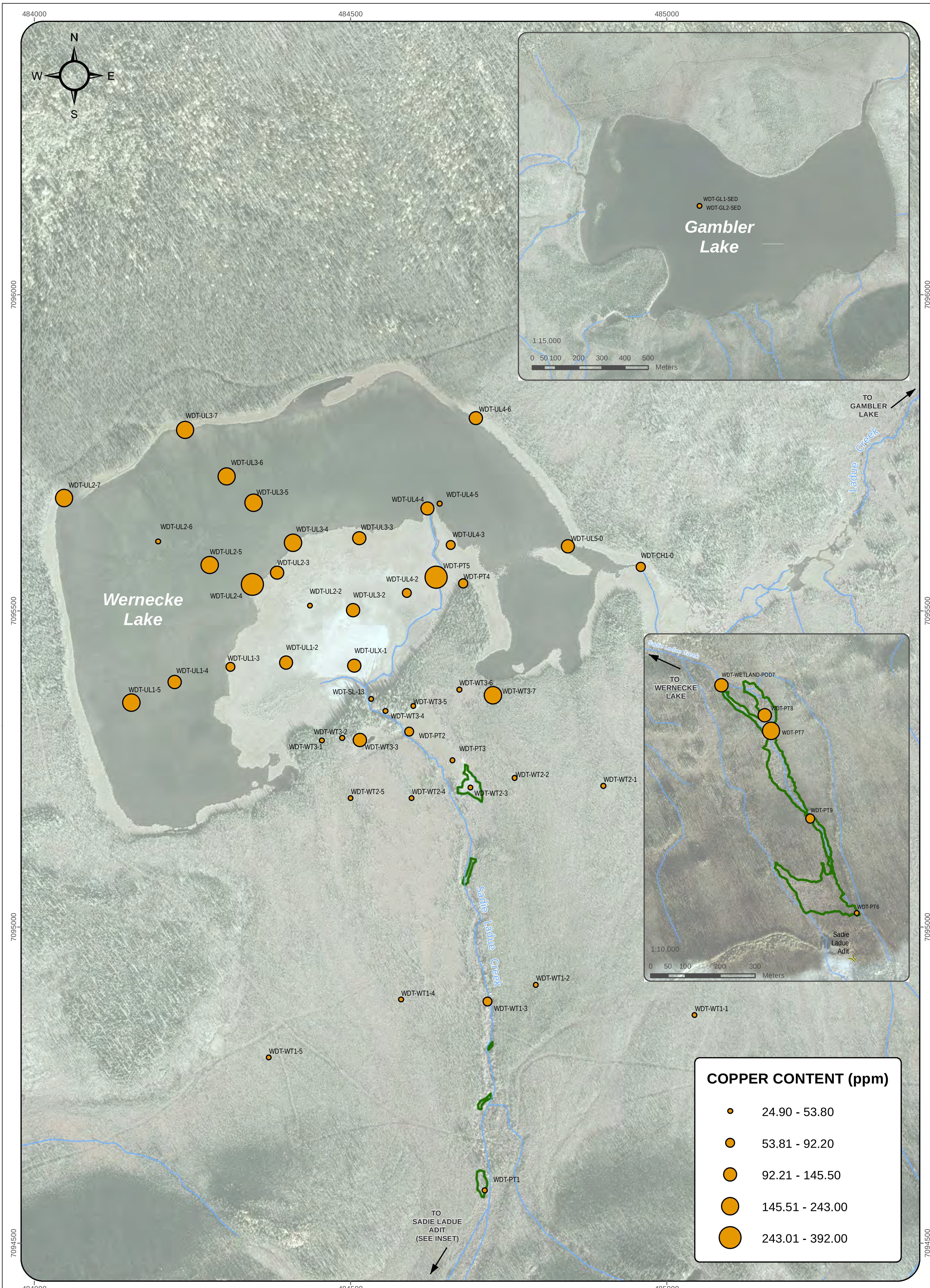

Talings Pods

Watercourse

1:5,500 *(when printed on 11 x 17 paper)*

0 50 100 200 300 400

Meters

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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FIGURE 6

SEDIMENT METAL CONCENTRATIONS

COPPER (Cu)

NOVEMBER 2013

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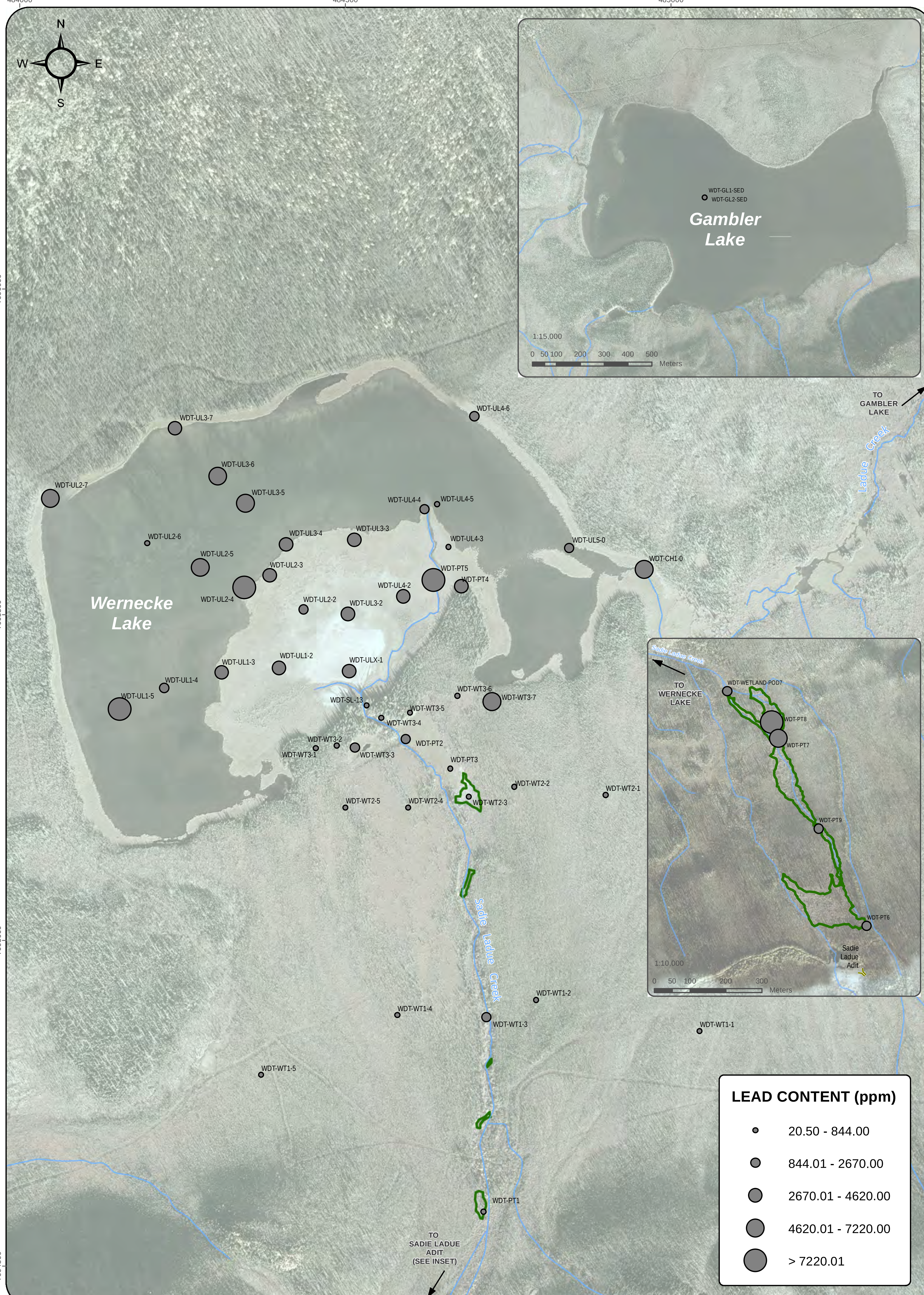

Talings Pods

Watercourse

1:5,500 *(when printed on 11 x 17 paper)*

0 50 100 200 300 400

Meters

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FIGURE 7

SEDIMENT METAL CONCENTRATIONS

LEAD (Pb)

NOVEMBER 2013

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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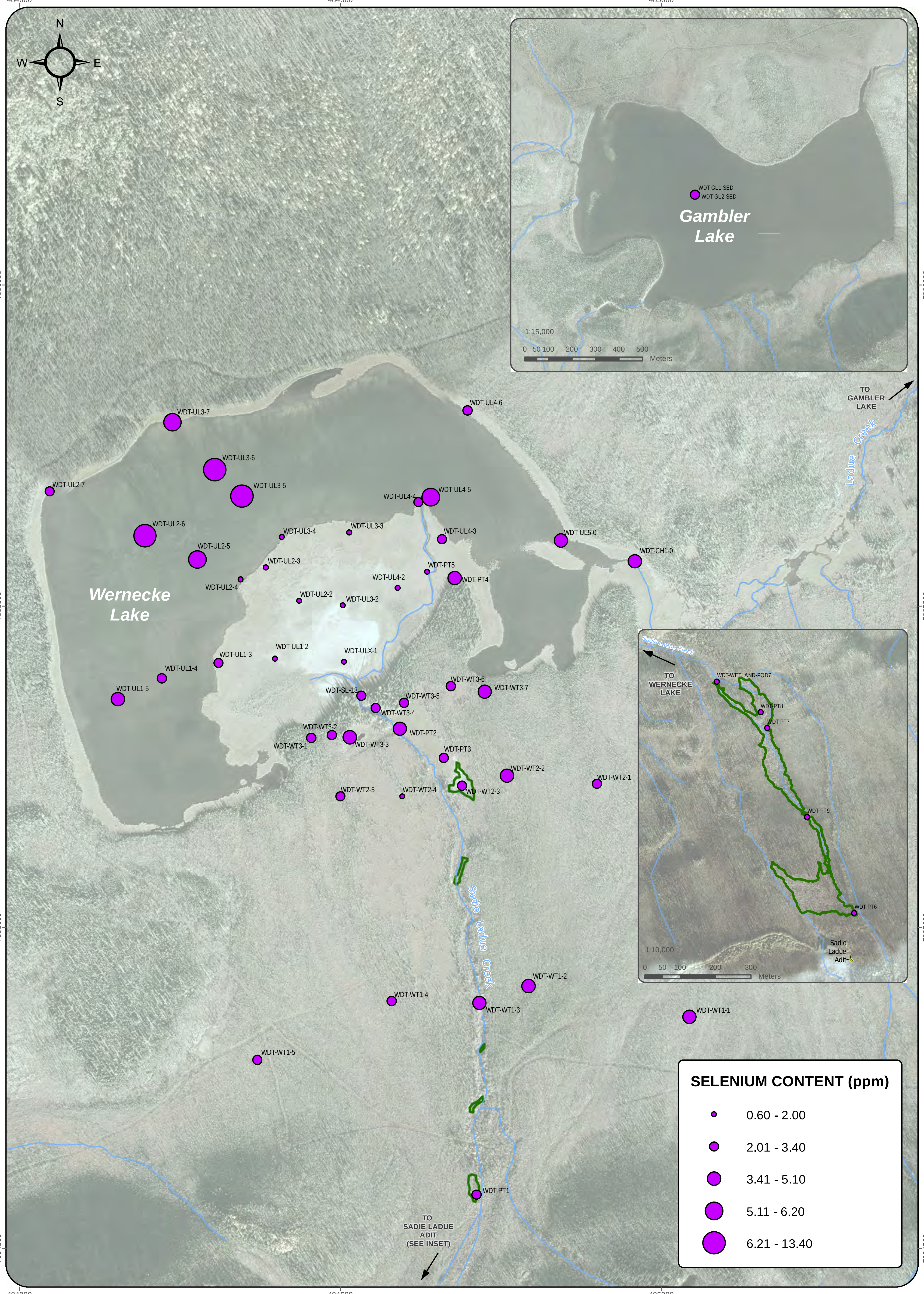

Talings Pods

Watercourse

1:5,500 *(when printed on 11 x 17 paper)*

0 50 100 200 300 400

Meters

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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FIGURE 8

SEDIMENT METAL CONCENTRATIONS

SELENIUM (Se)

NOVEMBER 2013

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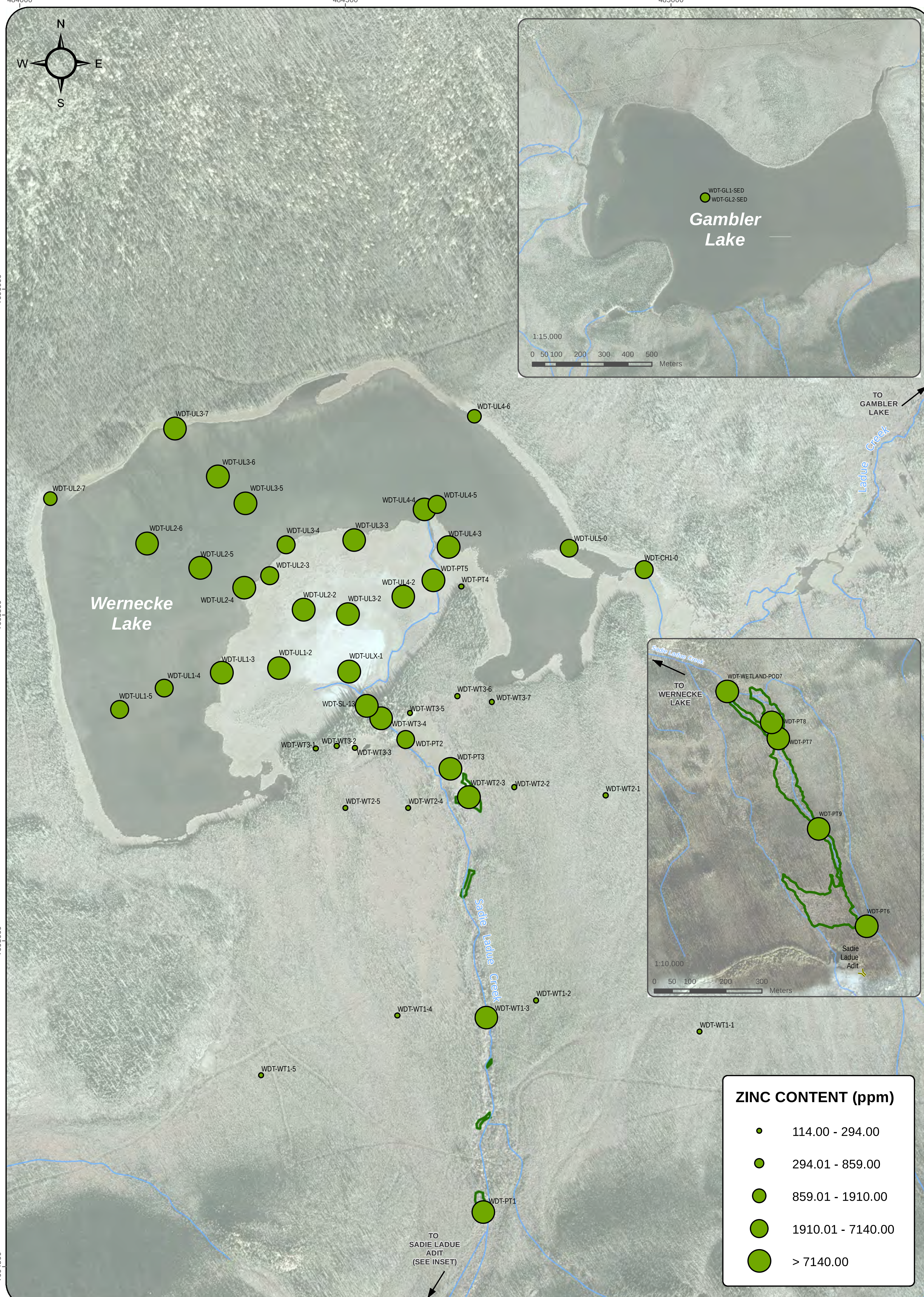

Talings Pods

Watercourse

1:5,500 *(when printed on 11 x 17 paper)*

0 50 100 200 300 400

Meters

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FIGURE 9

SEDIMENT METAL CONCENTRATIONS

ZINC (Zn)

NOVEMBER 2013

Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

Datum: NAD 83; Projection: UTM Zone 8N

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(Last edited by: jpan;2013-11-07/16:34 PM)

Figure 3 through Figure 8 generally illustrate a similar pattern showing elevated metal concentrations within the Ladue Creek stream channel (and tailings pods) and in the tailings delta where tailings are known and expected. The transects across the alluvial fan above Wernecke Lake show that the elevated metal contents are generally not observed outside the immediate stream channel. In particular, the transect WT3 shows that the elevated berm through which Sadie Ladue Creek cuts immediately upstream of the tailings delta does not appear to be comprised of tailings material. This may contradict Interralogic (2012a) which suggested that significant tailings may underlie much of the low-lying areas adjacent to the creek near Wernecke Lake. This implies that tailings have not widely dispersed in the alluvial fan above Wernecke Lake and are generally confined to the Sadie Ladue Creek stream channel, associated tailings pods, and Wernecke Lake.

With a few exceptions, Figure 3 through Figure 8 show similarly elevated metal concentrations within tailings sediments throughout Wernecke Lake compared with known tailings samples collected at the tailings delta and pods within Sadie Ladue Creek. This implies that tailings and/or dissolved metals have been well distributed throughout Wernecke Lake. The relatively low concentration of metals in Gambler Lake imply that large scale transport of tailings and/or dissolved metals seems to be limited to Wernecke Lake. Selenium (Figure 8) and to a lesser extent copper (Figure 6) and lead (Figure 7) show generally lower concentrations within tailings samples from the delta than in Wernecke Lake sediment samples.

As was noted above, comparison of tailings and sediment sample metal concentrations to reference values shows that many of the COPC elements (Se, Cd, As, Ag, Zn, Pb) even the relatively low samples (i.e. those outside the Sadie Ladue creek channel above Wernecke Lake) can contain significant metal concentrations of COPC elements, generally above CCME Sediment Quality Guidelines and above 10x Crustal Abundance. This may reflect trace tailings deposition from wind, or may simply reflect elevated background concentrations downgradient of mineralized areas.

In some test pits, multiple samples at different depths (up to 4) were collected where there was a discernable difference between layers, e.g., an oxidized cap or major differences in grain size or organics content. Figure 10 shows the depth versus the concentration of selected metals within three samples taken from WDT-UL-2 in the tailings delta. Figure 10 does not show any consistent pattern of metal concentration with depth but shows that elevated concentrations remain throughout the test pit. Ag and As are not shown on this figure but exceeded their MDL (of 100 ppm). Figure 11 shows metal concentrations from 4 samples collected at 5, 15, 25 and 60 cm depth from test pit WDT-WT2-3 dug in a tailings pod next to the Sadie Ladue Creek. Figure 11 shows a depletion of Se and Zn at 15cm followed by an increase at 25 cm and then a sharp decrease in the bottom sample at 60 cm, while Se and Zn appear to increase at 60 cm.

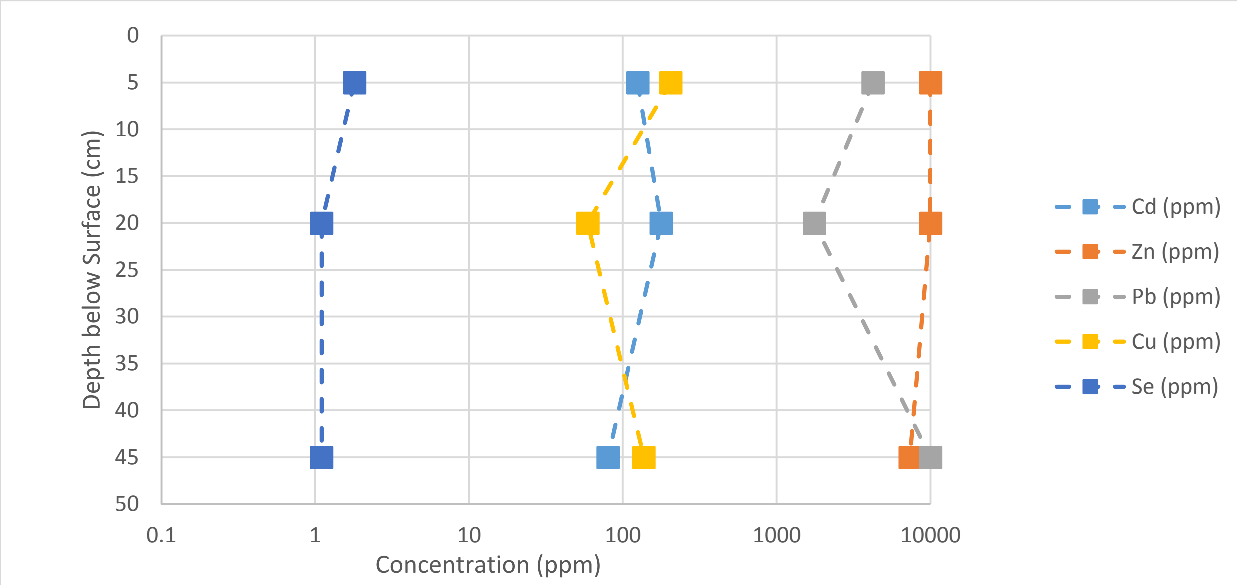


Figure 10: Depth and Metal Concentration in Wernecke Lake Tailings Delta – WDT-UL-2

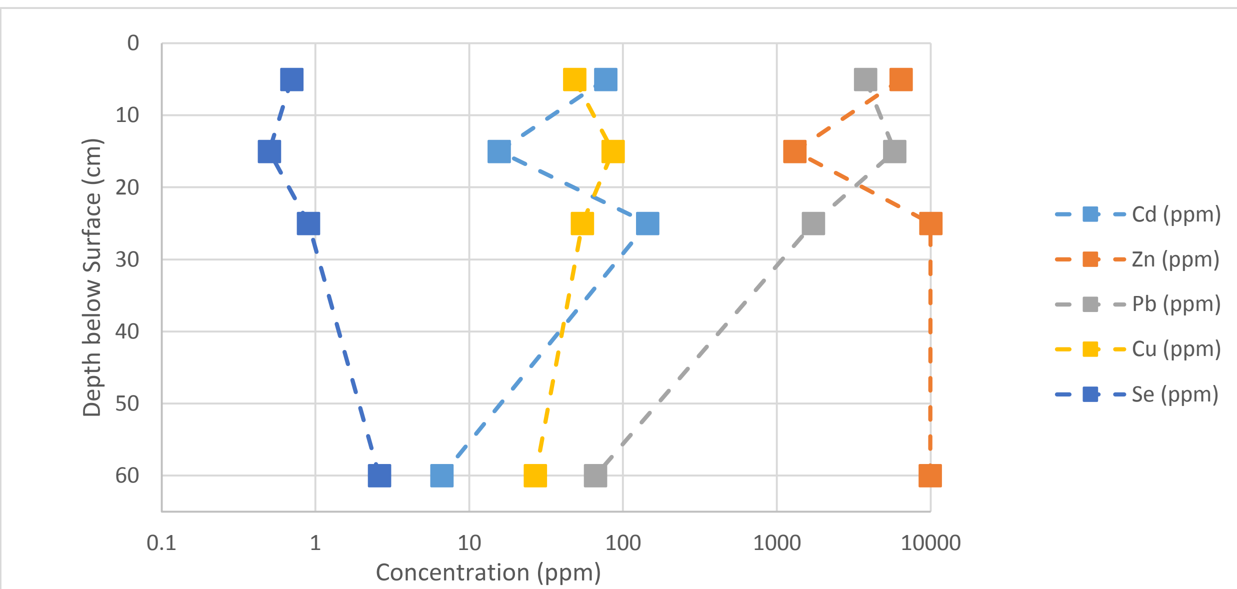


Figure 11: Depth and Metal Concentration in Sadie Ladue Creek Tailings Pod – WDT-WT2-3

6.1.2.2 Acid Base Accounting

The principal purpose of ABA testing is to provide quantitative determination of the balance between acid producing and acid consuming minerals contained within geologic materials. ABA testing results were conducted on 24 samples from 13 test pits and lake sediment samples. Complete ABA results are included in

Appendix A2. With the exception of GL-2, most of the samples selected for ABA testing were thought to contain a significant amount of tailings material. A statistical summary of ABA results is presented in Table 6.

Table 6: ABA Results Statistical Summary

Statistic	MPA ($kgCaCO_3/t$)	FIZZ RATING	NNP ($kgCaCO_3/t$)	NP ($kgCaCO_3/t$)	Paste pH	Ratio (NP:MPA)
No. of observations	24	24	24	24	24	24
Minimum	1.600	1.000	-24.000	7.000	5.900	0.570
Maximum	106.500	4.000	103.000	179.000	7.500	16.000
1st Quartile	10.350	2.000	7.500	24.750	6.925	1.450
Median	25.200	2.000	24.000	42.000	7.000	2.225
3rd Quartile	48.900	3.000	61.500	109.750	7.300	2.970
Mean	33.571	2.375	34.125	67.708	6.971	3.056
Variance (n-1)	756.840	0.940	1492.984	2840.042	0.192	11.316
Standard deviation (n-1)	27.511	0.970	38.639	53.292	0.438	3.364
Skewness (Pearson)	0.893	0.069	0.245	0.599	-1.056	2.753
Geometric mean	22.040	2.161		46.693	6.957	2.122
Statistic	**S_Tot %**	**S_SO_4(HCl) %**	**S_Sulphide (calc) %**	**S_SO_4(Carb) %**	**C (%)**	**CO_2 (%)**
No. of observations	24	24	24	24	24	24
Minimum	0.050	0.005	0.030	0.005	0.070	0.200
Maximum	3.400	0.120	3.280	0.160	7.410	27.100
1st Quartile	0.330	0.010	0.320	0.010	1.483	5.450
Median	0.805	0.015	0.795	0.010	2.910	10.650
3rd Quartile	1.565	0.030	1.545	0.043	4.640	17.000
Mean	1.073	0.026	1.043	0.031	3.069	11.242
Variance (n-1)	0.773	0.001	0.738	0.002	5.268	70.630
Standard deviation (n-1)	0.879	0.031	0.859	0.040	2.295	8.404
Skewness (Pearson)	0.890	2.192	0.883	2.043	0.405	0.403
Geometric mean	0.704	0.016	0.670	0.017	1.770	6.435

Neutralizing Potential (NP)

NP within the sample set varied between 1.6 kg $CaCO_3$/t and 106.5 kg $CaCO_3$/t with a median value of 25.2 kg $CaCO_3$/t.

Figure 12 shows a positive correlation between CO_2 (inorganic) and NP indicating that the primary source of neutralizing potential is from carbonate minerals. The fizz test results (described below) indicate that reactive carbonates (calcite) is present in most samples. This is consistent with geochemical characterization work elsewhere in the district which has determined that calcite is the main neutralizing mineral.

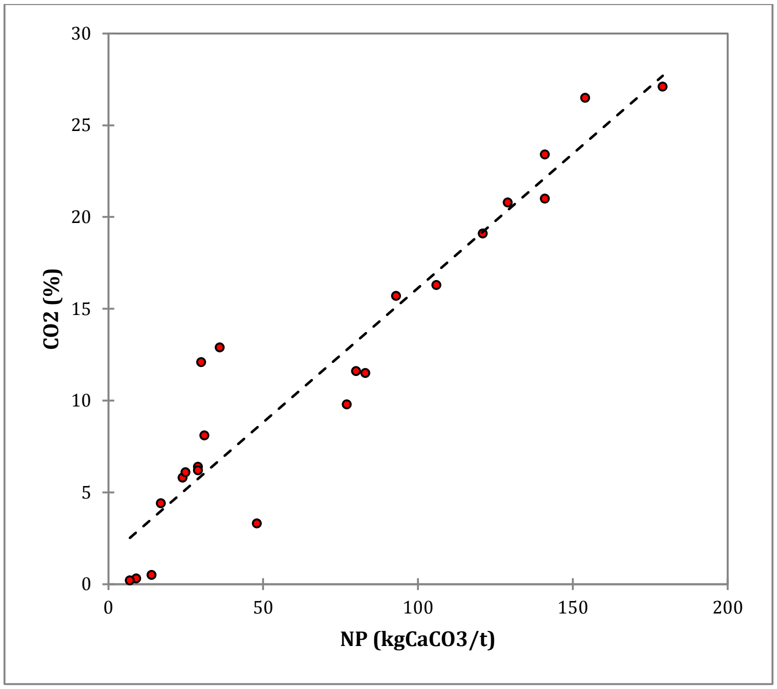


Figure 12: CO2 versus NP

Maximum Potential Acidity (MPA)

MPA within the sample set varied between 7 kg CaCO3/t and 179 kg CaCO3/t with a median value of 42 kg CaCO3/t based on total sulphur of 0.05 to 3.4%. The Sobek method uses total sulphur (x31.25) to calculate MPA which could result in over-estimation of MPA if significant non-acid generating sulphate phases such as barite or gypsum were present. Sulphate was measured via HCl and carbonate leach which showed minimums of 0.05% and maximums of 0.12% and 0.16%, respectively.

Neutralization Potential Ratio (NPR)

NPR within the sample set varied between 0.57 and 16 with a median value of 2.23. MEND (2009) suggests that samples with NPR greater than 2 are non-potentially acid generating provided no significant errors have been made in the estimation of effective NP and AP. Based on experience elsewhere in the district that indicates the ubiquity of siderite within vein faults which are the primary hosts of mineralization, conservative methods for measuring ABA including siderite correction were used for these samples. AP is calculated using the Sobek method based on total sulphur, which is conservative, as some sulphur fraction is generally found in the form of non-acid generating or low solubility sulphates. Because of this, the ABA measurements are considered conservative and unlikely to contain significant errors in estimation.

Figure 13 shows NP plotted versus MPA by sample type along with MEND criteria. Four of five sediment samples showed NPRs of 1:1 or less, while all four samples from the tailings delta showed NPR of 2:1 or greater. 10 of 15 creek/pod samples had an NPR of > 2:1 with four samples between 1:1 and 2:1 and one sample less than 1:1. Table 7 shows the distribution of samples according to NPR range from the ABA dataset.

A total of 16 of the 24 or 67% of samples from the ABA dataset have NPRs of >2, indicating minimal potential for net acidity. Four samples had a NPR of between 1 and 2, indicating uncertain potential for generation of net acidity and the remaining four samples had NPRs of <1, indicating potential for net acid generation.

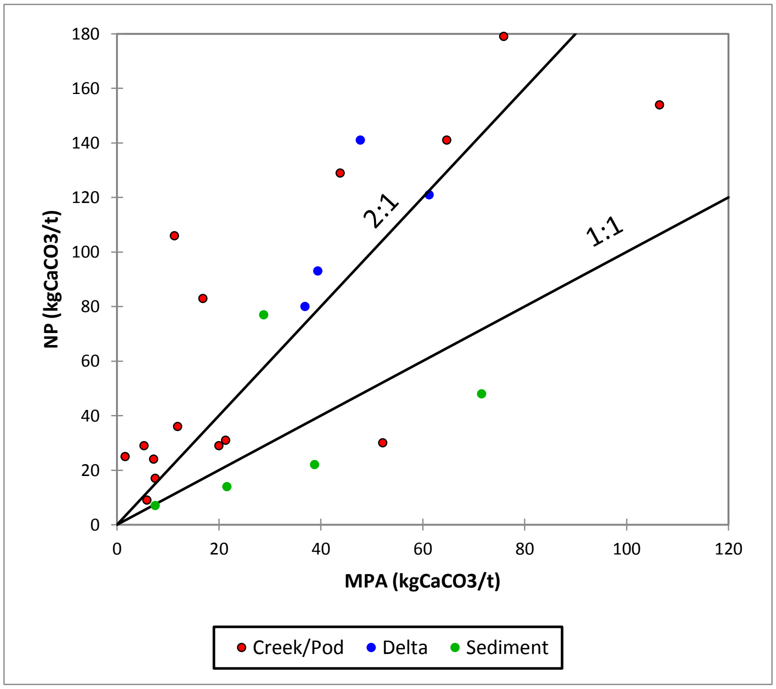


Figure 13: NP vs. MPA

Table 7: Distribution of Neutralizing Potential Ratios

NPR	< 1	1 to 2	>2	Total
Number of Samples	4	4	16	24
Relative Frequency (%)	17%	17%	67%	100%

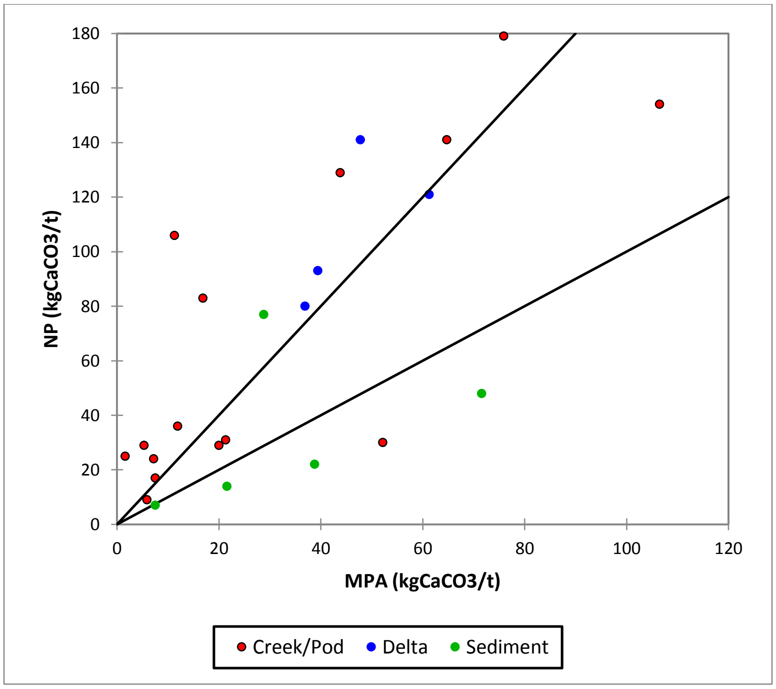


Figure 13: NP vs. MPA

Table 7 shows that 67% of the samples had NPRs of greater than 2, indicating minimal potential for net acidity.

Net Neutralization Potential (NNP)

NNP is significant because materials with sulphide minerals whose net neutralizing potential is negative may result in net acid generation unless sulphide content is very low and/or there are significant slow release, non-carbonate sources of alkalinity.

Although it is not the preferred method of characterizing the future potential for ARD, NNP provides an overall balance of acid producing and acid neutralizing materials, and can also provide another useful metric of ARD potential. Hutt and Morin (1999) showed that waste rock with a NNP of > 20 kg $CaCO_3$/tonne were very unlikely to generate net acidity. Samples with negative NNP are assumed to have potential for net acid generation due to excess MPA compared with the NP in the sample. Similar to samples with NPR 1<2, the potential for net acid generation in samples with between 0 and 20 kg $CaCO_3$/t is assumed to be uncertain without further testwork or study (e.g. kinetic testing). Table 8 shows the distribution of samples according to NNP ranges.

Table 8: Distribution of Net Neutralizing Potential

NNP	# of Samples NNP < 0 kg CaCO3/t	# of Samples NNP 0<20 kg CaCO3/t	# of Samples NNP >20 kg CaCO3/t	Total
Number of Samples	**5**	**4**	**15**	**24**

Relative Frequency (%)	**21%**	**17%**	**63%**	**100%**

Paste pH
Paste pH values ranged between 5.9 and 7.5 with a median value of 7.0. These results are consistent with the overall net acid neutralizing nature of the tailings and mixed samples collected in the area.

Fizz Rating

The fizz rating used in ABA testing is a ranking system between 1 and 4 (1 being no effervescence, 4 being vigorous effervescence). Samples varied between 1 and 4 with a median value of 2.

6.1.2.3 Tailings Leachability via Shake Flask Extraction

The principal purpose of shake flask testing is to provide an indication of short-term metal leaching potential, and is the recommended solubility test procedure for determining the mass of soluble constituents (mg/kg) at higher water to solids ratios (MEND, 2009). SFE test results can be used as an indicator of the potential magnitude of effects that could result from the interactions of water that comes into contact with the material (tailings), or provide inputs for geochemical modeling.

The 24 SFE test results were compared with water quality guidelines and background concentrations as described in Minnow, 2013. Complete SFE results are included in Appendix A3. Table 9 shows a summary of elements for which Canadian water quality guidelines (CWQG) exist, and which exceed either the CWQG or Keno District background concentrations, as determined in Minnow, 2013.

Table 9: SFE Test Results Comparison with CWQG and Background Concentrations

Element	Al	As	Cd	Cr	Co	Cu	Fe
Number of Samples ≥ CWQG	6	14	24	6	12	14	11
Number of Samples ≥ Background	0	16	21	10	23	9	10
% of Samples ≥ CWQG	25%	58%	100%	25%	50%	58%	46%
% of Samples ≥ Background	0%	67%	88%	42%	96%	38%	42%
CWQG[a]	**0.1**	**0.005**	**0.000017**	**0.001**	**0.0025**	**0.003**	**0.3**
Background[b]	**0.66**	**0.0034**	**0.0006**	**0.00064**	**0.00029**	**0.0071**	**0.72**
Element	**Pb**	**Hg**	**Mo**	**Ni**	**Se**	**Ag**	**Zn**
Number of Samples ≥ CWQG	23	4	0	1	8	18	24
Number of Samples ≥ Background	21	7[c]	8	23	8	19	24
% of Samples ≥ CWQG	96%	17%	0%	4%	33%	75%	100%
% of Samples ≥ Background	88%	29%	33%	96%	33%	79%	100%
CWQG[a]	**0.004**	**0.00026**	**0.073**	**0.096**	**0.001**	**0.0001**	**0.03**
Background[b]	**0.021**	**0.00001**	**0.00035**	**0.0015**	**0.00109**	**0.000047**	**0.014**

a – CWQG as defined and according to assumptions presented in Table 4, Minnow 2013
b – Background concentrations as presented in Table 4, Minnow 2013
c – Detection limit for mercury (0.00005 ppm) exceeded background concentration

As can be seen from Table 9, background concentrations are frequently lower than CWQG. Of these elements, Al, As, Cd, Cr, Co, Cu, Fe, Pb, Hg, Se, Ag and Zn exceeded CWQG in the SFE tests in greater than 10% of the samples. This indicates that the Wernecke dispersed tailings may have potential for leaching of these elements and that pore water currently present is likely to have elevated concentration of these metals.

As shown in Figure 14 selenium showed a positive correlation with total organic carbon (TOC), which in part, may reflect the higher selenium concentrations associated with the Wernecke Lake sediments, which were frequently organic rich. The two outliers on this plot are WDT-WT1-1-15cm and WDT-WT3-2-40, which are both extremely organic rich soil samples that are spatially removed by lateral distance and/or depth from the known tailings deposits.

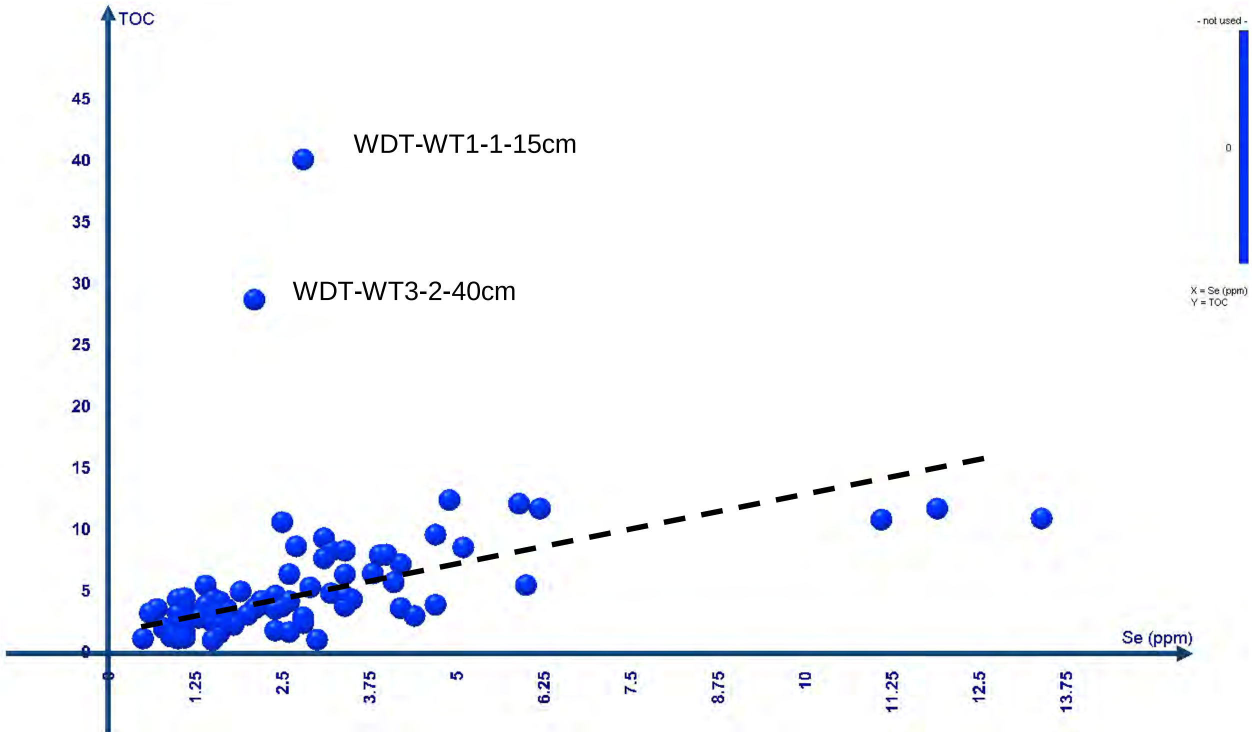


Figure 14: Total Organic Carbon vs. Selenium

Comparisons between some of the COPC leachable metals via SFE test and their total concentration generally indicate weak positive correlations (Figure 15 to Figure 18). pH values measured from the SFE tests were plotted as a color gradient, and may indicate that higher pH may limit metal solubility for some constituents. The range of pH values in these samples (5.8-8.0) does not appear to exert a strong influence on metal solubility. However, elevation of pH to higher levels (>8.5) by lime amendment is used in the district in order to affect precipitation of metal hydroxides and effectively reduce solubility of some of the major COPCs (especially zinc).

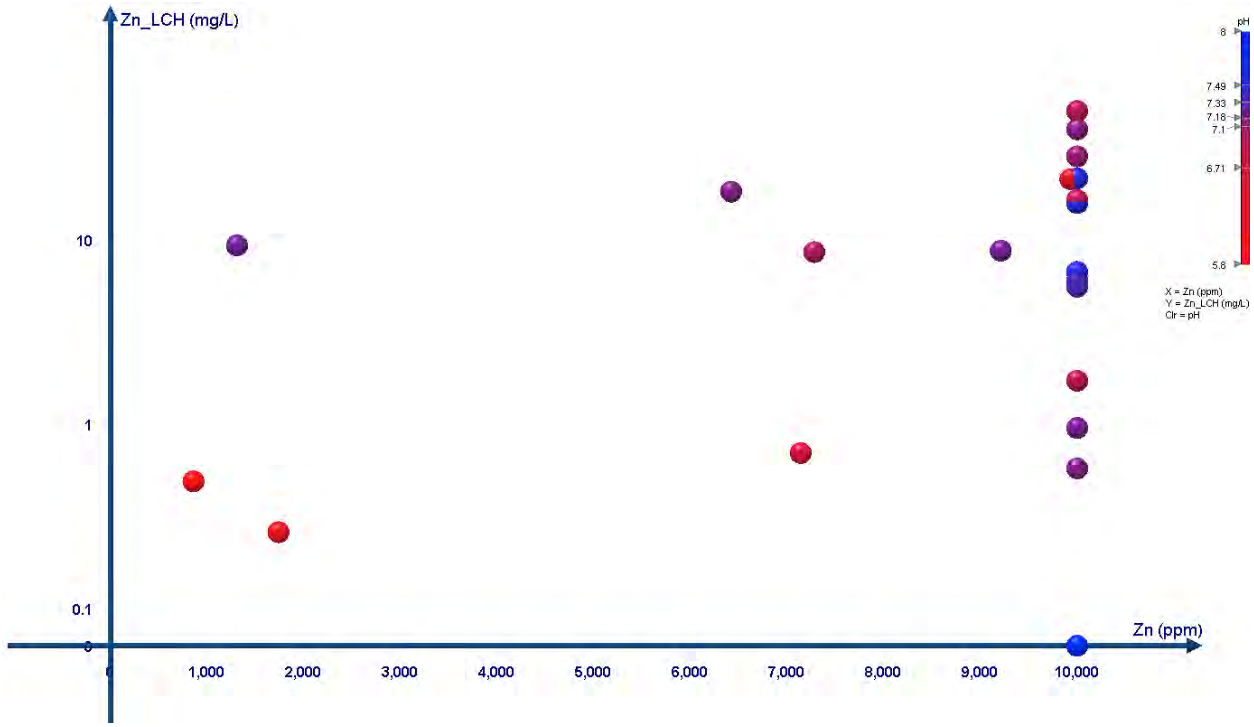


Figure 15: Leachable Zinc vs. Contained Zinc with pH Color Gradient

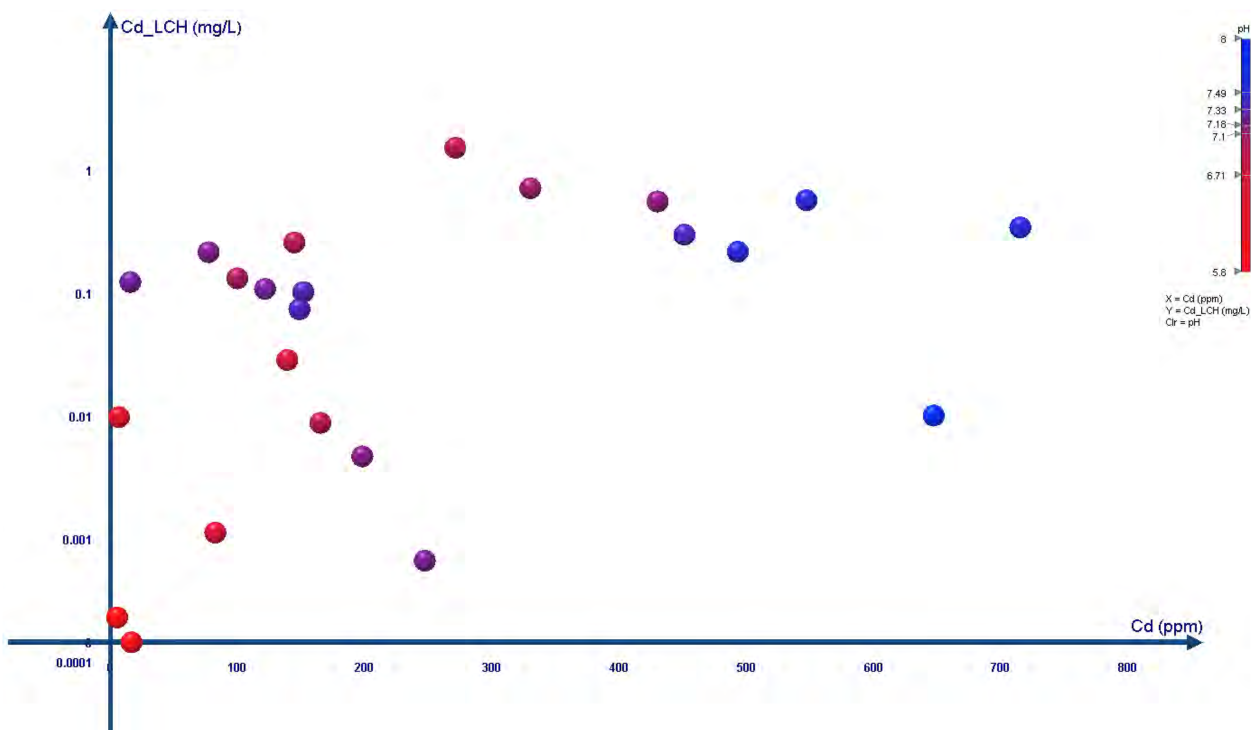


Figure 16: Leachable Cadmium vs. Contained Cadmium with pH Color Gradient

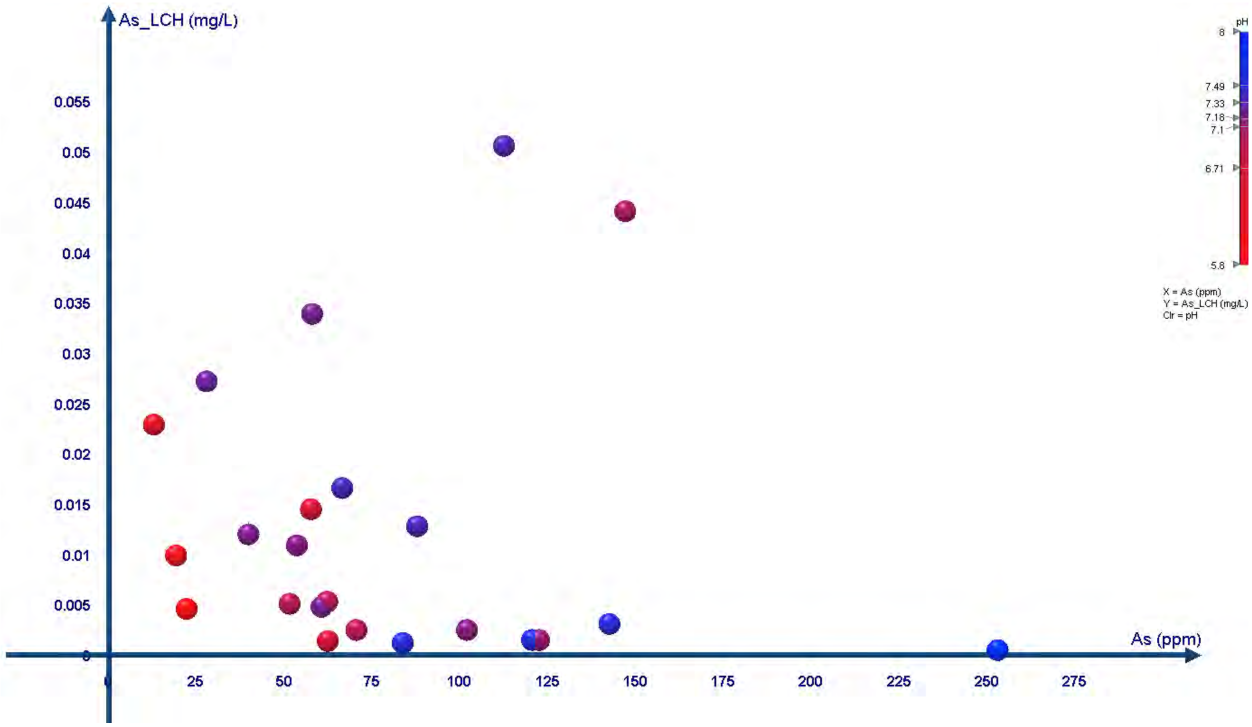


Figure 17: Leachable Arsenic vs. Contained Arsenic with pH Color Gradient

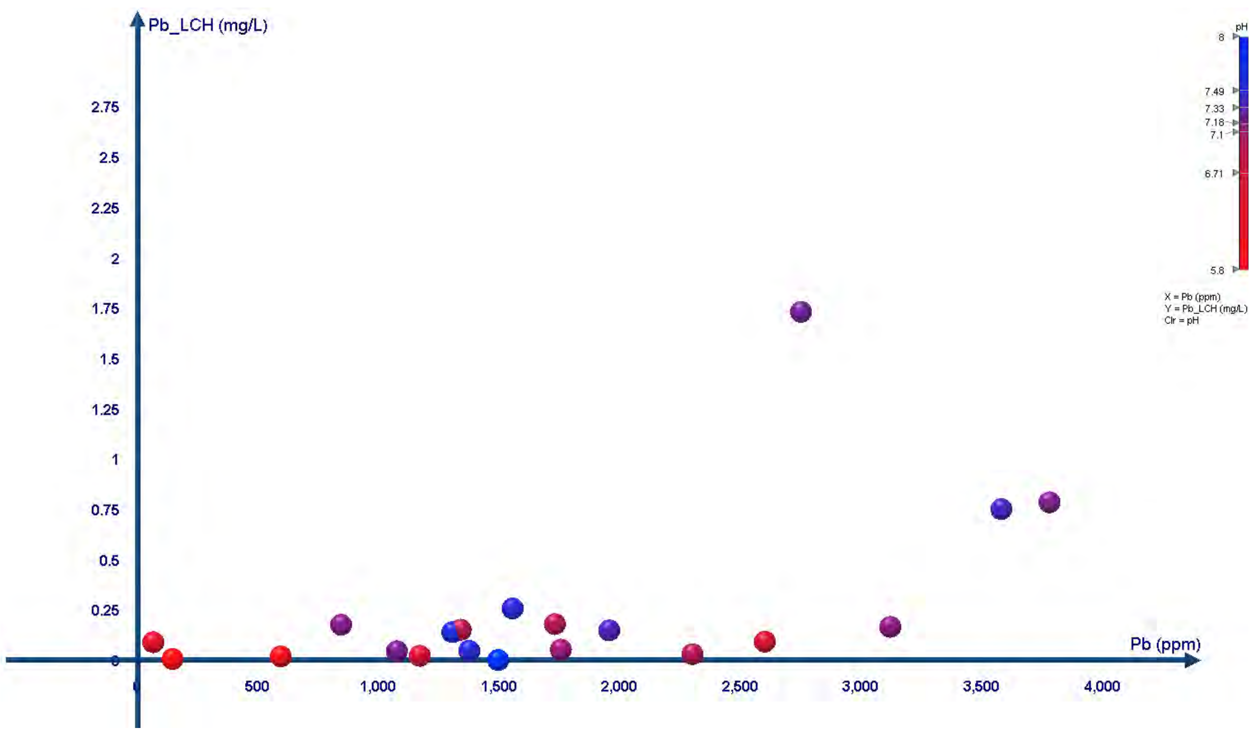


Figure 18: Leachable Lead vs. Contained Lead with pH Color Gradient

6.2 WATER QUALITY SAMPLING

6.2.1 Upper Ladue Watershed

Complete water quality analysis results of the Wernecke Tailings Investigation are presented in Appendix B compared with CCME Guidelines for the Protection of Aquatic Life (CCME-FAL) and the Keno District background water quality (Minnow, 2013). Also presented are the calculated flow and measured in situ parameters for the sampling event. Quarterly sampling results from the upper Keno Ladue watershed are also included in the table of results and in the analysis. The sample stations codes and relative locations are presented in Table 10 below and shown in Figure 2.

Table 10: Upper Ladue Watershed Surface Water Quality Stations

Station Name	Station location description
KV-35	Sadie Ladue 600 Adit
KL-15	Creek draining the Sadie Ladue 600 adit at the UKHM claim boundary
KL-10	Sadie Ladue Creek upstream of Wernecke Lake
UL-W1	Wernecke Lake NE of tailings fan
UL-W2	Wernecke Lake NW of tailings fan
KL-11	Ladue Creek downstream of Wernecke Lake and upstream of Gambler Gulch
KL-12	Ladue Creek downstream of Gambler Gulch
KL-14	Gambler Gulch
GL-1-1m	Gambler Lake at a 1 m depth
GL-1-3m	Gambler Lake at a 3 m depth
KL-13	Ladue Creek upstream of the confluence with Ladue Lake

Plots of concentrations for six selected analytes are presented in Figures 19 to 26. Samples collected October 19 and 20, 2012 are grouped under the label ‘Oct 2012’, samples from June 6 and 7, 2013 are grouped under ‘June 2013’, samples from August 29 and 30 were grouped under ‘August 2013’, and samples from September 27 and October 3, 2013are called ‘Sept 2013’. Select analytes include arsenic, aluminum, cadmium, iron, lead, and zinc. Where the concentration of an analyte was below the reported detection limit (RDL), half the RDL was used for analysis. Some general trends identified in the dataset are discussed in the following sections.

6.2.1.1 pH

The pH for all stations from the Sadie Ladue 600 Adit to the outflow of Gambler Lake was neutral to slightly alkaline for all sampling events, ranging from 7.14 to 8.13 for field pH. For the September 2013 sampling event pH was higher in Wernecke and Gambler Lakes than in the creeks, and pH decreased as the distance from Sadie Ladue Creek increased.

6.2.1.2 TSS

Total suspended solids levels are generally low, except for the June 2013 sampling event, where TSS was a high of 128 mg/L on Sadie Ladue Creek (KL-10) and above detection limits at all other stations along Sadie Ladue and Ladue Creeks and Gambler Gulch. This event was likely associated with a large amount of erosion from spring snowmelt.

6.2.1.3 Specific Conductance

Specific conductance ranged from 223.5 (KL-12 in June 2012) to 787.5 µs/cm (KV-35 in Sept 2013). All measurements for June 2012 were low. For the other three sampling events specific conductance tends to decrease from the Sadie Ladue adit down the drainage to the outlet of Gambler Lake.

6.2.1.4 Total Zinc

Total zinc concentrations are shown in Figure 19 for the 4 sampling events and 11 sample locations. All samples collected in the Sadie Ladue drainage (KV-35, KL-15, and KL-10), Wernecke Lake (UL-W1 and UL-W2) and its outlet (KL-11) exceed both CCME-FAL and Keno District background water quality (Minnow, 2013). Gambler Gulch (KL-14) and Gambler Lake (GL-1-1m and GL-1-3m) samples are below CCME and background, except for the August 2013 Gambler Gulch sample. KL-15, which drains the Sadie Ladue 600 adit and passes through the Wernecke tailings impoundment, has the highest levels of zinc at each sampling event where it was included. From KL-15 to the outlet of Gambler Lake (KL-13) a reduction in zinc concentration is observed in each sampling event. In Oct 2012, KL-15 was 80 times larger than background, while KL-13 was ~57% of background. For the September 2013 sampling event an exception with respect to zinc attenuation is the higher concentration at KL-11 than in Wernecke Lake. Total zinc loading is shown in Figure 20, and shows a similar declining trend from KL-10 to KL-13. An exception is KL-11, Ladue Creek upstream of Gambler Gulch, which has less zinc loading than KL-12, Ladue Creek downstream of Gambler Gulch, in August and September, despite low zinc loading on Gambler Gulch (KL-14).

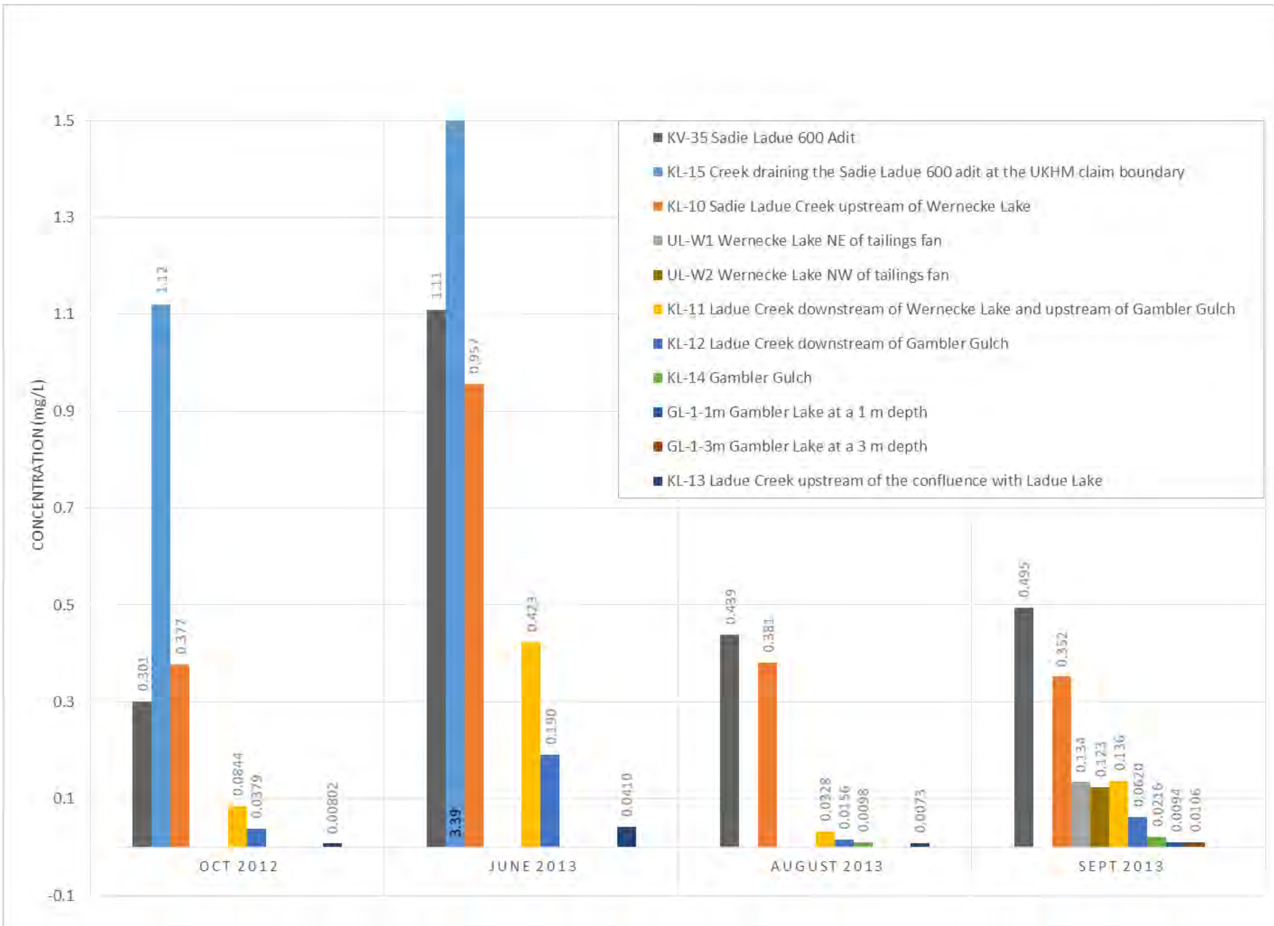


Figure 19: Total Zinc Concentration – Upper Ladue Watershed

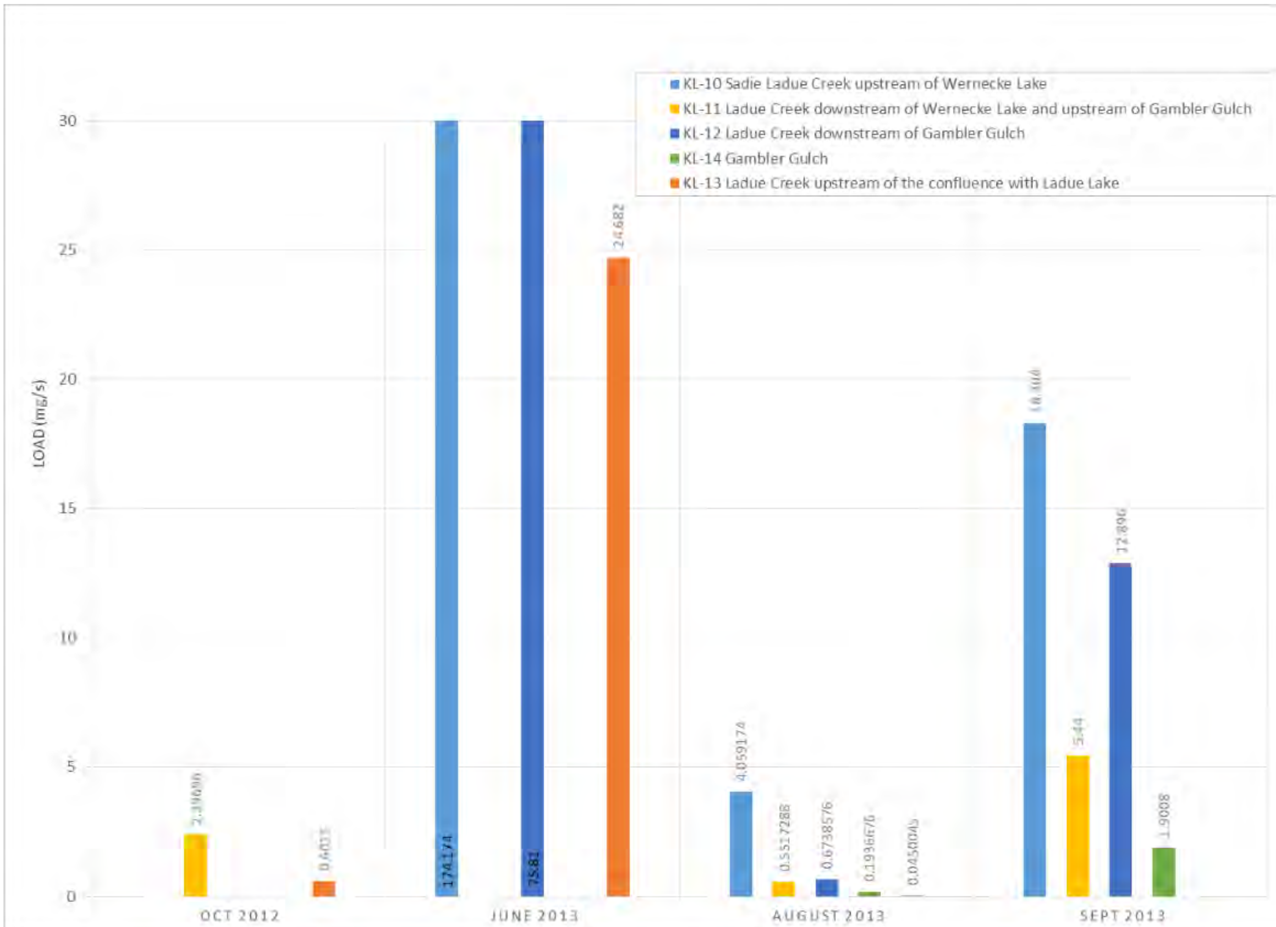


Figure 20: Total Zinc Loading - Upper Ladue Watershed

6.2.1.5 Total Cadmium

Total cadmium concentrations are shown in Figure 21. Cadmium follows a similar trend to zinc, however, the cadmium concentration at KV-35 is lower than that at KL-10 for 3 of the 4 sampling events. Similarly, all samples upstream of Gambler Gulch exceed CCME-FAL and background, however, Gambler Gulch only exceeds CCME. Gambler Lake samples are below both CCME and background, while the Gambler Lake outlet has exceeded CCME and background one out of three sampling events. Cadmium concentration declines between KL-15 to KL-13 for each sampling event. Figure 22 shows cadmium loading. Similar to zinc loading a declining trend is observed from KL-10 to KL-13, with KL-12 again exceeding KL-11 in August and September 2013.

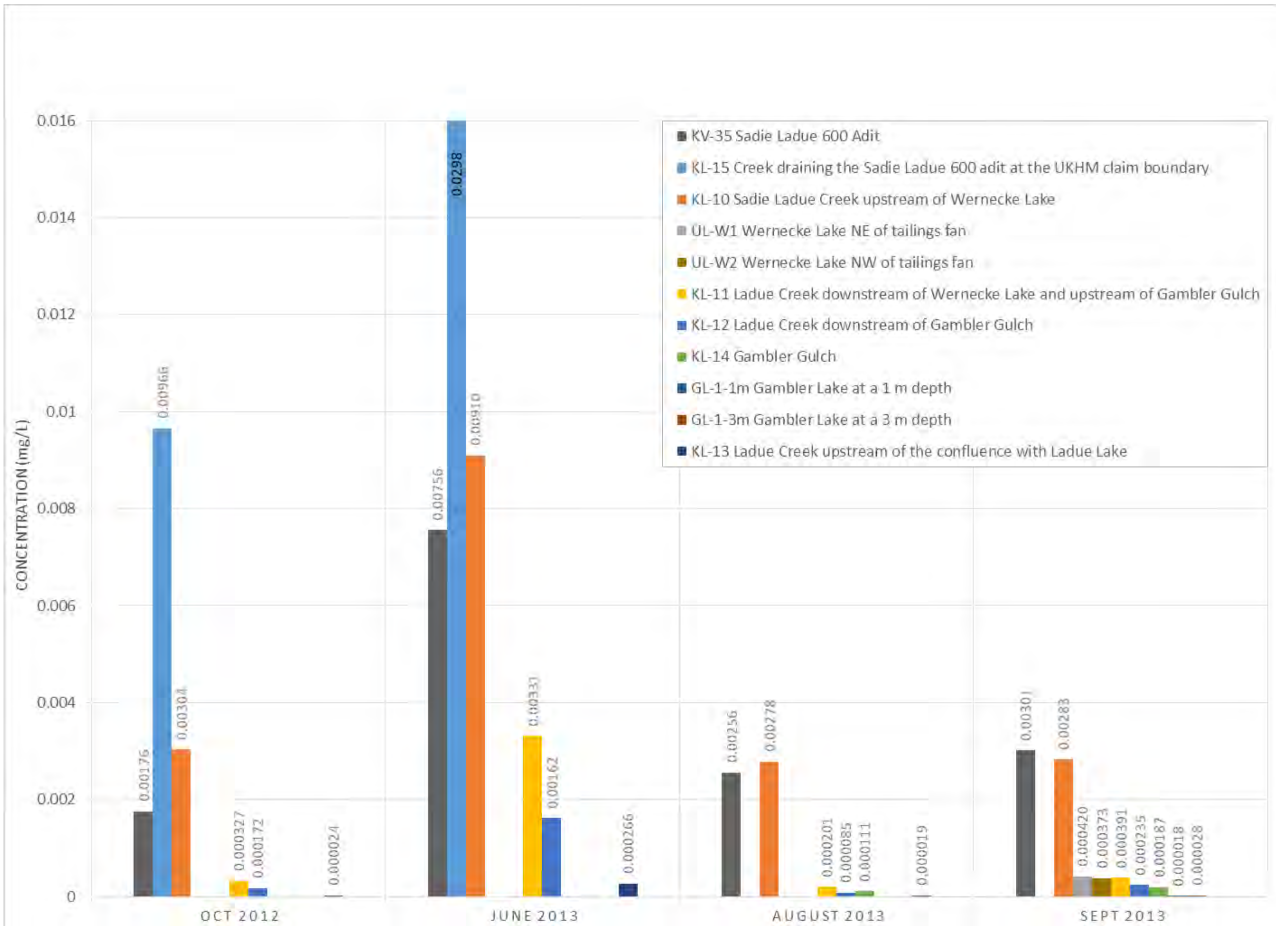


Figure 21: Total Cadmium Concentration – Upper Ladue Watershed

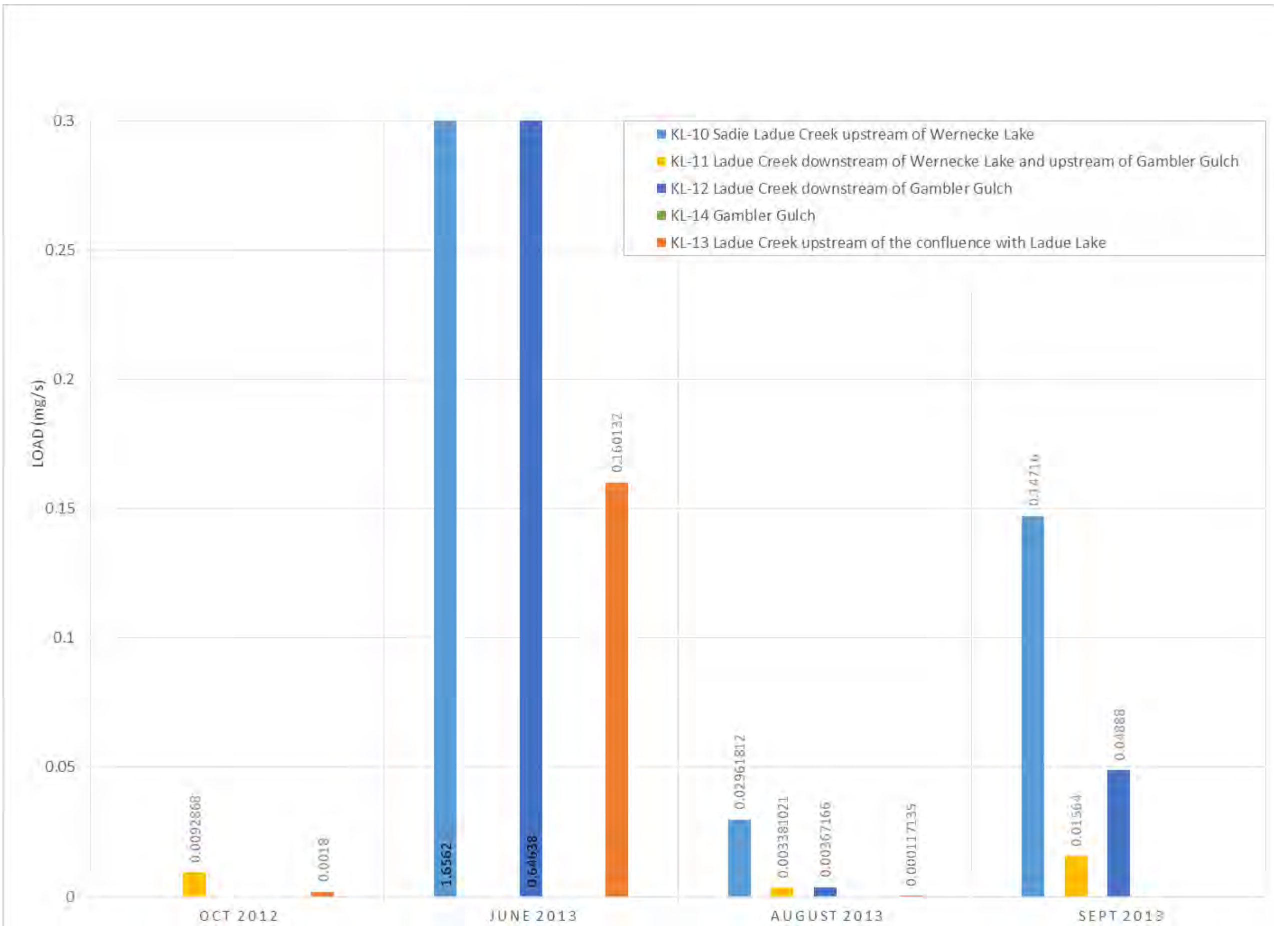


Figure 22: Total Cadmium Loading - Upper Ladue Watershed

6.2.1.6 Total Iron

Figure 23 shows total iron concentration. The Sadie Ladue 600 Adit has lower concentrations of iron than CCME-FAL and background for all sampling events, while KL-10 has the highest concentration of iron of all stations for each sampling event. Only KL-10, KL-11 and KL-12 have sampling events for which iron exceeds CCME. For the September 2013 sampling event, lake concentrations of iron are much lower than for the creek samples, potentially indicating that Wernecke Lake is acting as a sink for iron.

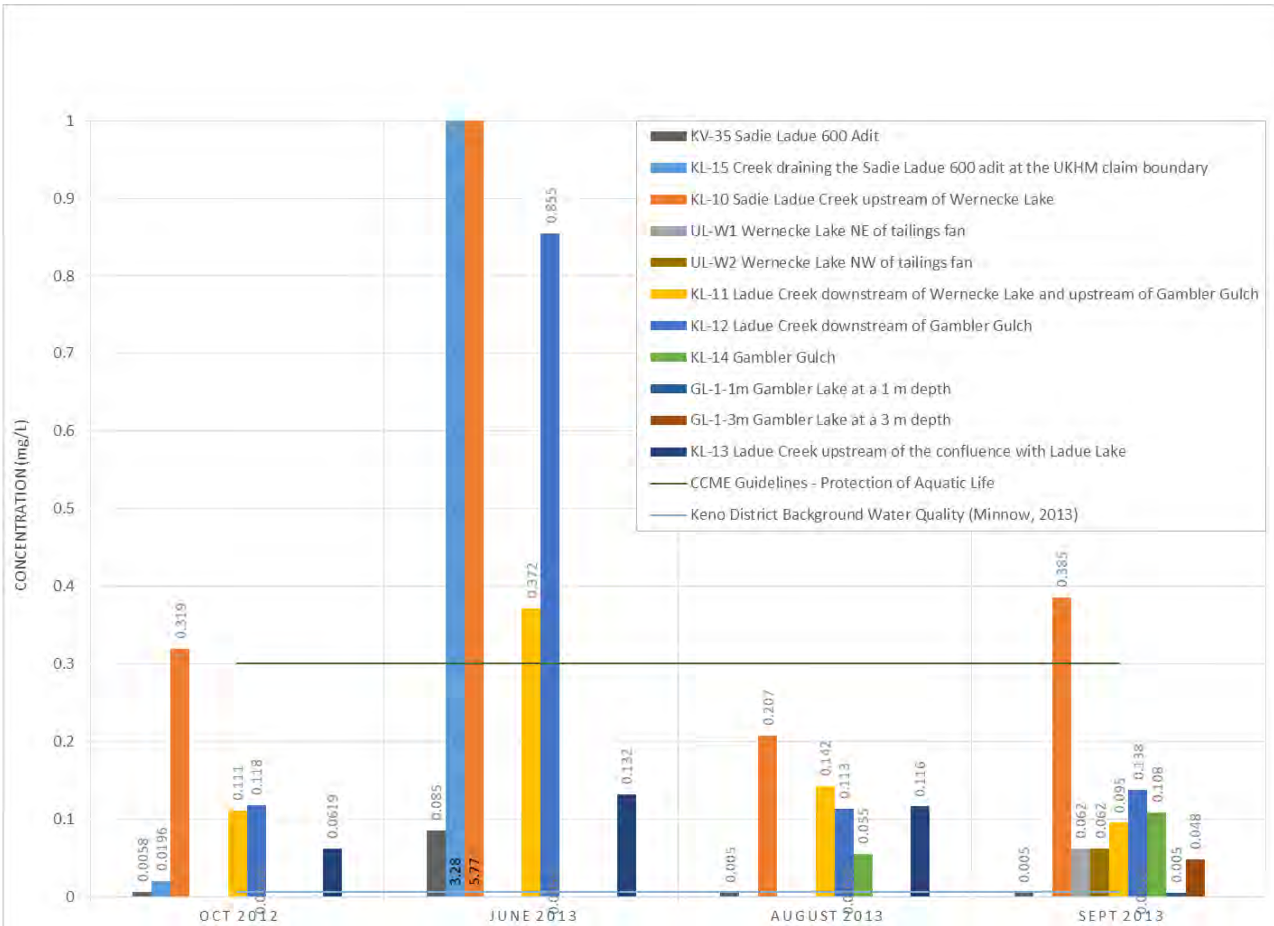


Figure 23: Total Iron Concentration – Upper Ladue Watershed

6.2.1.7 Total Lead

Figure 24 shows total lead concentration. While the June 2013 sampling event mimics the decline in concentration down the drainage of zinc and cadmium, for the three other sampling events, the highest level of lead, above CCME-FAL and background, is KL-11. In addition in the September 2013 sampling event, both of the Wernecke Lake samples (UL-W1 and UL-W3) are also elevated – above CCME and background. This trend possibly results from the influence of the tailings in Wernecke Lake on the water quality in and downstream of the lake.

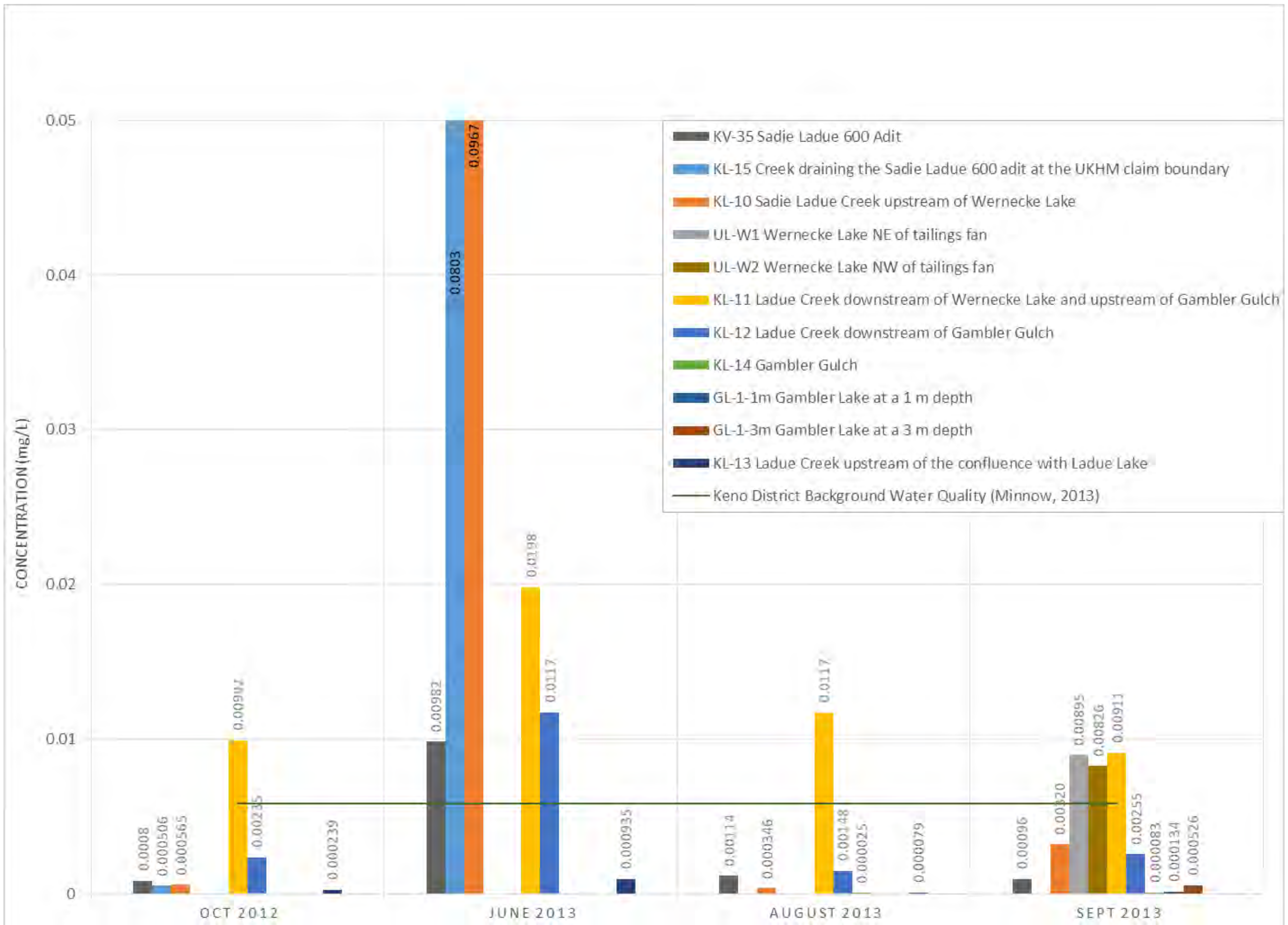


Figure 24: Total Lead Concentration – Upper Ladue Watershed

6.2.1.8 Total Arsenic

Total arsenic concentrations are shown in Figure 25. Most samples are below CCME and background, except for the June 2013 KL-10 samples and the adit samples for the remaining sampling events. A declining trend is not apparent, although some decrease is noted for downstream stations for most sampling events. An exception is the Gambler Lake (GL-1-3m) September 2013 sample, which has a higher arsenic concentration than all other locations except the Sadie Ladue adit.

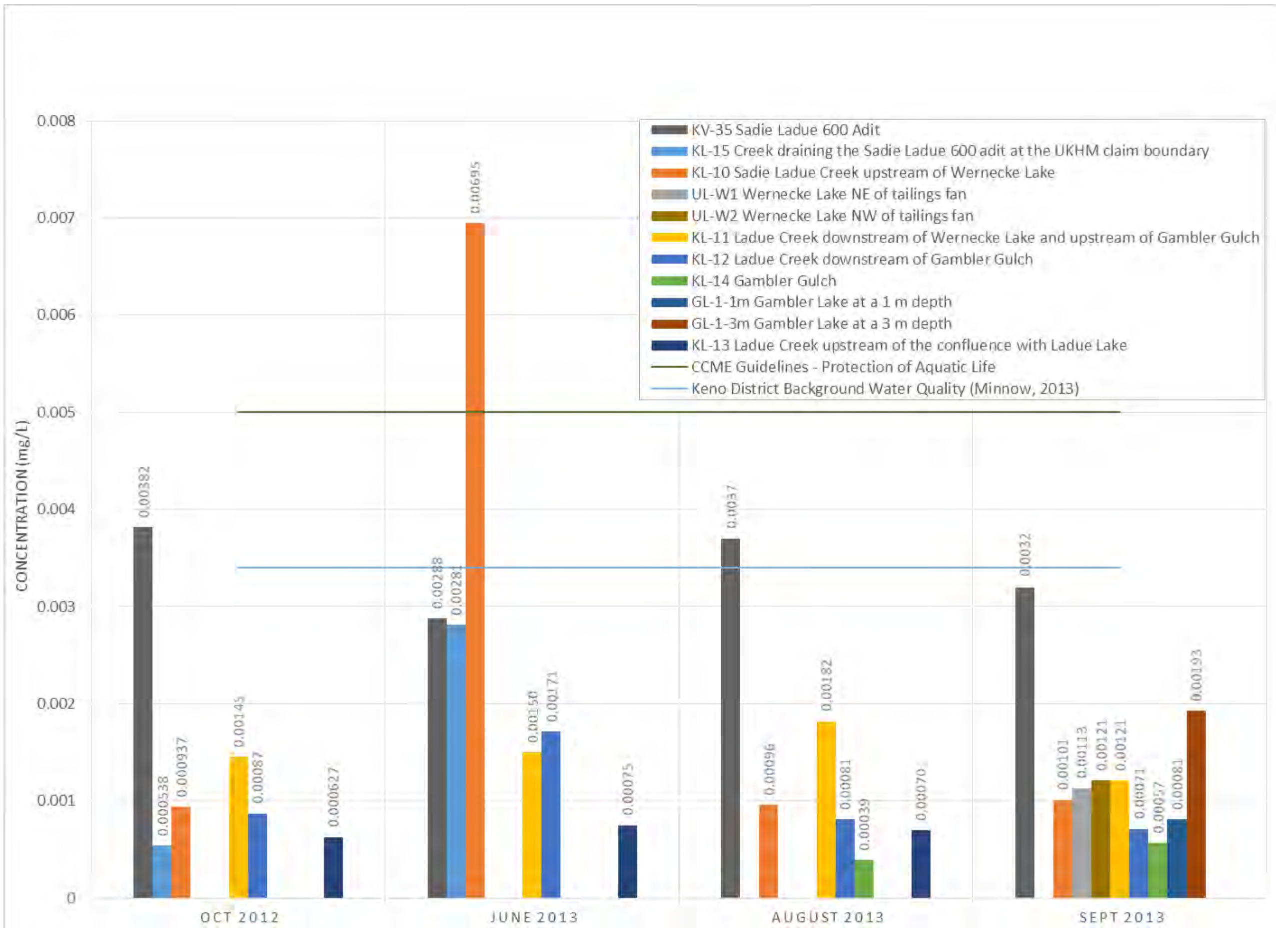


Figure 25: Total Arsenic Concentration – Upper Ladue Watershed

6.2.1.9 Total Silver

Figure 26 shows total silver concentrations. Apart from KL-15, KL-10 and KL-12 for the June 2013 sampling event, and KL-11 for all 2013 samples, all samples are below CCME and background. Similar to total lead concentrations, with KL-11, UL-W1 and UL-W3 having relatively higher concentrations than other samples locations, this trend could result from the influence of Wernecke Lake submerged tailings.

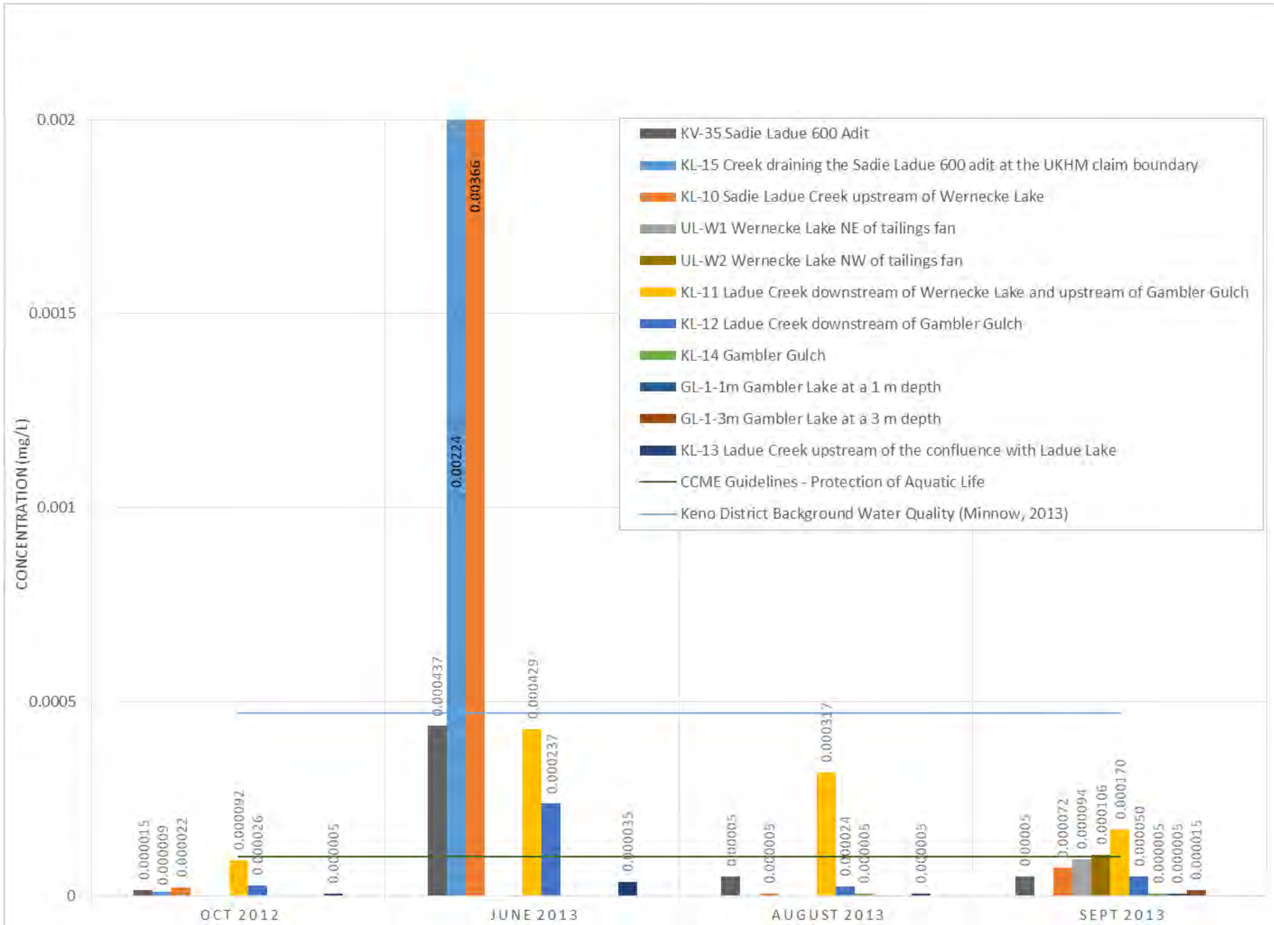


Figure 26: Total Silver Concentration – Upper Ladue watershed

6.2.1.10 Dissolved Metals

Dissolved metals generally follow the trend of total metals, and make-up most of the observed total concentrations. Thus, as concluded in Interralogic (2012a), dissolution is the primary mechanism by which loading occurs.

6.2.2 Lower Ladue Watershed

Quarterly sampling results from the lower Keno Ladue watershed are presented in Appendix C compared with CCME Guidelines for the Protection of Aquatic Life (CCME-FAL) and the Keno District background water quality (Minnow, 2013). The sample stations codes and relative locations are presented in Table 11 below and shown in Figure 27.

Table 11: Lower Ladue Watershed Surface Water Quality Stations

Station Name	Station location description
KL-13	Ladue Creek upstream of the confluence with Ladue Lake
KL-2	Keno Ladue River upstream of Ladue Creek and Ladue Lake
KL-5	Keno Ladue River downstream of Ladue Lake
KL-4	Keno Ladue River downstream of Ladue Lake and upstream of Faro Gulch
KL-8	Faro Gulch
KL-9	Faro Gulch upstream of the confluence with Keno Ladue River
KL-7	McKay Gulch
KL-3	Keno Ladue River upstream of Silver Basin Gulch and downstream of Faro Gulch and McKay Gulch
KL-6	Silver Basin Gulch
KL-1	Keno Ladue River downstream of Silver Basin Gulch

ERDC has collected three quarterly samples in the Keno Ladue watershed as part of the surface water quality monitoring (Special Project 009). The stations in Table 11 are in addition to the upper watershed Keno Ladue stations presented in section 6.2.1.

Plots of concentrations for the six selected analytes are presented in Figures 28 to 33. Samples collected October 19 and 20, 2012 are grouped under the label 'Oct 2012', samples from June 6 and 7, 2013 are grouped under 'June 2013', and samples from August 29 and 30 were grouped under 'August 2013'. No samples were collected in September 2013. As above, select analytes include arsenic, aluminum, cadmium, iron, lead, and zinc and half the RDL was used for analysis when the concentration of an analyte was below the RDL. Some general trends identified in the dataset are discussed in the following sections.

6.2.2.1 pH

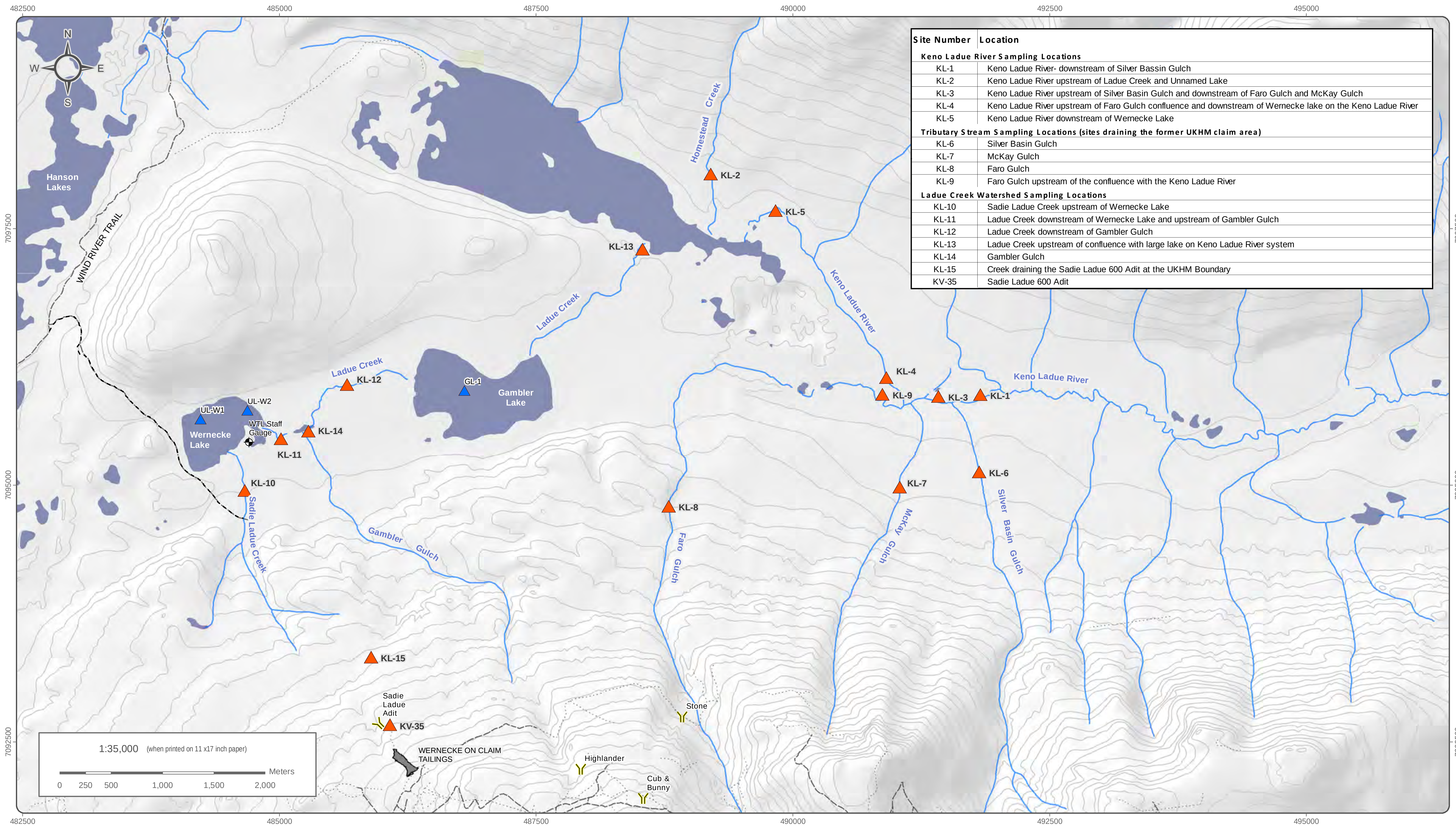
The pH for all stations in the lower Ladue watershed was neutral to slightly alkaline for all sampling events, ranging from 6.94 to 7.91 for field pH.

6.2.2.2 TSS

Total suspended solids levels were highest for all stations for the June 2013 sampling event, as was observed for the upper watershed (section 6.2.1.2). This event was likely associated with a large amount of erosion from spring snowmelt. Lower TSS is observed for the August and October sampling events. Levels of TSS are fairly low in the creeks entering Ladue Lake (KL-13, KL-2, and KL-5), and the Keno Ladue River exiting the lake (KL-4). Higher TSS is observed on Faro Gulch, McKay Gulch and Silver Basin Gulch, contributing to higher TSS downstream on the Keno Ladue River.

6.2.2.3 Specific Conductance

Specific conductance ranged from 71.8 (KL-2 in June 2012) to 934.5 µs/cm (KL-6 in Oct 2012). As in the upper watershed, measurements for June 2013 were low. For the other two sampling events specific conductance tended to be lowest on KL-2 and highest on Faro Gulch, McKay Gulch and Silver Basin Gulch.



Site Number	Location
Keno Ladue River Sampling Locations	
KL-1	Keno Ladue River- downstream of Silver Bassin Gulch
KL-2	Keno Ladue River upstream of Ladue Creek and Unnamed Lake
KL-3	Keno Ladue River upstream of Silver Basin Gulch and downstream of Faro Gulch and McKay Gulch
KL-4	Keno Ladue River upstream of Faro Gulch confluence and downstream of Wernecke lake on the Keno Ladue River
KL-5	Keno Ladue River downstream of Wernecke Lake
Tributary Stream Sampling Locations (sites draining the former UKHM claim area)	
KL-6	Silver Basin Gulch
KL-7	McKay Gulch
KL-8	Faro Gulch
KL-9	Faro Gulch upstream of the confluence with the Keno Ladue River
Ladue Creek Watershed Sampling Locations	
KL-10	Sadie Ladue Creek upstream of Wernecke Lake
KL-11	Ladue Creek downstream of Wernecke Lake and upstream of Gambler Gulch
KL-12	Ladue Creek downstream of Gambler Gulch
KL-13	Ladue Creek upstream of confluence with large lake on Keno Ladue River system
KL-14	Gambler Gulch
KL-15	Creek draining the Sadie Ladue 600 Adit at the UKHM Boundary
KV-35	Sadie Ladue 600 Adit

National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Map Projection: UTM Zone 8N

Lake Water Monitoring Station (Wernecke off claim investigation only)

Creek Water Monitoring Station

Adit

Watercourse (from 2006 Aerial Imagery)

Track

Trail

Contours (100 ft intervals)

ERDC

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WERNECKE TAILINGS INVESTIGATION

FIGURE 27
KENO LADUE WATER QUALITY MONITORING STATIONS

NOVEMBER 2013

I:\ALEX-05-01\gis\mxd\UKHM\Overview_Maps\WQ\02-SURFACEWATER\specific\Keno-Ladue-Wernecke\Proposed Keno Ladue Watershed Surface Water Quality Monitoring 20131113.mxd
(Last edited by: jpan; 11/18/2013/15:57 PM)

6.2.2.4 Total Zinc

Total zinc concentrations are shown in Figure 28 for the 3 sampling events and 9 sample locations. The June 2013 samples appear higher in zinc than the other two sampling events, similar to the upper watershed samples, with KL-13, KL-3 and KL-1 exceeding background and CCME. The 4 samples from Faro Gulch exceed background, but only the upper station (KL-9) also exceeds CCME in August 2013. Zinc concentrations decline from KL-13 to KL-4, after which the contribution from Faro Gulch (KL-8 and KL-9) appears to increase the concentration of zinc at KL-3, with little influence of McKay Gulch (KL-7). Finally, the contribution of Silver Basin Gulch appears to have little impact on the final water quality at KL-1. Thus, in the lower Ladue watershed, despite the zinc reduction from Ladue Lake, Faro Gulch contributes to an increase in zinc concentration in the Keno Ladue River. Faro Gulch is impacted by historical mining which is independent of the Wernecke camp and tailings.

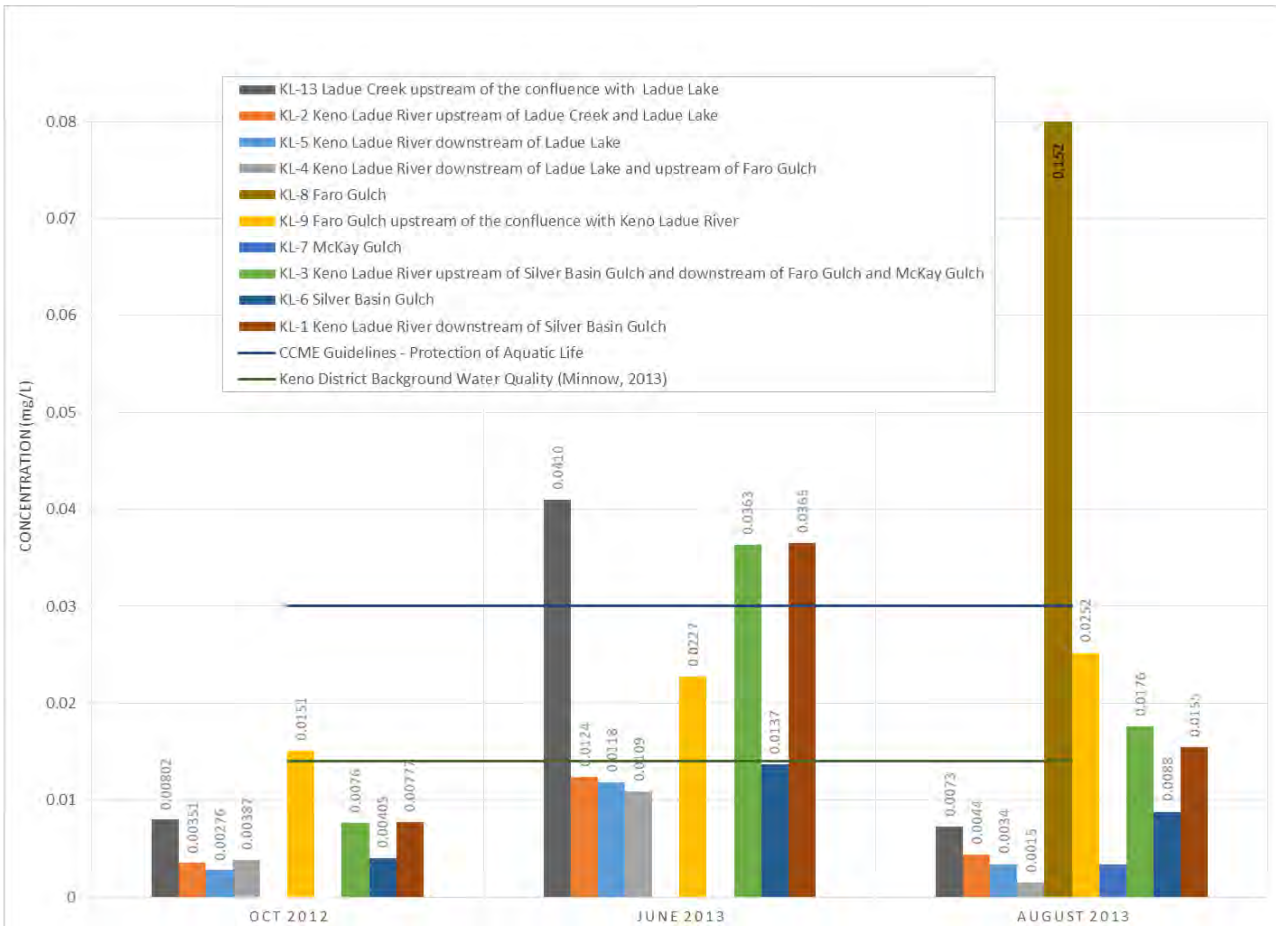


Figure 28: Total Zinc Concentration – Lower Ladue Watershed

6.2.2.5 Total Cadmium

Total cadmium concentrations are shown in Figure 29. Cadmium follows a similar trend to zinc for the June sampling event, however, for both October 2013 and August 2013 KL-13 cadmium concentration is lower than most stations except KL-4 and KL-5. Faro Gulch (KL-8 and KL-9) again contributes to increase cadmium concentrations downstream, while Silver Basin also has little impact on the final water quality at KL-1. For the June sampling event, most stations exceed CCME, and KL-13, KL-6, KL-3 and KL-1 exceed background, representing high levels on the Keno Ladue River, but less so for the downstream tributaries (apart from KL-6). In contrast for the August 2013 sampling event is it the tributaries – KL-8, KL-9 and KL-6 which have the highest levels of cadmium, above background and CCME, while only the downstream Keno Ladue River locations have high levels of cadmium, above CCME but not background.

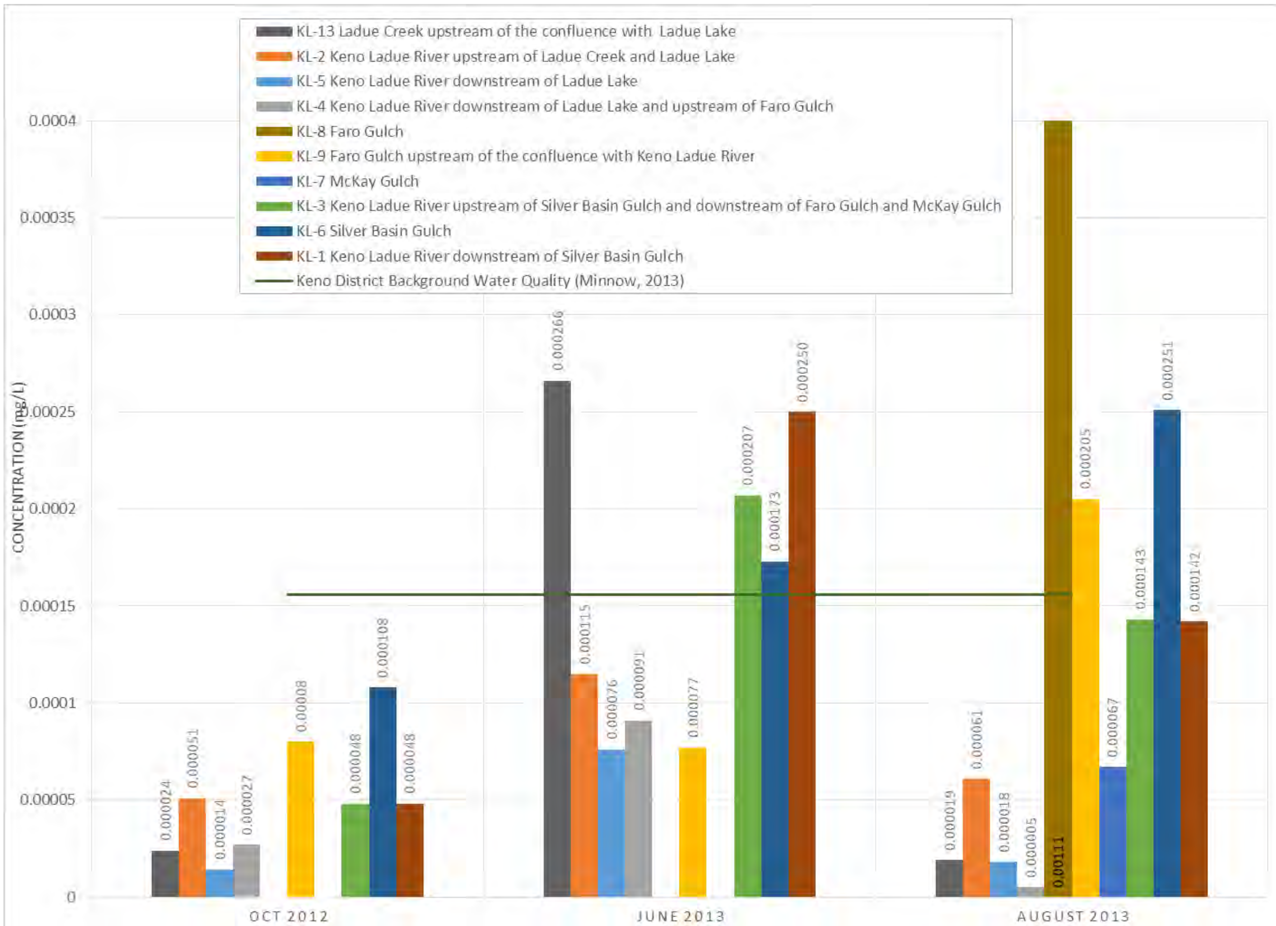


Figure 29: Total Cadmium Concentration – Lower Ladue Watershed

6.2.2.6 Total Iron

Figure 30 shows total iron concentrations. Iron concentrations appear to increase down the drainage with high levels in Silver Basin Gulch. The June 2013 sampling again experiences the highest levels of iron, with levels above CCME and baseline for most stations (except KL-13 and KL-5).

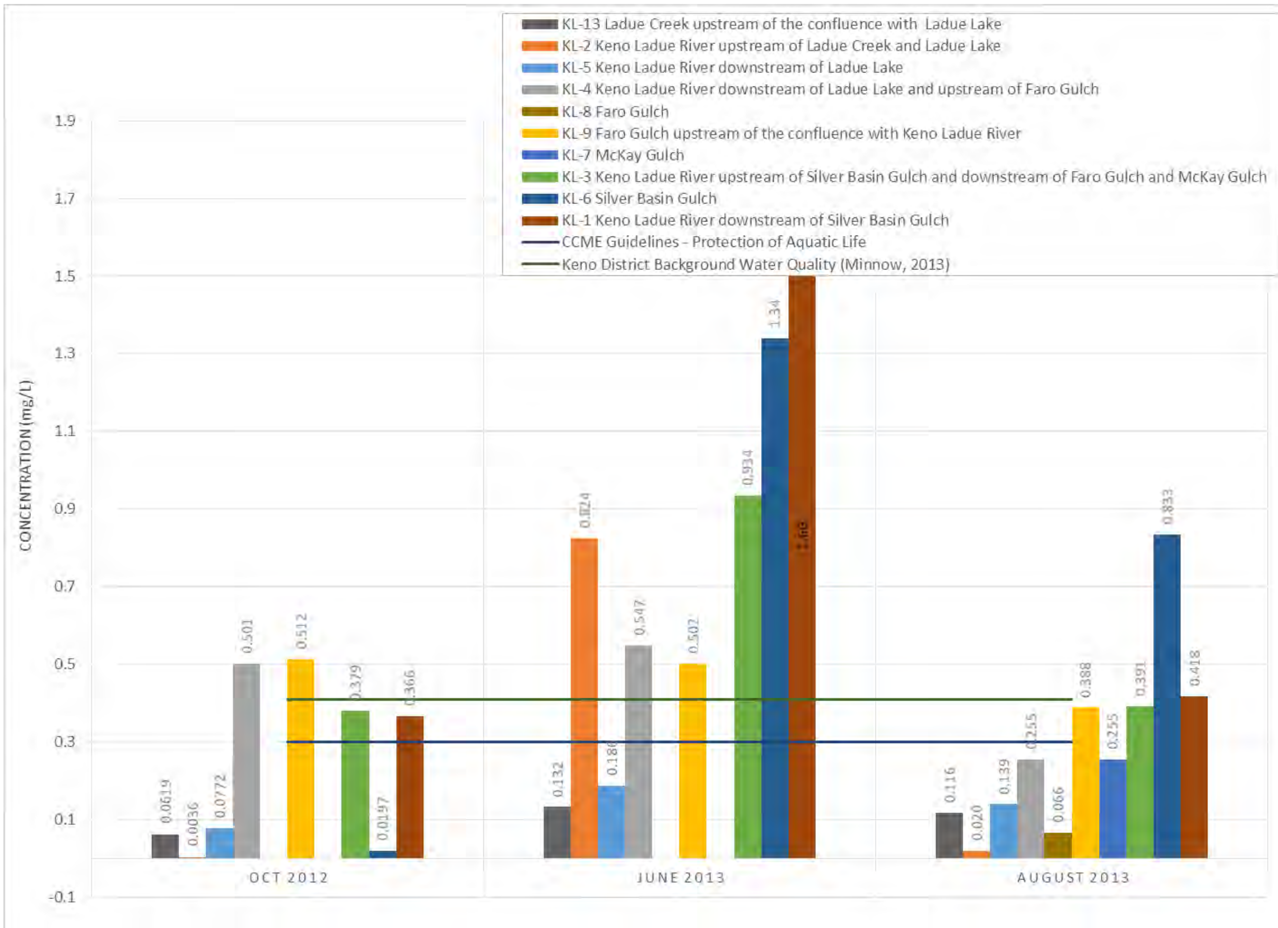


Figure 30: Total Iron Concentration – Lower Ladue Watershed

6.2.2.7 Total Lead

Figure 31 shows total lead concentration. While the October 2012 event shows some increase at KL-3 after Faro Gulch, lead concentrations tend to decrease to KL-1. In contrast for both the June and August 2013 events, higher levels on Faro Gulch and Silver Basin Gulch tend to results in increased lead concentrations downstream. Only the June KL-9, KL-6 and KL-2 samples exceed CCME, while no samples exceed background.

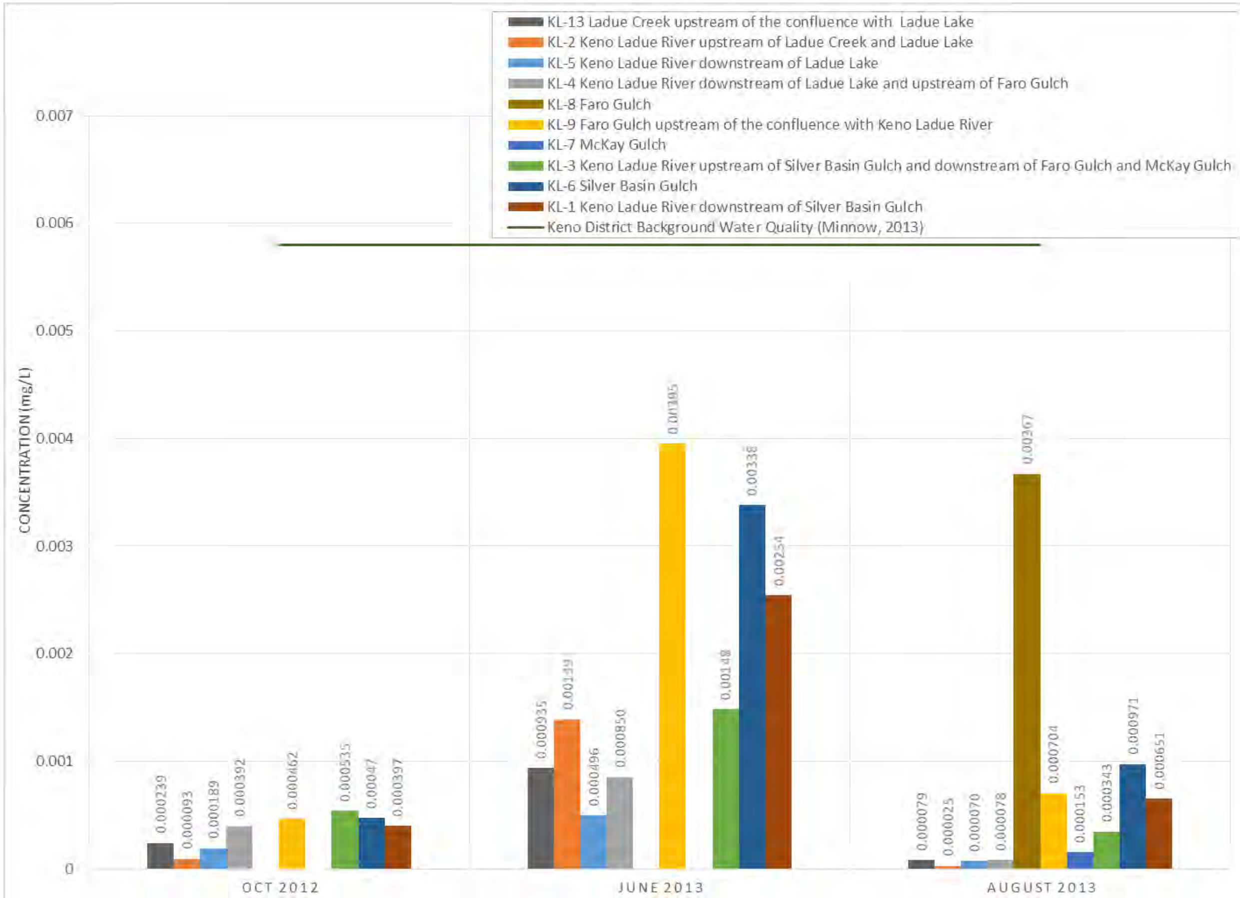


Figure 31: Total Lead Concentration – Lower Ladue Watershed

6.2.2.8 Total Arsenic

Total arsenic concentrations are shown in Figure 32. Most samples are below CCME and background, except for the June 2013 KL-6 sample. An increase in arsenic concentration downstream through the drainage occurs in June and August 2013 with increasing levels from KL-2 to KL-4 to KL-3. High arsenic at KL-6 in June results in high levels at KL-1, while lower levels at KL-6 in August results in lower levels in KL-1.

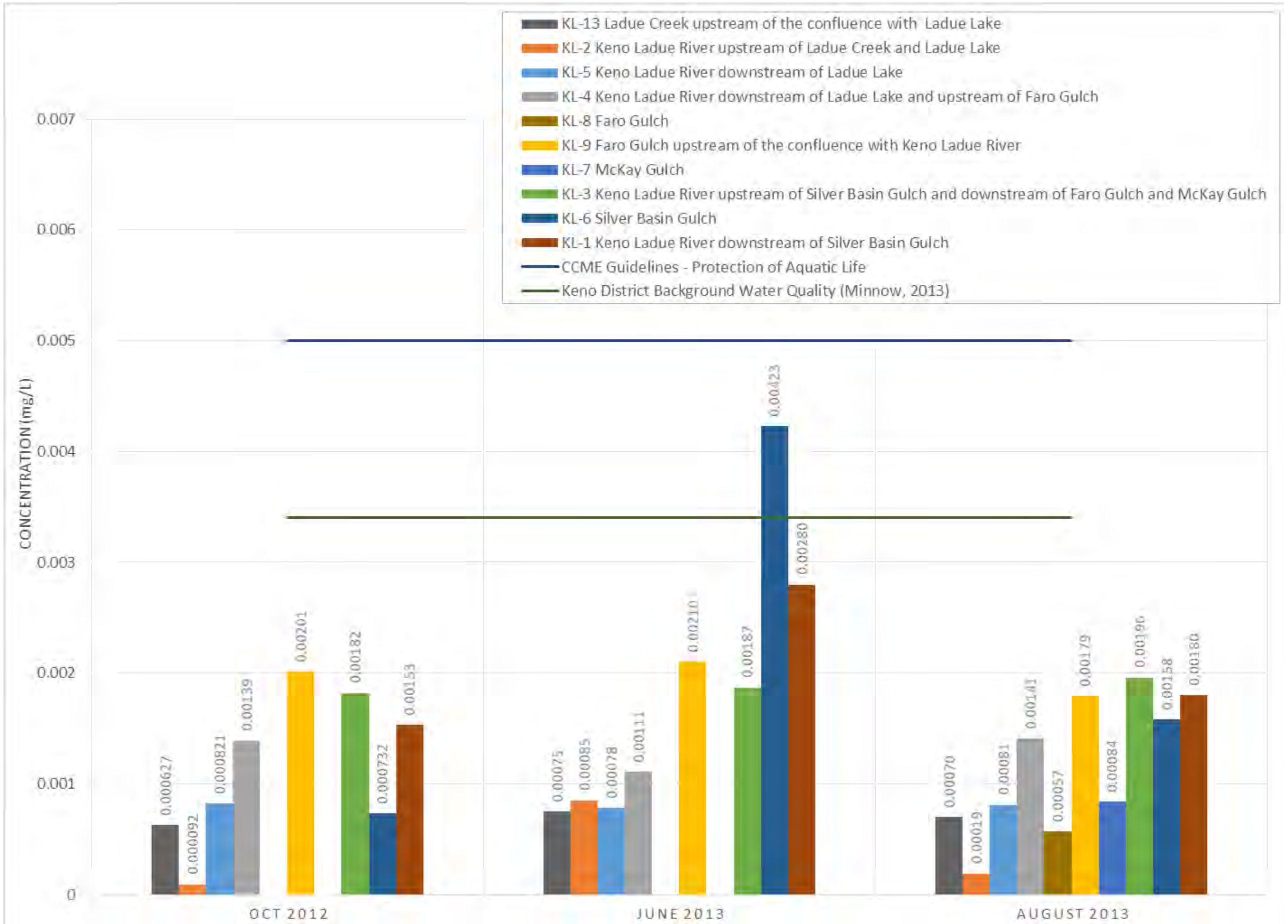


Figure 32: Total Arsenic Concentration – Lower Ladue Watershed

6.2.2.9 Total Silver

Figure 33 shows total silver concentrations. All samples are below CCME and background. The June 2013 samples are again higher than the October 2012 or August 2013 samples, with high levels on Faro Gulch and Silver Basin Gulch, and increasing concentrations downstream on the Keno Ladue River system. For October 2012 and August 2013 most samples are below detection limit.

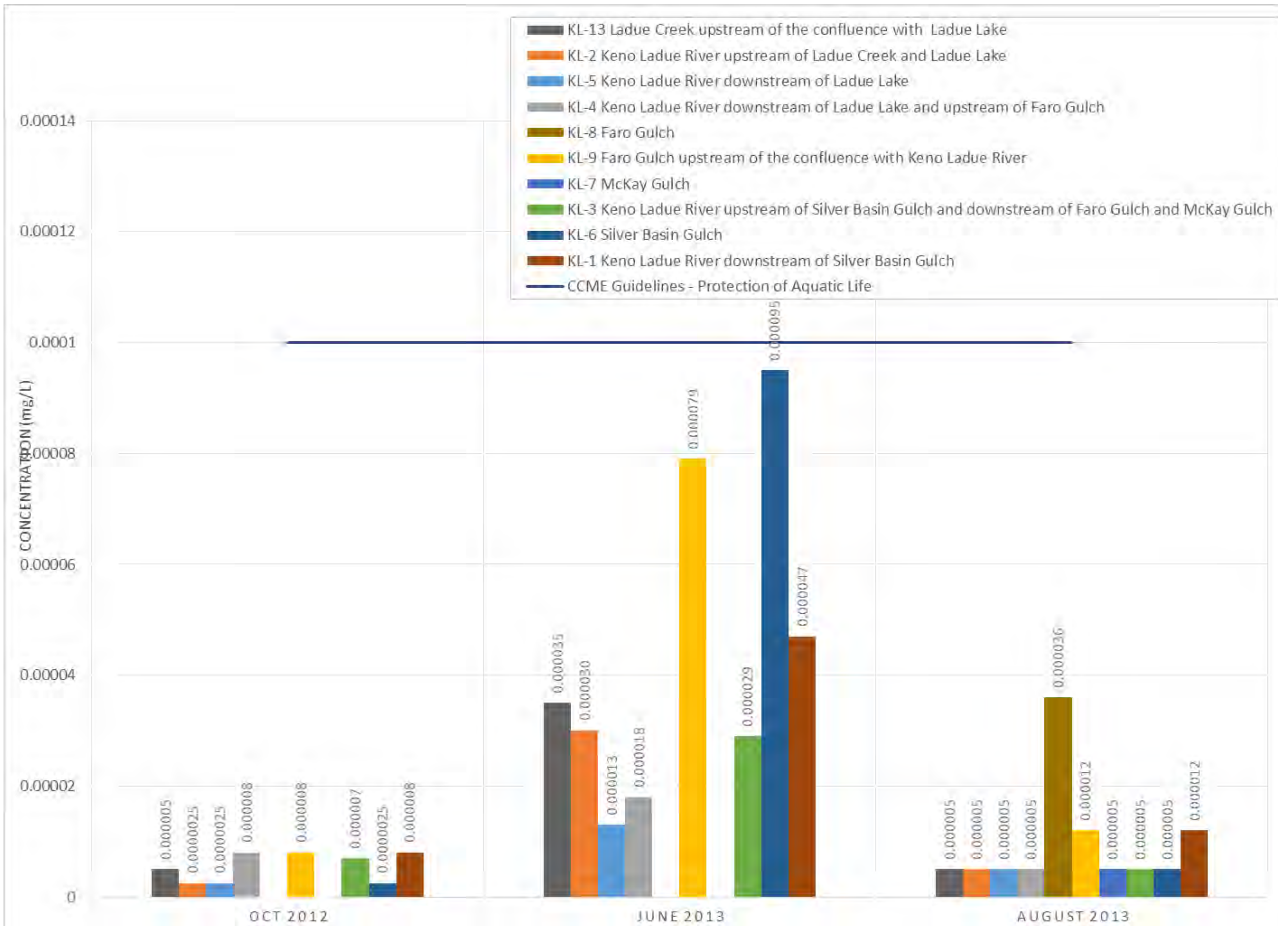
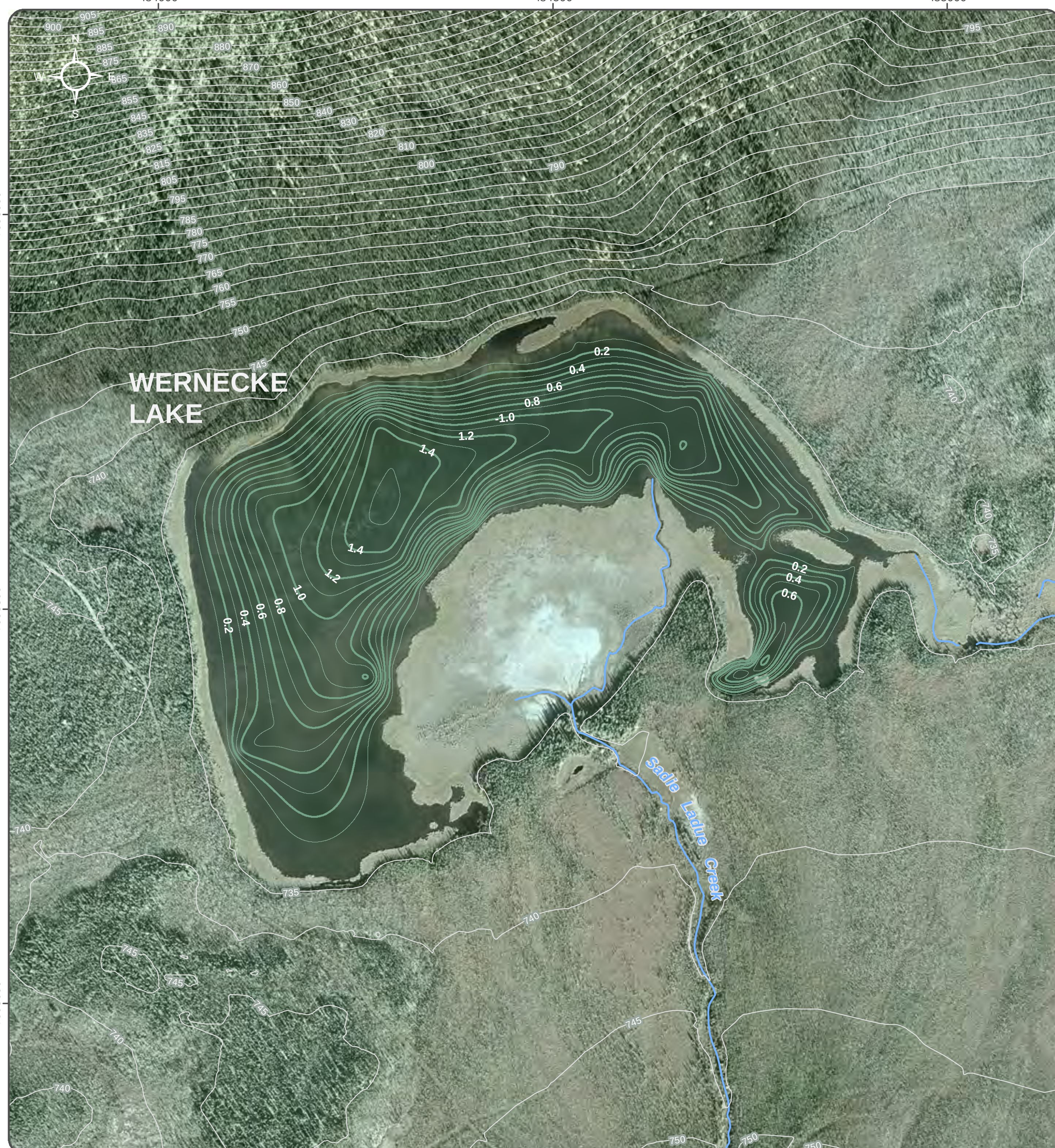


Figure 33: Total Silver Concentration – Lower Ladue Watershed

6.3 BATHYMETRY

Using the bathymetric measurements and estimates, and ESRI Spatial Analyst, a model of Wernecke Lake bathymetry was created and is shown in Figure 34.

Using the Wernecke Lake bathymetry model, pre-tailings deposition (circa 1920) lake bathymetry was inferred, and is shown Figure 35.



Depth Contour (metres)
Contours (5 metre Intervals)

1:7,000 *When printed on 8 1/2 by 11 inch paper*

Meters
0 100 200 300 400

Aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Imagery acquired September 13th and 14th 2006. Site hydrography 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta. Bathymetry data generated from 65 depth measurments and 12 depth estimates (collected September 26th 2013 and using ESRI ArcGIS Spatial Analyst toolset.

Map Datum: NAD83; Projection UTM Zone 8N

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WERNECKE TAILINGS INVESTIGATION

FIGURE 34
WERNECKE LAKE BATHYMETRY

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(*Last edited by: jpan; 11/15/2013/14:42 PM*)

— Depth contour (metres)
— Contours (5 metre Intervals)

1:7,000 *When printed on 8 1/2 by 11 inch paper*

Meters
0 100 200 300 400

Aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Imagery acquired September 13th and 14th 2006. Site hydrography 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta. Bathymetry data generated from 65 depth measurments and 12 depth estimates (collected September 26th 2013 and using ESRI ArcGIS Spatial Analyst toolset.

Map Datum: NAD83; Projection UTM Zone 8N

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WERNECKE TAILINGS INVESTIGATION

FIGURE 35

HYPOTHETICAL PRE-TAILINGS WERNECKE LAKE BATHYMETRY

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(*Last edited by: jpan; 11/15/2013/14:44 PM*)

Using the two bathymetry models, the volume of tailings in Wernecke Lake was estimated. Depth to water measurements in soil pits on the tailings delta were used to estimate the volume of tailings in the tailings delta (above water). The estimation and the associated assumptions as described in the following section.

6.4 VOLUME OF TAILINGS

Volume estimates were prepared for dispersed tailings deposits originating from the Wernecke mill tailings. The volume of tailings in pods, submerged in Wernecke Lake, and in the Wernecke Lake tailings delta are presented in the following subsections.

6.4.1 Tailings Pods

The volume of the seven tailings pods described in section 6.1.1 were estimated, the results of which are described below.

The area of each pod was calculated using a GPS tracking function. The depth of tailings in each of the pods is not known, however, PWGSC (2000) noted the depth of tailings in the tailings impoundment to be 1 to 2.5 m and Interralogic (2012a) concluded that dispersed tailings occur with decreasing depth and extent in steeper areas with higher erosional energy. Based on the average slope of the pod and adjacent soil pits, the depth of tailings in each pod was estimated, allowing the calculation of an estimated volume of tailings for each tailings pod. The resulting area, estimated average depth of tailings, and estimated volume of each pod is provided in Table 12. Of note, both Pod 6 and Pod 7 are primarily on the UKHM claims, with small lobes beyond the claim boundary.

Table 12: Estimated Volume of Tailings in Tailing Pods

Pod	Area of Pod (m^2)	Average Slope (%)	Adjacent Soil Pits	Average depth of soil pits (m)	Estimated Average Depth of Tailings (m)	Estimated Volume of Tailings (m^3)
POD1	981	3.3	WDT-WT2-3 & WDT-PT3	0.60	1.2	1,177
POD2	246	8.7			1.0	246
POD3	37	13.0	WDT-WT1-3	0.60	1.0	37
POD4	142	11.1			1.0	142
POD5	487	11.0	WDT-PT1	0.35	0.7	341
POD6	15,021	16.7	WDT-PT6	0.50	0.7	10,515
POD7	18,933	18.8	WDT-PT7, WDT-PT8, WDT-PT9, WDT-WDTLAND-POD7	0.27	0.5	9,467
Total	35,847					21,924

The total estimated volume of tailings in pods along the drainage is 21,924 m^3.

6.4.2 Submerged Tailings in Wernecke Lake

Current and hypothetical pre-tailings deposition (circa 1920) Wernecke Lake bathymetry were modelled such that the difference in lake volumes could be used to estimate the volume of submerged tailings in the lake. A cross section of the lake, from A to A' to B' (Figure 36a) is shown (Figure 36b), indicating the estimated volume of tailings.

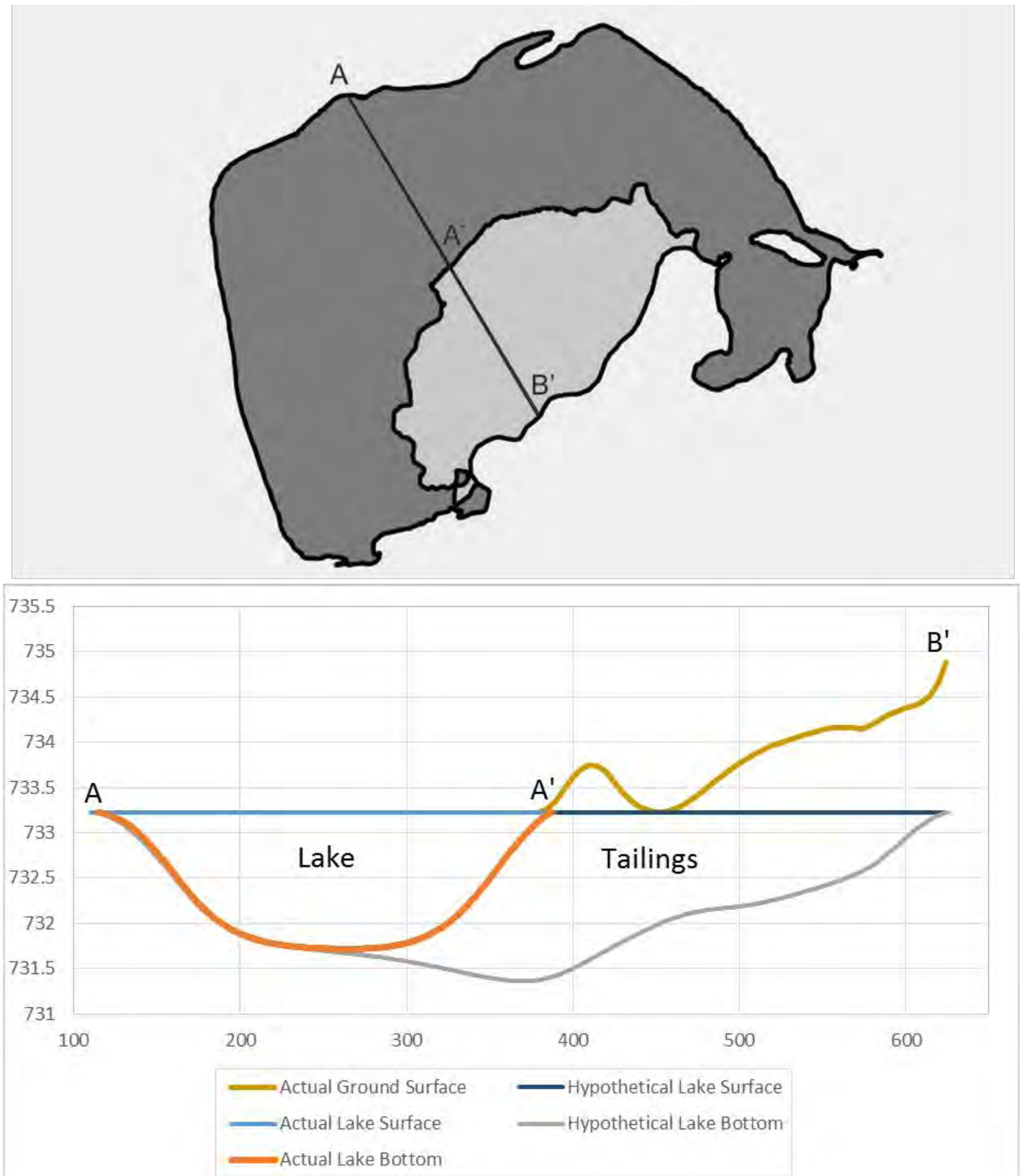

Figure 36: Wernecke Lake Cross Sections

Two different methods were used to estimate the current and pre-tailings deposition volume of Wernecke Lake. The Triangular Irregular Networks (TIN) method is a digital means to represent surface morphology. It uses vertices (points) to construct a series of edges to form a network of triangles using Delaunay triangulation. The Topo to Raster method is an interpolation method specifically designed for the creation of hydrologically correct digital elevation models. It is based on the ANUDEM program (ESRI, 2013).

The resulting estimated volumes of Wernecke Lake, and the estimated volume of tailings in the lake are shown in Table 13. Averaging the two methods, an estimated volume of subaqueous tailings of 144,081 m^3 is obtained.

Table 13: Estimated Volume of Tailings in Wernecke Lake (submerged)

Method	Pre-Tailings Deposition Lake Volume (m^3)	Current Lake Volume (m^3)	Volume of Tailings (m^3)
TIN method	272,099	114,991	157,108
Topo to raster Method	278,093	147,040	131,053
Average	275,096	131,016	144,081

6.4.3 Tailings Delta

The tailings delta in Wernecke Lake covers an area of 97,257 m^2. Depth to water measurements from the UL1, UL2, UL3 and UL4 transect soil pits on the tailings delta were used to estimate the volume of tailings in the tailings delta (above water). Figure 37 shows the measurements and their locations on the delta. The deepest depth to water measured was 0.63 m at ULX-1, which is close to where Sadie Ladue Creek exits the forest. Depth to water decreases outward from this point, to the edges of the tailings delta which are partially submerged in water. A depth of 0.4 m was assumed for the entire tailings delta, resulting in a volume of tailings of 38,903 m^3.

◇ Depth to water reading
Contours (5 metre Intervals)

1:5,500 *When printed on 8 1/2 by 11 inch paper*

Meters
0 100 200 300 400

Aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Imagery acquired September 13th and 14th 2006. Site hydrography 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta. Bathymetry data generated from 65 depth measurments and 12 depth estimates (collected September 26th 2013 and using ESRI ArcGIS Spatial Analyst toolset.

Map Datum: NAD83; Projection UTM Zone 8N

ERDC

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WERNECKE TAILINGS INVESTIGATION

FIGURE 37

DEPTH TO WATER ON THE TAILINGS DELTA

I:\ALEX-05-01\gis\mxd\UKHM\Studies\WerneckeTailings-SadieLadue\Fall 2013 Report\Fig-37-DepthWater_20131115.mxd
(*Last edited by: jpan; 11/15/2013/14:47 PM*)

6.4.4 Total Estimated Dispersed Tailings Volume

The total volume of dispersed tailings estimated from tailings pods, submerged tailings in Wernecke Lake, and the tailings delta in the recent Wernecke Tailings Investigation is presented in Table 14.

Table 14: Estimated Total Volume of Tailings

Location	Estimated Volume of Tailings (m^3)		
	Low Range	Average	High Range
Tailings Pods	21,924	21,924	21,924
Subaqueous Tailings	131,053	144,081	157,108
Tailings Delta	38,903	38,903	38,903
Total	191,880	204,907	217,935

The total estimated volume of tailings using the above-described measurements and calculations ranges from 191,880 to 217,935 m^3 with an average of 204,908 m^3. This estimate also does not include the upslope tailings impoundment, which Interralogic (2012a) estimated to be 1170 m^3, however, the upslope tailings deposit of 18,135 m^2 appears to be included (POD 6 and some of POD7). With the tailings impoundment included the total estimated volume of tailings would be 206,078 m^3 on average. This estimate is high compared to the Interralogic's (2012a) estimate of 122,165 m^3 of tailings deposited, calculated from the 244,330 tonnes of ore that were processed from the Wernecke mill (assuming a 25% recovery, and an average density of 1.5). The 70% increase in tailings volume estimated from tailings pods, the tailings delta and submerged in Wernecke Lake, likely results from the fact that the dispersed tailings while being transported down the Sadie Ladue drainage have been thoroughly mixed with natural sediment, as evidenced by the interbedded sands and silts observed in the soil pits both in the drainage and on the tailings delta.

7 CONCLUSIONS & CLOSURE CONSIDERATIONS

The presence of tailings pods throughout the Sadie Ladue drainage, in addition to the confirmation of the presence of tailings in the delta and dispersed throughout Wernecke Lake has allowed a rudimentary estimation of tailings, both in areal coverage and volume. The lack of elevated metal concentrations outside the Sadie Ladue Creek channel implies that tailings were transported directly within the channel and have not widely dispersed in the alluvial fan above Wernecke Lake. Likewise, the water chemistry confirms that impacts from the Sadie Ladue adit and tailings, are generally confined to Wernecke Lake and the Ladue Creek above Gambler Lake.

The following summarizes the findings of the various investigation tasks:

Spatial Distribution and Condition of Dispersed Tailings

- Tailings were identified within seven tailings pods delineated along the Sadie Ladue drainage, within the active stream channel of Sadie Ladue creek, and within the tailings delta and sediments of Wernecke Lake;

- Early pioneering plant species are colonizing outward from the edge of undisturbed areas into the tailings delta at Wernecke Lake and tailings pods within the Sadie Ladue creek stream channel and confined flood plain;

Soil and Sediment Sampling

- ICP trace metals results for tailings sampling showed that for all of the elements for which CCME Sediment Quality Guidelines for the protection of freshwater aquatic life exist (As, Cd, Cu, Pb, Hg, Zn), at least 72% of samples exceeded the guideline;

- COPC metals were elevated within the Ladue Creek stream channel (and tailings pods) and in the tailings delta where tailings were known and expected. This implies that tailings have not widely dispersed in the alluvial fan above Wernecke Lake and are generally confined to the Sadie Ladue Creek stream channel, associated tailings pods, and Wernecke Lake;

- COPC metal concentrations within tailings sediments throughout Wernecke Lake were generally similar to samples collected in tailings delta and pods within Sadie Ladue Creek. This implies that tailings and/or dissolved metals have been well distributed throughout Wernecke Lake. The relatively low concentration of metals in Gambler Lake imply that large scale transport of tailings and/or dissolved metals seems to be limited to Wernecke Lake;

- As was noted above, comparison of tailings and sediment sample metal concentrations to reference values shows that many of the COPC elements (Se, Cd, As, Ag, Zn, Pb) even the relatively low samples (i.e. those outside the Sadie Ladue creek channel above Wernecke Lake) can contain significant metal concentrations of COPC elements, generally above CCME Sediment Quality Guidelines and above 10x Crustal Abundance. This may reflect trace tailings deposition from wind, or may simply reflect elevated background concentrations downgradient of mineralized areas;

- 67% of samples had NPRs of >2, indicating the majority of the tailings material is unlikely to generate net acidity. Four of five sediment samples had NPR of 1 or less, while all four tailings delta samples had NPR of 2 or greater. 10 of 15 creek/pod samples had an NPR of > 2 with four samples between 1 and 3 with one sample with NPR less 1;

- Al, As, Cd, Cr, Co, Cu, Fe, Pb, Hg, Se, Ag and Zn exceeded CWQG in the SFE tests in greater than 10% of the samples. This indicates that the Wernecke dispersed tailings may have potential for leaching of these elements and that pore water currently present is likely to have elevated concentration of these metals;

- Total contained metal concentrations correlate weakly with leachable metal concentrations for most COPCs. Samples with elevated pH (>7.5) may indicate some suppression of dissolved metal concentrations for some COPCs;

Water Quality

- Despite the presence of elevated levels of zinc and cadmium in Wernecke Lake, zinc and cadmium attenuation and/or dilution appears to occur from the Sadie Ladue adit to the outlet of Gambler Lake;

- Lead and silver concentrations appear to be quite high in and leaving Wernecke Lake relative to both upstream and downstream concentrations for most sampling events, indicating that the presence of tailings in the lake may be influencing the concentration of these metals. Lower levels of iron in the lake may indicate that Wernecke Lake is acting as a sink for iron and other metals;

- In the Lower Ladue Watershed, despite a reduction in zinc downstream of Ladue Lake, Faro Gulch appears to contribute to an increase in zinc concentrations in the Keno Ladue River. In contrast elevated cadmium concentrations are observed downstream linked both to high concentrations in the Upper Ladue Watershed and high concentrations in the downstream tributaries;

- In the upper watershed zinc and cadmium concentrations exceeded CCME-FAL and background for most samples, while iron, lead, silver and arsenic concentrations were below these thresholds for the majority of the samples. The lower watershed generally had lower concentrations of these metals with the majority of samples below CCME and/or background even for zinc and cadmium;

- Seasonally, the June sampling event saw the highest levels of metals and TSS, while August, September and October sampling events had lower concentrations both in the Upper and Lower Ladue Watershed;

Bathymetry

- Depth measurements and estimates were used to create a bathymetry model of Wernecke Lake, and to infer the lake bathymetry prior to the deposition of the Wernecke dispersed tailings. These models were used to estimate the volume of tailings in the lake, assuming that the difference in volume was equal to the volume of tailings;

Tailings Volume

- The total estimated volume of tailings determined from this investigation ranges from 191,880 to 217,935 m^3 with an average of 204,908 m^3. Including the upslope tailings impoundment the total estimated volume of tailings would be 206,078 m^3 on average; and

- This volume is high compared to previous estimates calculated from the ore processed from the Wernecke mill, however the increased tailings volume calculated from dispersed deposits likely results from the fact the dispersed tailings were mixed with natural sediment while being transported down the Sadie Ladue drainage.

Considerations for closure include:

- Tailings pods and the tailings delta in Wernecke Lake have partially revegetated naturally and stabilized over the last 80 years. This progression can serve as a solid basis for understanding what nutrients and plant species will succeed in future reclamation planning for the area;

- The area is remote and access is currently limited given the dense vegetation and distance from currently active roads. This is true both from the Wernecke mill down to Wernecke Lake, and from the Wind River Trail/Hanson Lake Road to Wernecke Lake. Any heavy equipment that would be required for closure would require construction of significant access road(s), with associated impacts that would bring. Much of the area is peat bog and underlain by permafrost, which would be impacted by access roads and construction activities;

- The small pods of tailings down near Wernecke Lake are sufficiently small as to have only limited impact to water quality and likely would require limited reclamation that could be accomplished with small or portable equipment, whereas the upper pods (6 and 7) may require a more aggressive reclamation effort with access for larger trucks/equipment;

- Given the observation of pioneer species colonizing the edges of the tailings delta, the possibility of encouraging revegetation by preparing and amending the exposed pods of dispersed tailings with nutrients/topsoil/additional seeding would accelerate the natural process of reclamation; and

- A key consideration of reclaiming the tailings pods and delta will be the trade-off between financial and environmental cost of additional disturbance of ground (i.e., from road construction, borrow pits, and new facilities) and the short and long-term benefit of various aggressiveness levels of reclamation.

Further investigation that could provide additional needed context to closure options for the Wernecke dispersed tailings include:

- Observations of seasonal fluctuations of Wernecke Lake to determine the importance of Sadie Ladue creek to lake level. This will be possible given the installation of the Wernecke Lake staff gauge, and ongoing funding of the Keno Ladue sampling program;

- Winter lake ice measurements on Wernecke Lake to determine is the lake freezes to the bottom in winter;

- Summer fish surveys in the Ladue drainage to determine if the watershed provides critical habitat to any fish species;
- Collections of seeds of pioneer species present on the tailings delta;
- Higher resolution surveying of the tailings materials to get a better estimate of volumes of tailings pods and the delta;
- Sampling of the Wernecke Lake bottom material to determine the thickness and extent of burial of tailings in the lake bottom sediments;
- Additional water quality sampling in Wernecke Lake, along the Ladue Creek to Gambler Lake, including Gambler Gulch and the outlet of Gambler Lake to evaluate the seasonal variability of mass loading; and
- Additional flow measurements at the entrance to Wernecke Lake and along Ladue Creek and Gambler Gulch.

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APPENDIX A

SOIL AND SEDIMENT SAMPLING RAW DATA

Sample ID	Al %	As (ppm)	Au (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Ca %	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Fe %	Ga (ppm)	Ge (ppm)	Hf (ppm)	Hg (ppm)	In (ppm)	K %	La (ppm)	Li (ppm)	Mg %	Mn (ppm)	Mo (ppm)
WDT-WT1-1-15CM	0.29	12.6	0.1	5	270	0.2	0.06	1.85	2.52	3.4	42.2	7	0.12	32.8	1.16	0.64	0.025	0.03	0.11	0.006	0.02	1.9	0.6	0.16	2450	6.37
WDT-WT1-1-25CM	1.1	12	0.1	5	250	0.36	0.22	0.62	1.69	22.6	6.9	20	0.98	48.5	1.74	3.2	0.025	0.04	0.06	0.028	0.04	11.3	14.8	0.37	148	1.3
WDT-WT1-2-15CM	1.05	34.2	0.1	5	230	0.34	0.26	0.8	1.18	20.3	9.2	19	1.01	31.8	3.68	3.07	0.025	0.05	0.08	0.031	0.05	10.1	14.6	0.39	533	3.5
WDT-WT1-2-45CM	0.92	30.1	0.1	5	200	0.35	0.22	0.66	1.55	22.6	11.2	18	0.73	45.8	3.1	2.62	0.025	0.05	0.06	0.034	0.05	11.1	14	0.4	268	3.81
WDT-WT1-3-10CM	0.28	101.5	0.1	5	80	0.18	0.1	0.69	155	7.88	8.4	5	0.73	74.5	12.4	1.73	0.05	0.02	1.5	1.62	0.02	3.8	4.3	1.13	38400	2.12
WDT-WT1-3-25CM	0.75	54.6	0.1	5	190	0.31	0.2	0.73	70.5	19.65	8.3	14	0.79	60.7	4.28	2.36	0.025	0.03	0.41	0.657	0.03	9.9	10.8	0.55	9000	1.9
WDT-WT1-3-40CM	0.36	108.5	0.1	5	140	0.12	0.11	0.77	47.7	10.4	5.3	7	0.55	56.8	10.6	1.65	0.07	0.04	1	1.465	0.02	5.3	5.3	1.07	31900	2.05
WDT-WT1-4-30CM	1	36.3	0.1	5	180	0.32	0.22	0.44	1.27	28.6	6.8	19	0.79	40.7	2.37	2.88	0.05	0.07	0.08	0.046	0.04	14.2	15	0.4	189	3.55
WDT-WT1-4-45CM	0.72	38.9	0.1	5	130	0.24	0.22	0.43	1.92	32.5	11.2	15	0.48	44.8	3.4	2.11	0.06	0.09	0.03	0.039	0.03	15.2	11.3	0.33	232	6.16
WDT-WT1-5-35CM	1.09	10.2	0.1	5	190	0.34	0.25	0.35	1.2	30.7	7.2	21	0.88	39	1.5	3.05	0.06	0.05	0.06	0.031	0.04	14	15.7	0.4	111	1.08
WDT-WT2-1-35CM	1.21	41.6	0.1	5	240	0.35	0.24	0.67	1.13	23.6	11.6	22	1.27	40.4	3.31	3.36	0.025	0.06	0.09	0.036	0.05	11.9	17.2	0.43	299	3.2
WDT-WT2-2-38CM	1.07	14.7	0.1	5	230	0.35	0.26	0.8	2.02	24.3	16.4	21	1.05	51.8	2.15	2.99	0.06	0.06	0.09	0.031	0.05	12.2	15.3	0.38	259	2.05
WDT-WT2-3-5CM	0.17	39.8	0.1	5	110	0.1	0.07	0.34	77.2	6.63	5	5	1.35	48.3	6.59	0.95	0.025	0.001	0.5	3.09	0.02	3.2	1.2	0.48	23400	0.61
WDT-WT2-3-15CM	0.07	27.9	0.1	5	70	0.08	0.07	0.25	15.6	4.27	1.6	2	0.46	86	6.06	0.63	0.025	0.02	0.25	2.32	0.01	2	0.4	0.33	20400	0.36
WDT-WT2-3-25CM	0.17	62.2	0.1	5	210	0.14	0.09	0.48	144.5	5.2	4.7	3	1.29	54.4	9.43	1.32	0.025	0.04	0.53	3.69	0.03	2.5	0.9	0.68	37200	0.45
WDT-WT2-3-60CM	0.83	12.9	0.1	5	130	0.25	0.19	0.51	6.63	18.4	10.3	16	0.66	26.9	1.45	2.4	0.05	0.04	0.11	0.071	0.05	9.2	11.5	0.34	1070	1.53
WDT-WT2-4-40CM	0.96	40.7	0.1	5	100	0.19	0.22	0.32	1.7	25.1	8.6	18	0.77	24.9	3.6	2.67	0.05	0.03	0.03	0.066	0.03	12.5	15.3	0.39	581	5.44
WDT-WT2-5-35CM	1.31	27.9	0.1	5	250	0.37	0.29	0.38	1.24	26.9	9.6	23	1.12	39.5	2.56	3.61	0.025	0.04	0.09	0.044	0.06	13.3	17.6	0.46	236	4.02
WDT-WT3-1-25CM	0.99	14.4	0.1	5	220	0.3	0.23	0.58	1.15	24.1	9.2	19	0.7	45.4	2.14	2.76	0.05	0.06	0.07	0.032	0.04	11.9	14.1	0.4	138	1.57
WDT-WT3-2-40CM	0.54	5.5	0.1	5	120	0.28	0.1	0.57	2.92	10.3	8.8	9	0.43	33	0.77	1.12	0.025	0.02	0.08	0.029	0.02	5	2.6	0.11	171	5.53
WDT-WT3-3-15CM	0.97	5.5	0.1	5	200	0.34	0.19	0.7	4.11	21.1	5.1	20	0.97	48.5	1.41	2.53	0.025	0.06	0.06	0.038	0.04	10.6	12.3	0.37	221	1.27
WDT-WT3-3-40CM	0.85	20.6	0.1	5	160	0.32	0.23	0.53	1.77	23.2	10	17	0.74	44	2.16	2.53	0.025	0.05	0.08	0.041	0.04	11.5	12.8	0.37	253	3.63
WDT-WT3-3-55CM	1.19	18.2	0.1	5	230	0.31	0.28	0.57	1.83	26.1	11.3	23	0.95	49.2	2.58	3.35	0.08	0.09	0.08	0.036	0.06	12.8	17.7	0.5	374	2.25
WDT-WT3-4-15CM	0.42	51.5	0.1	5	90	0.2	0.11	0.91	165	9.79	6.3	8	0.64	60.6	7.34	1.7	0.05	0.02	0.92	0.829	0.03	4.8	6.3	0.78	22200	1.48
WDT-WT3-4-35CM	0.07	83.7	0.1	5	20	0.07	0.06	1.3	493	2.6	6.5	1	0.51	110	22.7	1.92	0.025	0.02	2.99	0.61	0.02	1.1	1.4	2.11	50000	1
WDT-WT3-5-35CM	0.87	19.1	0.1	5	190	0.28	0.21	0.52	3.25	22.6	7.6	17	0.74	43.3	1.96	2.67	0.025	0.03	0.08	0.034	0.04	11.3	11.9	0.34	437	1.23
WDT-WT3-6-15CM	0.9	23.4	0.1	5	250	0.29	0.21	2.39	2.04	28.9	11.9	19	0.69	47.1	2.92	2.64	0.05	0.08	0.08	0.036	0.05	14.9	16.2	0.84	519	3.26
WDT-WT3-6-25CM	0.93	29.5	0.1	5	330	0.35	0.22	1	1.76	25.8	13.3	19	0.67	53.8	2.83	2.6	0.025	0.05	0.07	0.042	0.05	13.6	16.1	0.57	572	3.54
WDT-WT3-7-30CM	1.24	13.2	0.1	5	270	0.4	0.26	0.41	1.54	30.6	7.7	23	1.02	51.4	1.81	3.53	0.025	0.06	0.09	0.04	0.05	15.8	19.7	0.45	113	1.06
WDT-UL1-2-5CM	0.06	86.1	0.1	5	20	0.06	0.08	0.75	376	2.2	5.4	1	0.36	172	17.8	1.12	0.025	0.001	2.31	5.43	0.01	1	1.3	1.37	50000	0.71
WDT-UL1-2-30CM	0.05	56.1	0.1	5	40	0.07	0.08	0.49	256	2.02	4	1	0.32	146.5	12.7	0.75	0.025	0.02	1.17	4.74	0.01	0.9	0.7	0.8	46600	0.52
WDT-UL1-2-80CM	0.05	78.5	0.1	5	10	0.05	0.05	1.08	508	2.18	7.5	1	0.42	107	18.5	1.19	0.025	0.03	2.51	2.99	0.02	1	1.2	1.56	50000	0.5
WDT-UL1-3-10CM	0.28	80.5	0.1	5	70	0.12	0.09	0.83	202	5.5	6.4	6	0.81	98.5	9.22	1.24	0.025	0.02	1.02	2.19	0.03	2.6	3.6	0.86	28400	1.47
WDT-UL1-3-25CM	0.11	72.1	0.1	5	50	0.08	0.06	0.98	290	3.7	5.8	3	0.61	119	12.2	1.01	0.025	0.02	1.44	3.26	0.02	1.7	1.5	1.03	40100	0.67
WDT-UL1-4-SED	0.7	37.7	0.1	5	120	0.25	0.15	1.67	58.1	12.9	8.4	14	1.33	88	3.82	2.06	0.025	0.04	0.43	1.83	0.06	6.3	10.2	0.49	8290	1.19
WDT-UL1-5-SED	0.84	38.3	0.1	5	140	0.31	0.21	3.46	65.4	12.9	9.5	17	1.59	105	3.88	2.31	0.025	0.05	0.53	1.615	0.08	6	11.5	0.55	6870	1.48
WDT-UL2-2-5CM	0.12	51.5	0.1	5	40	0.12	0.1	0.36	125	3.32	5.7	3	0.61	205	8.13	0.76	0.025	0.001	0.89	5.41	0.02	1.5	1.5	0.51	28000	0.84
WDT-UL2-2-20CM	0.05	28.8	0.1	5	40	0.025	0.04	0.43	177.5	2.34	2.8	1	0.32	59.1	7.27	0.56	0.025	0.02	0.66	3.38	0.01	1.1	0.7	0.51	26200	0.27
WDT-UL2-2-45CM	0.08	57.5	0.1	5	100	0.12	0.07	0.43	80.2	3.34	3.3	3	0.51	137	7.76	0.62	0.025	0.03	0.5	4.91	0.01	1.6	0.7	0.45	25500	0.45
WDT-UL2-3-20CM	0.07	26.2	0.1	5	50	0.06	0.03	0.37	89.3	2.71	2.8	2	0.39	44.8	4.83	0.46	0.025	0.02	0.35	2.99	0.01	1.2	0.8	0.33	17050	0.46
WDT-UL2-4-SED	0.12	30.9	0.1	5	40	0.08	0.07	0.95	125.5	2.78	3.2	3	0.65	116.5	4.92	0.56	0.025	0.001	0.55	3.78	0.02	1.3	1.3	0.35	16000	0.47
WDT-UL2-5-SED	0.68	82.4	0.1	5	70	0.4	0.28	1.88	148	8.52	10.3	13	3.02	299	7.43	2.12	0.025	0.04	1.34	8.5	0.1	4.1	7	0.67	16850	2.73
WDT-UL2-6-SED	0.88	74.3	0.1	5	40	0.4	0.28	1.64	155	11.7	14.1	16	2.75	192.5	6.55	2.46	0.05	0.05	0.97	3.49	0.11	5.7	9.6	0.68	11500	5.25
WDT-UL2-7-SED	0.82	14.3	0.1	5	100	0.33	0.16	0.75	16.85	24.5	6.7	16	1.73	42.2	1.61	2.36	0.05	0.04	0.17	0.315	0.04	11.6	12.1	0.5	1010	0.84
WDT-UL3-2-5CM	0.04	70.5	0.1	5	30	0.08	0.15	0.4	497	1.47	5.6	1	0.3	243	17.1	1.13	0.05	0.02	2.54	12.15	0.01	0.7	0.8	1.05	50000	0.41

Sample ID	Al %	As (ppm)	Au (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Ca %	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Fe %	Ga (ppm)	Ge (ppm)	Hf (ppm)	Hg (ppm)	In (ppm)	K %	La (ppm)	Li (ppm)	Mg %	Mn (ppm)	Mo (ppm)
WDT-UL3-2-50CM	0.1	76.8	0.1	5	40	0.1	0.05	0.96	282	3.69	5.5	3	0.73	76	12.25	1	0.025	0.04	1.31	2.83	0.03	1.7	1.2	1.03	44200	0.66
WDT-UL3-3-15CM	0.05	29.1	0.1	5	30	0.08	0.07	0.36	128	2.43	2.4	2	0.33	112	6.19	0.52	0.025	0.02	0.51	3.78	0.01	1.1	0.6	0.4	21900	0.43
WDT-UL3-4-SED	0.1	34.4	0.1	5	30	0.07	0.07	0.62	69	2.91	2.4	3	0.61	145.5	3.77	0.48	0.025	0.02	0.48	3.87	0.02	1.4	0.9	0.27	12050	0.64
WDT-UL3-5-SED	0.58	68	0.1	5	60	0.21	0.19	11.15	139	6.11	11.7	10	1.96	157	4.95	1.61	0.025	0.02	0.77	3.39	0.09	3.1	5.9	0.57	8330	4.36
WDT-UL3-6-SED	0.75	81.8	0.1	5	40	0.41	0.25	4.32	170	8.7	13	14	2.71	198	6.39	2.05	0.05	0.05	0.91	3.47	0.11	4.3	7.1	0.63	10950	4.52
WDT-UL3-7-SED	0.88	88.9	0.1	5	40	0.42	0.29	2.63	153.5	15.35	17.9	16	3.38	204	6.37	2.47	0.05	0.05	1.13	3.83	0.09	6.9	8.4	0.69	15950	4.14
WDT-UL4-2-10CM	0.09	102	0.1	5	30	0.07	0.06	0.96	430	3.22	5.8	2	0.47	114	16.2	1.14	0.025	0.02	2.46	2.71	0.02	1.5	1.6	1.39	50000	0.7
WDT-UL4-2-20CM	0.03	106	0.1	5	20	0.05	0.07	0.74	640	1.57	8.6	0.5	0.34	186	21.9	1.43	0.025	0.001	3.39	4.94	0.01	0.7	1.1	1.7	50000	0.41
WDT-UL4-2-35CM	0.04	94.3	0.1	5	20	0.025	0.06	0.82	513	1.89	6.8	1	0.4	136.5	18.3	1.32	0.025	0.02	2.79	3.52	0.01	0.8	1	1.48	50000	0.42
WDT-UL4-3-10CM	0.35	60.6	0.1	5	80	0.15	0.1	1.11	247	8.44	6.5	7	0.58	66.2	10.05	1.63	0.025	0.03	1.29	0.974	0.02	4.1	5.2	1.01	29200	1.06
WDT-UL4-3-25CM	0.16	59.6	0.1	5	70	0.11	0.07	0.96	200	4.4	4.6	4	0.76	92.2	9.43	1.05	0.025	0.02	1.04	2.68	0.02	2.1	1.8	0.85	31400	0.78
WDT-UL4-4-SED	0.54	53.6	0.1	5	120	0.23	0.14	1.34	198	12	9.2	11	0.72	63.9	8.45	2.02	0.025	0.03	1.1	0.489	0.04	5.8	8.4	0.93	20900	1.56
WDT-UL4-5-SED	0.99	57.6	0.1	5	120	0.38	0.27	1.54	82.4	17.35	13.7	19	1.89	126.5	5.05	2.88	0.025	0.06	0.59	1.725	0.09	7.9	13.5	0.66	8820	3.12
WDT-UL4-6-SED	0.69	19.2	0.1	5	120	0.23	0.17	0.81	16.5	24.6	7.9	14	0.89	50	1.52	2.07	0.025	0.04	0.17	0.319	0.04	11.5	9.6	0.36	1160	0.89
WDT-UL5-0-SED	1.07	40.1	0.1	5	120	0.4	0.25	1.99	55	16.75	14	20	1.65	107	3.65	2.97	0.025	0.06	0.45	1.145	0.08	7.7	14.8	0.58	5240	1.77
WDT-ULX-1-53CM	0.1	87.8	0.1	5	30	0.07	0.04	1.35	451	4.09	7.6	3	0.67	78.5	15.15	1.16	0.025	0.04	2	0.379	0.03	1.8	1.4	1.47	50000	0.91
WDT-ULX-1-5CM	0.05	70.5	0.1	5	30	0.05	0.08	0.32	271	1.86	4	1	0.29	105.5	14.7	1.04	0.025	0.02	1.43	9.1	0.01	0.8	0.8	0.88	50000	0.27
WDT-CH1-0-SED	0.83	50.9	0.1	5	140	0.34	0.24	1.02	73.7	15	10.7	16	1.98	122	3.59	2.14	0.025	0.03	0.65	2.16	0.07	7.5	9.8	0.49	6710	1.41
WDT-PT1-5CM	0.12	147	0.1	5	70	0.08	0.09	0.65	99.7	4.4	4.5	3	0.55	90.8	14.25	1.07	0.025	0.001	1.54	2.94	0.02	2	1.4	1.12	48000	0.68
WDT-PT1-20CM	0.27	113.5	0.1	5	160	0.15	0.11	0.94	189.5	5.94	5.8	5	0.55	84.1	8.96	1.21	0.025	0.02	1.05	1.85	0.03	2.9	3	0.76	29500	1.52
WDT-PT2-15CM	0.7	39.1	0.1	5	200	0.26	0.2	0.78	33.1	20.2	9.3	14	0.71	50.4	3.41	2.02	0.025	0.04	0.26	0.363	0.04	10.3	9.3	0.45	4470	2.4
WDT-PT2-25CM	0.63	43.4	0.1	5	160	0.24	0.19	0.74	62.6	16.1	8.9	12	0.72	51.2	3.94	1.85	0.025	0.05	0.37	0.519	0.04	8.1	8.5	0.5	7770	1.43
WDT-PT3-15CM	0.23	74.6	0.1	5	70	0.13	0.08	0.78	183	6.88	5.4	5	0.55	63.3	10.8	1.33	0.025	0.02	1.16	1.335	0.03	3.2	3.2	0.97	36300	1.05
WDT-PT3-25CM	0.37	68.3	0.1	5	90	0.16	0.12	0.78	167	8.68	6.3	7	0.64	71.4	9.95	1.64	0.025	0.02	1.01	1.5	0.03	4.4	5.2	0.91	31500	1.45
WDT-PT4-45CM	0.88	25.1	0.1	5	210	0.31	0.22	0.71	2.19	21.7	12.5	17	0.82	52.6	2.12	2.44	0.05	0.06	0.07	0.036	0.03	11.3	12.4	0.35	216	3.57
WDT-PT5-15CM	0.13	78.2	0.1	5	70	0.08	0.07	0.86	169.5	3.78	4.1	3	0.59	82.4	8.38	0.85	0.025	0.02	0.86	2.49	0.02	1.7	1.4	0.73	27900	0.81
WDT-PT6-10CM	0.13	122.5	0.1	5	10	0.11	0.04	1	330	4.96	7.1	3	1	61.2	16.1	1.47	0.05	0.04	3.11	0.594	0.04	2.2	1.1	1.57	50000	0.74
WDT-PT6-22CM	0.05	122	0.1	5	30	0.08	0.1	0.34	115	2.68	3.7	2	0.38	87.5	13.1	1.11	0.025	0.02	1.19	11.4	0.01	1.3	0.5	0.74	50000	0.46
WDT-PT6-35CM	0.04	168.5	0.1	5	20	0.05	0.25	0.57	278	2.01	4.3	1	0.34	392	21.8	1.53	0.05	0.02	2.52	0.65	0.01	0.9	0.8	1.78	50000	0.73
WDT-PT7-8CM	0.16	143	0.1	5	20	0.11	0.03	1.1	222	5.62	6.1	4	1.04	41.6	14.9	1.56	0.025	0.03	2.16	0.365	0.05	2.5	1.4	1.48	50000	0.86
WDT-WETLAND-POD7-7CM	0.38	57.9	0.1	5	60	0.15	0.13	0.56	121.5	9.93	4.4	7	0.65	94.5	6.09	1.72	0.025	0.02	0.77	1.985	0.03	5	5.5	0.55	18800	1.04
WDT-WETLAND-POD7-18CI	0.12	112.5	0.1	5	40	0.11	0.1	0.77	151.5	4.75	5.6	3	0.57	157	11.25	1.37	0.025	0.001	1.69	3.37	0.02	2.2	1.6	0.89	39500	0.79
WDT-PT8-4CM	0.1	253	0.1	5	10	0.1	0.04	0.68	647	4.76	9.6	1	0.66	70.1	17.8	1.85	0.05	0.03	2.93	0.526	0.03	2.1	0.6	0.89	50000	0.72
WDT-PT8-10CM	0.1	142.5	0.1	5	10	0.09	0.03	0.78	547	3.82	7.1	1	0.77	77.5	17	1.87	0.05	0.05	3.16	0.56	0.03	1.8	1	1.62	50000	0.83
WDT-PT8-30CM	0.06	120.5	0.1	5	10	0.07	0.04	1.1	715	2.08	7.7	0.5	0.47	109.5	19.25	1.77	0.05	0.03	4.33	0.737	0.02	0.9	1.1	1.81	50000	0.44
WDT-PT9-4CM	0.79	66.5	0.1	5	110	0.33	0.18	0.6	148.5	16.15	10.7	15	0.91	120	5.93	2.97	0.025	0.03	0.75	1.89	0.05	8	12.5	0.64	14850	1.57
WDT-PT9-12CM	0.1	149	0.1	5	30	0.12	0.15	0.76	324	3.04	5.4	2	0.63	135	15.4	1.6	0.05	0.02	2.99	7.17	0.02	1.4	1.1	1.19	50000	0.59
WDT-PT9-34CM	0.92	15.6	0.1	5	230	0.25	0.18	0.52	63.8	19.7	7.6	18	0.58	23.3	2.13	2.82	0.025	0.04	0.1	0.061	0.05	9.7	14.5	0.4	690	1.23
WDT-SL-13	0.46	62.4	0.1	5	120	0.26	0.15	0.98	139	11.7	7.9	9	0.59	67.1	6.58	1.86	0.05	0.03	0.79	0.711	0.03	5.9	6.8	0.69	17700	1.63
WDT-GL2-SED	0.75	22.2	0.1	5	140	0.26	0.14	0.71	5.25	16.8	13.5	14	0.76	38.3	1.91	2.11	0.025	0.04	0.07	0.079	0.03	8.4	11.8	0.33	590	0.84
WDT-GL1-SED	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS

Sample ID	Na %	Nb (ppm)	Ni (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Re (ppm)	S %	Sb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Te (ppm)	Th (ppm)	Ti %	Tl (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)	TOC
WDT-WT1-1-15CM	0.005	0.17	26.4	1490	3.5	1.1	0.003	0.19	0.72	0.7	2.8	0.01	68.6	0.005	0.02	0.2	0.009	0.04	0.79	7	0.06	3.66	75	1	40.2
WDT-WT1-1-25CM	0.01	0.64	25.8	930	28.3	5.6	0.016	0.08	1.15	2.7	3.9	0.3	26.9	0.005	0.08	2.6	0.018	0.11	2.73	29	0.1	8.05	114	1.7	8.02
WDT-WT1-2-15CM	0.01	0.6	23.7	920	30.9	6.6	0.018	0.07	1.25	2.6	3.8	0.2	30.7	0.005	0.09	2.2	0.018	0.09	2.09	30	0.24	7.65	145	1.6	6.53
WDT-WT1-2-45CM	0.01	0.56	34.9	1030	23	5.7	0.004	0.04	1.47	2.8	2.8	0.2	25.2	0.005	0.06	3.4	0.019	0.1	1.24	28	0.14	8.24	169	2.6	2.96
WDT-WT1-3-10CM	0.01	0.17	15.1	540	1830	3.2	0.002	0.38	101	2.5	2.2	2.1	14.9	0.005	0.02	1.6	0.008	0.08	0.78	13	0.09	9.98	10000	0.9	4
WDT-WT1-3-25CM	0.01	0.41	28.8	960	632	5.2	0.006	0.11	24.6	2.5	4.7	0.8	24.9	0.005	0.07	2.5	0.017	0.09	1.01	22	0.13	9.14	6620	1.3	3.97
WDT-WT1-3-40CM	0.01	0.26	17.7	650	1355	2.7	0.003	0.07	66	2.1	1.5	1.6	14.6	0.005	0.02	1.9	0.013	0.05	0.53	15	0.09	8.38	3680	1.3	2.56
WDT-WT1-4-30CM	0.01	0.65	26.2	1060	29.1	4.6	0.003	0.02	1.65	2.4	2.4	0.3	21.5	0.005	0.05	4.5	0.023	0.09	0.92	31	0.19	7.44	152	2.7	1.88
WDT-WT1-4-45CM	0.01	0.36	39	1310	20.3	3	0.001	0.01	1.41	2.4	3	0.2	18.3	0.005	0.08	5.3	0.015	0.05	0.82	20	0.13	8.35	202	4.4	1.14
WDT-WT1-5-35CM	0.01	0.74	23.9	900	29	5.5	0.003	0.01	1.02	2.7	2.8	0.3	17.9	0.005	0.02	4.6	0.026	0.09	1.35	30	0.12	7.98	137	2.7	2.49
WDT-WT2-1-35CM	0.01	0.72	33.1	970	46.4	7.4	0.009	0.08	1.43	3.2	3.1	0.3	28.2	0.005	0.06	3.3	0.02	0.1	2.04	32	0.12	9.19	192	2.2	7.75
WDT-WT2-2-38CM	0.01	0.7	35.1	1000	36.7	7.6	0.005	0.07	1.31	3	4.2	0.3	32.3	0.005	0.03	3.1	0.02	0.11	2.77	30	0.11	9.4	179	2.3	7.29
WDT-WT2-3-5CM	0.005	0.025	10.1	310	3780	2.9	0.0005	0.19	122.5	1.1	0.7	3.4	4.7	0.005	0.03	1.6	0.0025	0.06	0.39	5	0.58	4.35	6420	0.25	3.64
WDT-WT2-3-15CM	0.005	0.025	5.8	260	5840	1.2	0.0005	0.06	312	0.8	0.5	2.2	2.3	0.005	0.01	1	0.0025	0.03	0.33	3	0.22	3.56	1310	0.9	1.23
WDT-WT2-3-25CM	0.005	0.025	12.1	300	1730	3.4	0.001	0.57	101.5	1.4	0.9	3.8	5.3	0.005	0.03	1.5	0.0025	0.07	0.37	5	0.44	6.13	10000	2.2	1.63
WDT-WT2-3-60CM	0.01	0.51	39.3	920	66.2	5.7	0.018	0.19	2.44	2.3	2.6	0.3	20.2	0.005	0.07	2.6	0.018	0.08	1.35	24	0.11	6.62	9930	1.5	6.47
WDT-WT2-4-40CM	0.01	0.45	26	1150	38	5.1	0.002	0.01	2.23	1.6	1.5	0.3	16.1	0.005	0.04	3.6	0.016	0.09	0.77	25	0.11	5.15	255	1.4	1.11
WDT-WT2-5-35CM	0.01	0.72	28.4	970	32	8	0.006	0.03	1.41	3	2.1	0.3	19.2	0.005	0.09	4.3	0.021	0.13	1.44	36	0.13	7.44	184	1.7	3.68
WDT-WT3-1-25CM	0.01	0.71	33.2	950	26.6	5.5	0.002	0.03	1.29	2.9	2.6	0.3	23.5	0.005	0.06	3.9	0.022	0.08	1.25	29	0.11	8.45	149	3.3	4.26
WDT-WT3-2-40CM	0.01	0.19	36.2	720	20.5	2.5	0.002	0.16	1.37	1.9	2.1	0.01	17.7	0.005	0.04	0.8	0.008	0.04	0.83	8	0.025	6.6	170	0.8	28.8
WDT-WT3-3-15CM	0.01	0.64	24.7	910	69.4	5.5	0.009	0.12	3.43	2.6	3.2	0.3	28	0.005	0.04	2.4	0.022	0.08	2.85	25	0.1	9.14	261	2.4	8.37
WDT-WT3-3-40CM	0.01	0.63	39	1110	25.9	5	0.004	0.06	1.66	2.6	4.4	0.2	22.1	0.005	0.05	3.8	0.023	0.08	1.24	27	0.11	7.81	179	3.1	3.07
WDT-WT3-3-55CM	0.01	0.85	39.5	920	29.1	6.9	0.008	0.11	1.44	3.3	3.5	0.3	24.5	0.005	0.06	4.6	0.027	0.12	1.81	33	0.12	8.57	206	3.6	4.42
WDT-WT3-4-15CM	0.01	0.27	18.2	750	1340	3.6	0.002	0.76	49.3	2.1	2.2	1.2	20.8	0.005	0.02	2.1	0.012	0.07	0.75	15	0.17	7.71	10000	1.4	4.3
WDT-WT3-4-35CM	0.01	0.025	8.2	190	1555	1.9	0.0005	1	100.5	3.2	1.5	2.3	12.6	0.005	0.04	0.5	0.0025	0.07	0.39	10	0.025	12.9	10000	0.8	3.2
WDT-WT3-5-35CM	0.01	0.65	30.7	1010	54	4.9	0.002	0.05	1.66	2.6	3.4	0.2	22.2	0.005	0.05	3.2	0.021	0.08	1.35	26	0.09	7.96	294	1.6	3.87
WDT-WT3-6-15CM	0.01	0.47	41.1	1100	24	5	0.002	0.04	1.47	3.1	2.6	0.2	49.7	0.005	0.04	4.3	0.024	0.11	0.67	28	0.12	8.36	167	3.5	1.76
WDT-WT3-6-25CM	0.01	0.4	43	1140	30.1	5.2	0.001	0.03	1.55	3.1	1.6	0.3	29.9	0.005	0.06	3.3	0.02	0.09	0.66	28	0.16	9.28	175	1.8	1.67
WDT-WT3-7-30CM	0.01	0.62	33.1	840	33.6	6.9	0.007	0.06	1.38	3.8	4.2	0.3	21.2	0.005	0.03	5.1	0.021	0.13	1.69	34	0.12	8.95	163	2.7	3.71
WDT-UL1-2-5CM	0.005	0.025	8.9	210	4110	1.3	0.001	0.8	224	2.5	1.7	4.8	6.3	0.005	0.005	0.7	0.0025	0.05	0.33	7	0.21	9.7	10000	0.7	3.63
WDT-UL1-2-30CM	0.005	0.025	8.4	240	6080	1.1	0.0005	0.55	288	1.5	0.8	3.5	4.2	0.005	0.005	0.8	0.0025	0.04	0.32	4	0.73	6.78	10000	0.7	2.07
WDT-UL1-2-80CM	0.005	0.025	11.9	300	2480	1.5	0.0005	0.86	131	2.6	1.1	3	12.9	0.005	0.005	0.8	0.0025	0.07	0.26	6	0.06	9.66	10000	1	3.15
WDT-UL1-3-10CM	0.005	0.09	17.2	440	3670	2.7	0.008	1.36	146	2	2.4	2.5	12.4	0.005	0.005	1.5	0.005	0.08	1.05	10	0.25	7.05	10000	0.9	3.63
WDT-UL1-3-25CM	0.005	0.025	9.8	320	4390	2	0.0005	0.74	161	2.1	1.7	3.3	11.2	0.005	0.005	1.1	0.0025	0.07	0.38	6	0.35	7.81	10000	1.1	2.31
WDT-UL1-4-SED	0.01	0.29	27.3	760	2880	6.1	0.01	1.08	131	2.3	3.2	2.5	36.4	0.005	0.01	2.8	0.014	0.11	1.37	19	0.21	6.53	4880	1.9	4.92
WDT-UL1-5-SED	0.01	0.28	35.9	710	2670	7.7	0.02	1.85	111.5	2.6	5.1	2.4	64.9	0.005	0.03	3	0.015	0.14	2.23	22	0.16	6.9	6410	2.2	8.65
WDT-UL2-2-5CM	0.005	0.025	11.6	260	4240	1.8	0.001	0.5	284	1.3	1.8	4.2	5.5	0.005	0.005	1.2	0.0025	0.05	0.52	5	0.22	5.11	10000	0.25	2.34
WDT-UL2-2-20CM	0.005	0.025	6.5	210	1760	1	0.0005	0.55	101	1.1	1.1	3	4.7	0.005	0.005	0.9	0.0025	0.03	0.2	3	0.43	4.29	10000	0.8	1.7
WDT-UL2-2-45CM	0.005	0.025	9	440	10000	1.3	0.0005	0.42	446	1.1	1.1	4.3	5.7	0.005	0.005	1.1	0.0025	0.05	0.5	3	1.03	4.51	7360	1.1	1.29
WDT-UL2-3-20CM	0.005	0.025	7.8	220	2050	1.1	0.0005	0.48	107	0.7	0.9	2.6	4.5	0.005	0.005	1	0.0025	0.03	0.26	3	0.18	3.19	6830	0.8	1.4
WDT-UL2-4-SED	0.005	0.025	8.5	270	3850	2.1	0.004	1.06	134	0.9	2	3.2	14.4	0.005	0.005	1.1	0.0025	0.04	0.61	5	0.23	3.44	9770	0.6	3.15
WDT-UL2-5-SED	0.005	0.13	34.6	550	10000	9.3	0.04	3.51	490	2.6	6	9.2	35.5	0.005	0.02	3.3	0.005	0.19	3	18	0.42	7.19	10000	2.4	5.58
WDT-UL2-6-SED	0.01	0.19	50.8	630	5190	11.2	0.072	4.39	217	2.7	11.9	4.9	40.1	0.005	0.06	2.9	0.008	0.23	8.57	23	0.25	7.95	10000	2.5	11.8
WDT-UL2-7-SED	0.005	0.29	22.7	1110	617	7.4	0.011	0.86	20.3	1.9	2.9	0.9	26.5	0.005	0.01	3.2	0.02	0.14	1.28	19	0.08	7.91	1910	1.5	5.4
WDT-UL3-2-5CM	0.005	0.025	11.3	170	5270	0.9	0.0005	1.04	332	1.9	1.6	9.2	3	0.005	0.01	0.7	0.0025	0.05	0.3	5	0.45	8.88	10000	0.7	3.24

Sample ID	Na %	Nb (ppm)	Ni (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Re (ppm)	S %	Sb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Te (ppm)	Th (ppm)	Ti %	Tl (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)	TOC
WDT-UL3-2-50CM	0.005	0.025	13.1	390	2140	2.6	0.001	0.9	116.5	2.1	1.1	2.7	11.5	0.005	0.005	1.2	0.0025	0.09	0.53	6	0.2	7.88	10000	1.4	2.35
WDT-UL3-3-15CM	0.005	0.025	5.7	220	3580	1.1	0.001	0.47	174	0.8	1	2.8	3.8	0.005	0.005	1	0.0025	0.03	0.33	3	0.08	3.74	9630	0.8	1.23
WDT-UL3-4-SED	0.005	0.025	7.3	260	3860	1.7	0.004	0.55	242	0.7	0.9	3.1	9	0.005	0.005	1.2	0.0025	0.04	0.49	3	0.14	2.81	5090	0.9	1.46
WDT-UL3-5-SED	0.01	0.14	37.4	600	4620	7.5	0.043	3.46	219	1.7	13.4	4.2	182	0.005	0.03	1.8	0.005	0.17	7.23	16	0.21	5.53	10000	1.1	11
WDT-UL3-6-SED	0.01	0.17	47	650	5480	9.5	0.065	4.52	285	2.3	11.1	4.8	67	0.005	0.03	2.6	0.007	0.23	6.73	20	0.26	6.95	10000	2.3	10.9
WDT-UL3-7-SED	0.01	0.18	49.1	640	7220	10.4	0.039	3.53	326	2.6	6.2	6.4	50.1	0.005	0.02	3.9	0.007	0.28	4.67	20	0.27	8.8	10000	2.9	11.8
WDT-UL4-2-10CM	0.005	0.025	9.7	300	3120	1.9	0.001	0.93	130.5	2.5	1.4	3.3	9.8	0.005	0.005	1.1	0.0025	0.06	0.37	7	0.16	9.71	10000	1	3.92
WDT-UL4-2-20CM	0.005	0.025	9.9	130	3590	1.1	0.0005	1.08	198	2.7	1.6	4.9	6.2	0.005	0.005	0.5	0.0025	0.08	0.24	7	0.1	11.15	10000	0.6	3.55
WDT-UL4-2-35CM	0.005	0.025	9.6	180	2490	1.3	0.0005	0.86	145	2.6	1	4	8.1	0.005	0.005	0.7	0.0025	0.06	0.27	6	0.22	10.15	10000	0.8	3.26
WDT-UL4-3-10CM	0.005	0.17	17.2	640	1075	2.6	0.002	0.64	53.6	2.5	2.5	1.5	19.9	0.005	0.02	1.8	0.009	0.07	0.58	13	0.07	8.53	10000	1.4	3.84
WDT-UL4-3-25CM	0.005	0.025	10.1	410	4440	2.6	0.001	0.86	152.5	1.8	1	2.8	12.8	0.005	0.005	1.4	0.0025	0.07	0.54	7	0.75	6.59	10000	1	4.41
WDT-UL4-4-SED	0.005	0.28	24.7	750	844	4.6	0.004	0.66	39.6	2.9	3.4	1.1	32.8	0.005	0.02	2.4	0.013	0.09	0.91	18	0.09	9.22	10000	1.4	6.44
WDT-UL4-5-SED	0.01	0.29	46.1	680	2600	9.8	0.031	2.37	130	3.1	5.9	2.7	40	0.005	0.03	3.3	0.013	0.16	2.72	25	0.17	8.63	7140	2.5	12.2
WDT-UL4-6-SED	0.01	0.34	27.7	940	594	5.3	0.009	0.69	25.8	1.9	2.7	0.7	32.1	0.005	0.02	2.8	0.015	0.1	1.42	17	0.09	7.06	1740	1.7	8.73
WDT-UL5-0-SED	0.01	0.36	47.3	750	1885	9.4	0.029	1.87	75.9	3.1	4.9	1.9	51.7	0.005	0.04	3.2	0.014	0.18	2.28	25	0.11	8.56	5220	2.8	12.5
WDT-ULX-1-53CM	0.005	0.025	13	540	1955	2.7	0.001	0.76	78.6	2.8	1.3	1.8	15.7	0.005	0.005	1.3	0.0025	0.1	0.35	7	0.025	9.82	10000	1.7	2.91
WDT-ULX-1-5CM	0.005	0.025	12.3	180	2300	1	0.0005	0.73	164	1.7	1	7.2	2.4	0.005	0.005	0.7	0.0025	0.05	0.22	5	0.37	7.59	10000	0.7	2.55
WDT-CH1-0-SED	0.005	0.33	34.7	760	3340	8.7	0.014	1.03	133.5	2.4	4.7	3.4	30.6	0.005	0.03	2.9	0.011	0.16	2.15	21	0.14	7.79	5560	1.7	9.68
WDT-PT1-5CM	0.005	0.05	9.3	350	6150	2.1	0.0005	0.32	190	2	1.1	3.2	7.7	0.005	0.01	1	0.0025	0.07	0.49	7	0.49	8.58	7280	0.5	3.87
WDT-PT1-20CM	0.005	0.1	21.8	550	3920	3.1	0.003	0.33	133.5	1.7	2.5	2.2	25.5	0.005	0.02	0.7	0.005	0.06	1.16	9	0.27	7.46	10000	0.6	10.7
WDT-PT2-15CM	0.005	0.47	30.6	1000	478	4.8	0.004	0.07	18.3	2.4	4.1	0.7	30.1	0.005	0.03	3	0.018	0.08	1.6	22	0.17	7.94	3090	1.7	5.81
WDT-PT2-25CM	0.005	0.44	28	880	777	4.3	0.005	0.39	26	2.4	3.4	1.2	26.3	0.005	0.04	2.9	0.018	0.11	0.98	20	0.14	7.76	6440	1.9	4.66
WDT-PT3-15CM	0.005	0.14	12.8	470	1450	2.9	0.001	0.49	78	2.3	1.5	1.7	12.9	0.005	0.01	1.4	0.006	0.05	0.53	10	0.15	8.13	10000	0.8	3.45
WDT-PT3-25CM	0.005	0.21	19.3	570	1475	3.6	0.001	0.48	74.7	2.4	2.4	1.7	17	0.005	0.04	1.6	0.009	0.07	0.78	14	0.14	8.63	10000	0.9	4.72
WDT-PT4-45CM	0.005	0.48	43.9	930	34.5	4.2	0.007	0.17	1.44	2.7	4	0.2	29.7	0.005	0.04	3.4	0.017	0.09	2.13	24	0.1	9.24	217	2.6	8.05
WDT-PT5-15CM	0.005	0.025	11	380	4020	2.1	0.001	0.81	157.5	1.5	1.1	2.6	11.9	0.005	0.01	1.1	0.0025	0.05	0.5	6	0.28	6.15	10000	0.8	2.74
WDT-PT6-10CM	0.005	0.025	12.9	510	1755	3.8	0.001	0.85	72.1	2.6	1.1	2.2	12.1	0.005	0.01	1.4	0.0025	0.1	0.4	7	0.025	10.25	10000	2	3.52
WDT-PT6-22CM	0.005	0.025	8.1	250	6870	1.4	0.0005	0.4	191	1.7	1.1	8.1	2.7	0.005	0.01	0.8	0.0025	0.03	0.34	5	2.48	7.37	8370	0.8	3.25
WDT-PT6-35CM	0.005	0.025	7.1	190	10000	1.2	0.0005	0.59	448	2.6	1.5	2.9	6.2	0.005	0.01	0.5	0.0025	0.08	0.58	7	0.025	11.2	10000	0.9	4.48
WDT-PT7-8CM	0.005	0.025	9	600	1400	4.3	0.0005	0.68	44.7	2.5	0.6	1.5	14.9	0.005	0.01	1.7	0.0025	0.09	0.3	7	0.025	9.31	10000	1.8	3.3
WDT-WETLAND-POD7-7CM	0.005	0.22	12.3	630	2750	3.2	0.001	0.24	143	1.6	1.6	2.1	14.2	0.005	0.02	1.8	0.01	0.06	0.69	12	0.23	5.66	9210	0.7	4.25
WDT-WETLAND-POD7-18CI	0.005	0.05	8.9	370	4850	2.3	0.001	0.32	235	1.9	1.7	3.7	13.2	0.005	0.01	1.3	0.0025	0.05	0.54	5	0.16	7.49	10000	0.5	2.91
WDT-PT8-4CM	0.005	0.025	14.3	480	1495	2.8	0.001	0.94	60.8	2.3	1.6	1.9	15.6	0.005	0.01	1.3	0.0025	0.13	0.39	6	0.025	9.83	10000	1.6	2.46
WDT-PT8-10CM	0.005	0.025	11.1	380	1375	2.9	0.001	1.06	58.9	2.3	1.4	1.8	9.6	0.005	0.01	1.2	0.0025	0.1	0.31	5	0.025	9.9	10000	2.1	3.59
WDT-PT8-30CM	0.005	0.025	9.6	250	1305	1.8	0.0005	1.35	83.9	2.4	1.9	2.1	12.6	0.005	0.01	0.7	0.0025	0.11	0.22	6	0.025	9.97	10000	1.1	5.06
WDT-PT9-4CM	0.005	0.39	25.1	800	3580	6.2	0.001	0.24	156	2.9	1.4	2.3	17.9	0.005	0.03	2.4	0.015	0.1	0.77	23	0.24	7.98	10000	0.8	5.55
WDT-PT9-12CM	0.005	0.025	9.1	390	10000	2.3	0.001	0.94	282	2	1.5	7.1	10.3	0.005	0.01	1.1	0.0025	0.08	0.38	6	0.7	8.88	10000	0.9	4.35
WDT-PT9-34CM	0.005	0.53	22	940	204	5.7	0.001	0.05	17.45	2.4	1.1	0.3	22.8	0.005	0.03	2.3	0.019	0.08	0.56	29	0.08	5.46	5810	1.4	4.53
WDT-SL-13	0.005	0.3	24.4	770	1170	3.8	0.006	0.59	47.3	2.5	3.4	1.2	26.3	0.005	0.04	2.2	0.012	0.07	1.19	17	0.1	8.65	10000	1.5	8.37
WDT-GL2-SED	0.005	0.46	35.5	1100	145.5	4.5	0.006	0.26	7.62	2	3.1	0.3	29	0.005	0.03	2.5	0.018	0.06	1.06	20	0.17	7.36	859	1.6	9.4
WDT-GL1-SED	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	NSS	8.95

Sample ID	MPA (kgCaCO3/t)	FIZZ RATING	NNP (kgCaCO3/t)	NP (kgCaCO3/t)	Paste pH	Ratio (NP:MPA)	S_Tot %	S_SO4(HCl) %	S_Sulphide (calc) %	S_SO4(Carb) %	C (%)	CO2 (%)
WDT-WT2-3-5CM	5.3	2	24	29	7	5.46	0.17	0.01	0.16	0.01	1.75	6.4
WDT-WT2-3-15CM	1.6	2	23	25	6.7	16	0.05	0.02	0.03	0.02	1.67	6.1
WDT-WT2-3-25CM	16.9	3	66	83	7.1	4.92	0.54	0.01	0.53	0.01	3.15	11.5
WDT-WT2-3-60CM	5.9	1	3	9	5.9	1.52	0.19	0.005	0.18	0.01	0.08	0.3
WDT-WT3-4-15CM	21.3	2	10	31	7	1.46	0.68	0.01	0.68	0.005	2.2	8.1
WDT-WT3-4-35CM	75.9	4	103	179	7.5	2.36	2.43	0.01	2.42	0.01	7.41	27.1
WDT-UL4-2-10CM	61.3	4	60	121	7.1	1.98	1.96	0.02	1.94	0.02	5.21	19.1
WDT-UL4-3-10CM	36.9	3	43	80	7.3	2.17	1.18	0.02	1.18	0.005	3.15	11.6
WDT-UL4-4-SED	28.8	3	48	77	7.4	2.68	0.92	0.01	0.91	0.01	2.67	9.8
WDT-UL4-5-SED	71.6	2	-24	48	7	0.67	2.29	0.03	2.25	0.04	0.91	3.3
WDT-UL4-6-SED	21.6	1	-8	14	6	0.65	0.69	0.02	0.68	0.01	0.14	0.5
WDT-ULX-1-53CM	47.8	4	93	141	7.4	2.95	1.53	0.005	1.52	0.01	5.74	21
WDT-ULX-1-5CM	39.4	3	54	93	6.5	2.36	1.26	0.07	1.17	0.09	4.29	15.7
WDT-PT1-5CM	11.3	3	95	106	7	9.42	0.36	0.02	0.35	0.01	4.45	16.3
WDT-PT6-10CM	43.8	3	85	129	7.1	2.95	1.4	0.03	1.35	0.05	5.69	20.8
WDT-WETLAND-POD7-7CM	7.2	2	17	24	7	3.34	0.23	0.01	0.23	0.005	1.58	5.8
WDT-WETLAND-POD7-18CM	11.9	2	24	36	7.2	3.03	0.38	0.01	0.38	0.005	3.53	12.9
WDT-PT8-4CM	52.2	2	-22	30	7.5	0.57	1.67	0.005	1.62	0.05	3.29	12.1
WDT-PT8-10CM	64.7	3	76	141	7.4	2.18	2.07	0.03	2.02	0.05	6.38	23.4
WDT-PT8-30CM	106.5	3	48	154	7.3	1.45	3.4	0.12	3.28	0.12	7.23	26.5
WDT-PT9-4CM	7.5	1	10	17	7	2.27	0.24	0.005	0.23	0.01	1.19	4.4
WDT-SL-13	20	2	9	29	6.6	1.45	0.64	0.03	0.62	0.02	1.69	6.2
WDT-GL2-SED	7.5	1	-1	7	6.3	0.93	0.24	0.01	0.23	0.01	0.07	0.2
WDT-GL1-SED	38.8	1	-17	22	7	0.57	1.24	0.11	1.08	0.16	0.18	0.7

ACCESS

Sample ID	Acidity (as CaCO3)	Alk, Total (as CaCO3)	Bromide (Br)	Chloride (Cl)	Cond.	Fluoride (F)	Nitrate (as N)	Nitrite (as N)	pH	Sulfate (SO4)	Anion Sum	Cation Sum	Anion Balance	Al_LCH (mg/L)	Sb_LCH (mg/L)	As_LCH (mg/L)	Ba_LCH (mg/L)	Be_LCH (mg/L)	Bi_LCH (mg/L)	B_LCH (mg/L)	Cd_LCH (mg/L)	Ca_LCH (mg/L)	Cr_LCH (mg/L)
WDT-WT2-3-5CM	23.1	35.6	<0.050	<0.50	326	0.043	0.0991	<0.0010	7.18	124	3.3	3.47	2.5	0.083	0.0872	0.012	0.0621	<0.0010	<0.0010	<0.020	0.215	38	<0.0010
WDT-WT2-3-15CM	12	15.8	<0.050	<0.50	117	0.025	0.026	<0.0010	7.24	39.5	1.14	1.45	11.9	0.263	0.165	0.0272	0.0524	<0.00050	<0.00050	<0.010	0.123	11.4	0.00132
WDT-WT2-3-25CM	21.9	31.1	<0.050	<0.50	158	0.036	<0.0050	<0.0010	6.99	45.7	1.57	1.47	-3.5	0.005	0.0641	0.0053	0.0961	<0.0010	<0.0010	<0.020	0.258	13.7	<0.0010
WDT-WT2-3-60CM	19.7	13.2	<0.050	<0.50	222	0.111	0.868	0.133	6.47	90.4	2.22	2.75	10.6	0.478	0.0102	0.0229	0.0855	<0.0010	<0.0010	<0.020	0.00982	25	0.0012
WDT-WT3-4-15CM	3	74.3	<0.050	<0.50	285	0.086	<0.0050	<0.0010	6.97	71.2	2.97	2.82	-2.7	0.0209	0.0549	0.0051	0.111	<0.00050	<0.00050	<0.010	0.00881	43.3	0.00025
WDT-WT3-4-35CM	7.5	37.5	<0.050	<0.50	157	0.021	<0.0050	0.0014	7.49	39.1	1.56	1.43	-4.5	0.0025	0.00934	0.0012	0.149	<0.00050	<0.00050	<0.010	0.217	16.6	0.00025
WDT-UL4-2-10CM	40.9	28.5	<0.050	<0.50	438	0.043	0.157	0.0028	7.16	190	4.54	4.17	-4.2	0.0125	0.0111	0.0025	0.0647	<0.0025	<0.0025	<0.050	0.555	48.1	0.00125
WDT-UL4-3-10CM	1.9	109	<0.050	<0.50	409	0.076	<0.0050	<0.0010	7.21	104	4.35	3.96	-4.6	0.0078	0.0789	0.0048	0.0917	<0.00050	<0.00050	<0.010	0.000669	57.4	0.00025
WDT-UL4-4-SED	4.3	192	<0.050	<0.50	489	0.12	0.103	0.0469	7.17	73.6	5.38	5.25	-1.2	0.0906	0.0249	0.0109	0.174	<0.00050	<0.00050	0.015	0.00471	71.8	0.00025
WDT-UL4-5-SED	4.1	93	<0.50	<5.0	1400	<0.20	<0.050	<0.010	6.63	818	18.9	15.9	-8.6	0.032	0.973	0.0145	0.391	<0.0010	<0.0010	<0.020	0.00113	240	0.0005
WDT-UL4-6-SED	2.6	13.2	<0.050	<0.50	655	0.036	0.0531	0.0154	6.17	321	6.96	6.6	-2.6	0.0328	0.639	0.0099	0.183	<0.00050	<0.00050	0.012	0.000145	95.7	0.00025
WDT-ULX-1-53CM	8.2	43.8	<0.050	<0.50	226	<0.020	0.0065	0.0053	7.36	64.4	2.22	2.06	-3.8	0.0025	0.044	0.0128	0.126	<0.00050	<0.00050	<0.010	0.298	25.6	0.00025
WDT-ULX-1-5CM	60.8	5.4	<0.050	<0.50	548	0.046	0.0492	<0.0010	6.98	268	5.69	5.2	-4.5	0.0125	0.00166	0.0025	0.0281	<0.0025	<0.0025	<0.050	1.52	64.1	0.00125
WDT-PT1-5CM	8	28.3	<0.050	<0.50	129	<0.020	0.186	<0.0010	7.1	34.3	1.29	1.53	8.6	0.196	0.0738	0.0441	0.0548	<0.00050	<0.00050	<0.010	0.132	12.7	0.00074
WDT-PT6-10CM	32.3	22	<0.050	<0.50	179	<0.020	0.006	<0.0010	7.13	63	1.75	1.56	-5.8	0.0075	0.00169	0.0015	0.0209	<0.0015	<0.0015	<0.030	0.712	10.5	0.00075
WDT-WETLAND-POD7-7CM	4.6	35.3	<0.050	<0.50	128	0.045	0.329	0.0012	7.22	29.9	1.35	1.89	16.4	0.655	0.0765	0.0339	0.0459	<0.00050	<0.00050	<0.010	0.108	15.2	0.00152
WDT-WETLAND-POD7-18CM	3.6	51.5	<0.050	<0.50	166	0.052	0.0741	<0.0010	7.33	32.6	1.72	1.98	7.2	0.125	0.0776	0.0506	0.0451	<0.00050	<0.00050	<0.010	0.102	22.2	0.00025
WDT-PT8-4CM	<1.0	64.1	<0.050	<0.50	478	0.028	0.0698	0.002	7.93	190	5.24	4.96	-2.7	0.0025	0.00025	0.0005	<0.0010	<0.00050	<0.00050	<0.010	0.0101	67.8	0.00025
WDT-PT8-10CM	21.7	34	<1.0	<10	2310	<0.40	<0.10	<0.020	7.49	1580	33.5	30.4	-4.8	0.0075	0.00308	0.0031	0.0161	<0.0015	<0.0015	<0.030	0.569	555	0.00075
WDT-PT8-30CM	23	35.2	<1.0	<10	2320	<0.40	<0.10	<0.020	7.53	1560	33.2	29.6	-5.8	0.0075	0.015	0.0015	0.0229	<0.0015	<0.0015	<0.030	0.341	548	0.00075
WDT-PT9-4CM	4.3	29.7	<0.050	<0.50	83.4	0.027	0.182	<0.0010	7.37	12.6	0.87	1.42	24	1.51	0.0449	0.0166	0.0444	<0.00050	<0.00050	<0.010	0.0739	8.23	0.00261
WDT-SL-13	6.1	30.2	<0.50	<5.0	1160	<0.20	<0.050	<0.010	6.71	669	14.5	13.3	-4.4	0.0086	0.0364	0.0014	0.0559	<0.00050	<0.00050	0.014	0.0286	201	0.00025
WDT-GL2-SED	3.6	24	<0.50	<5.0	1040	<0.20	<0.050	<0.010	5.93	600	13	10.3	-11.4	0.0465	0.00588	0.0046	0.446	<0.00050	<0.00050	0.014	0.000231	142	0.00025
WDT-GL1-SED	4.4	8.7	<0.50	<5.0	1210	<0.20	0.058	0.098	6.05	686	14.5	13.8	-2.2	0.0418	0.0175	0.0152	0.643	<0.00050	<0.00050	0.026	0.000269	194	0.00025

Sample ID	Co_LCH (mg/L)	Cu_LCH (mg/L)	Fe_LCH (mg/L)	Pb_LCH (mg/L)	Li_LCH (mg/L)	Mg_LCH (mg/L)	Mn_LCH (mg/L)	Hg_LCH (mg/L)	Mo_LCH (mg/L)	Ni_LCH (mg/L)	P_LCH (mg/L)	K_LCH (mg/L)	Se_LCH (mg/L)	Si_LCH (mg/L)	Ag_LCH (mg/L)	Na_LCH (mg/L)	Sr_LCH (mg/L)	Tl_LCH (mg/L)	Sn_LCH (mg/L)	Ti_LCH (mg/L)	U_LCH (mg/L)	V_LCH (mg/L)	Zn_LCH (mg/L)
WDT-WT2-3-5CM	0.00123	0.0098	2.45	0.784	<0.010	9.84	0.39	<0.000050	0.00096	0.0094	<0.30	1.43	0.0005	12.5	0.0101	0.44	0.11	<0.00020	<0.0010	<0.010	0.00013	<0.0020	18.2
WDT-WT2-3-15CM	0.00178	0.0627	5.89	2.54	<0.0050	2.27	0.996	0.000251	0.00046	0.00462	<0.30	0.696	0.00025	2.8	0.128	0.188	0.0335	<0.00010	0.00191	<0.010	0.000189	<0.0010	9.31
WDT-WT2-3-25CM	0.00538	0.0029	0.129	0.179	<0.010	2.19	2.2	<0.000050	0.0002	0.0092	<0.30	0.45	0.0005	1.93	0.00035	0.1	0.0358	<0.00020	<0.0010	<0.010	0.000029	<0.0020	16.4
WDT-WT2-3-60CM	0.0219	0.0161	6.44	0.089	<0.010	4.12	1.62	0.000127	0.0035	0.0488	<0.60	0.99	0.0013	3.73	0.00396	0.7	0.0607	<0.00020	<0.0010	0.041	0.000282	0.0114	21.3
WDT-WT3-4-15CM	0.00082	0.0058	1.1	0.151	<0.0050	5.61	1.6	<0.000050	0.00151	0.00656	<0.30	0.632	0.00064	1.05	0.00294	0.128	0.136	<0.00010	<0.00050	<0.010	0.000108	<0.0010	1.72
WDT-WT3-4-35CM	0.00602	0.0134	0.015	0.257	<0.0050	3.36	2.27	<0.000050	0.00197	0.00407	<0.30	1.12	0.00025	1.11	0.000612	0.187	0.0503	<0.00010	<0.00050	<0.010	0.000015	<0.0010	6.69
WDT-UL4-2-10CM	0.00697	0.0025	0.015	0.165	<0.025	4.92	2.93	<0.000050	0.000025	0.0274	<0.30	2.01	0.00125	1	0.00055	<0.25	0.11	<0.00050	<0.0025	<0.010	0.000025	<0.0050	39.6
WDT-UL4-3-10CM	0.00191	0.0038	1.06	0.0444	<0.0050	11.2	1.57	<0.000050	0.0027	0.00602	<0.30	0.273	0.00064	2.42	0.000295	0.565	0.166	<0.00010	<0.00050	<0.010	0.000522	<0.0010	0.954
WDT-UL4-4-SED	0.00238	0.013	3.4	0.176	<0.0050	15.5	2.29	0.000059	0.00828	0.00676	<0.30	1.74	0.00151	3.52	0.00381	1.18	0.254	<0.00010	<0.00050	0.015	0.00126	0.0033	0.576
WDT-UL4-5-SED	0.0103	0.0045	0.066	0.0916	<0.010	44	4.54	<0.000050	0.0106	0.0145	<0.30	1.46	0.0013	3.15	0.00241	1.32	0.695	<0.00020	<0.0010	0.013	0.000891	<0.0020	0.698
WDT-UL4-6-SED	0.00404	0.0014	0.093	0.0185	<0.0050	20.5	1.9	<0.000050	0.00489	0.00577	<0.30	0.947	0.00072	2.06	0.000479	0.821	0.294	<0.00010	<0.00050	<0.010	0.000056	0.001	0.26
WDT-ULX-1-53CM	0.011	0.0005	0.015	0.148	<0.0050	5.13	3.68	<0.000050	0.00224	0.025	<0.30	1.08	0.00025	2.68	<0.000050	0.32	0.055	0.00032	<0.00050	<0.010	0.000092	<0.0010	6
WDT-ULX-1-5CM	0.00393	0.0025	0.015	0.0295	<0.025	4.09	2.41	<0.000050	0.000025	0.0238	<0.30	1.24	0.00125	0.378	<0.00025	0.48	0.109	<0.00050	<0.0025	<0.010	0.000025	<0.0050	49.8
WDT-PT1-5CM	0.00119	0.0318	4.98	2.39	<0.0050	3.44	0.48	0.00166	0.0004	0.00329	<0.30	1.41	0.00025	2.01	0.179	0.232	0.0351	<0.00010	0.00184	<0.010	0.000139	0.001	8.57
WDT-PT6-10CM	0.00048	0.0015	0.015	0.0528	<0.015	1.48	0.226	<0.000050	0.000015	0.0034	<0.30	1.4	0.00055	0.819	<0.00015	<0.15	0.0182	<0.00030	<0.0015	<0.010	0.000015	<0.0030	28.3
WDT-WETLAND-POD7-7CM	0.0014	0.0416	8.23	1.73	<0.0050	3.55	0.416	0.00133	0.00115	0.00507	<0.30	0.812	0.00094	2.94	0.132	0.401	0.0474	<0.00010	0.00133	0.033	0.000203	0.0048	8.72
WDT-WETLAND-POD7-18CM	0.00076	0.0521	5.45	1.86	<0.0050	4.26	0.445	0.00228	0.00065	0.00263	<0.30	0.776	0.00098	2.2	0.185	0.237	0.0656	<0.00010	0.00143	<0.010	0.0001	<0.0010	5.56
WDT-PT8-4CM	<0.00010	0.0005	0.015	0.00028	<0.0050	18.8	0.00189	<0.000050	0.00005	<0.00050	<0.30	0.982	0.00025	0.172	0.000092	<0.050	0.0753	<0.00010	<0.00050	<0.010	0.000005	<0.0010	0.063
WDT-PT8-10CM	0.0104	0.0015	0.015	0.0463	<0.015	21.2	5.84	<0.000050	0.000015	0.012	<0.30	1.88	0.00055	0.848	<0.00015	<0.15	0.343	<0.00030	<0.0015	0.012	0.000238	<0.0030	21.5
WDT-PT8-30CM	0.0201	0.0015	0.015	0.139	<0.015	17.3	7.65	<0.000050	0.00036	0.0301	<0.30	1.97	0.00055	1.38	<0.00015	<0.15	0.43	<0.00030	<0.0015	0.012	0.000735	<0.0030	15.8
WDT-PT9-4CM	0.00119	0.0308	6.88	0.75	<0.0050	3.01	0.196	0.000498	0.00069	0.00577	<0.30	0.838	0.00025	4.13	0.0442	0.285	0.0243	<0.00010	0.00055	0.051	0.000132	0.0058	5.96
WDT-SL-13	0.00045	0.0053	0.148	0.0212	<0.0050	36.4	0.596	<0.000050	0.00075	0.02	<0.30	1.62	0.00208	1.26	0.00175	0.604	0.566	<0.00010	<0.00050	0.012	0.000039	<0.0010	5.56
WDT-GL2-SED	0.0248	0.0036	0.386	0.00545	0.0068	32.1	12.7	<0.000050	0.00047	0.0275	<0.30	1.51	0.00128	4.45	0.000381	1.09	0.507	<0.00010	<0.00050	0.012	0.000069	<0.0010	0.49
WDT-GL1-SED	0.101	0.0021	0.186	0.0212	0.0074	36.8	28	<0.000050	0.00043	0.166	<0.30	0.73	0.00187	6.96	0.000497	1.12	0.679	<0.00010	<0.00050	0.012	0.000115	<0.0010	0.706

APPENDIX B

UPPER KENO LADUE WATER SAMPLING RAW DATA

Station Name	Description	Sample Date	Discharge (Flow)	Discharge RPD	Water Level	Total Suspended Solids	pH (field)	pH (lab)	Specific Conductance (field)	Specific Conductance (lab)	Temperature (field)	Dissolved Oxygen (field)	Dissolved Oxygen (field)	ORP (field)	Hardness (from total)	Hardness (from dissolved)	Alkalinity, total	Alkalinity, bicarbonate HCO3	Chloride	Fluoride	Sulphate, dissolved	Cyanide, total	Ammonia (N)	Nitrite (N)	Nitrate (N)	Total Kjeldahl Nitrogen	Phosphate, total	Dissolved Organic Carbon	Total Organic Carbon	Aluminum (Al), total	Calculated Al-T CCME PAL	Antimony (Sb), total	Arsenic (As), total
			L/s	%	m	mg/L	pH units	pH units	µS/cm	µS/cm	C	mg/L	%	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CCME Guidelines - Protection of Aquatic Life							6.5-9	6.5-9				5.5							120	0.12			0.239	0.06	3					*			0.005
CCME Guidelines - Protection of Aquatic Life vs. Dissolved Metals							6.5-9	6.5-9				5.5							120	0.12			0.239	0.06	3								
Keno District Background Water Quality (Minnow, 2013)						20.7	7.17-8.49	7.44-8.30	699	714	5.2	10.3	72	349	384	389	93	113	1.3		221		0.031	0.056	0.31	0.44	0.027	9.26		0.15		0.001	0.0034
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	20/10/2012				2	8.01	8.17	624.4	725	-0.1	14.14	96.9	82.1	389	386	191	234	0.75		194	<0.00050	0.028	<0.050	<0.20	<0.20	0.0035	2.36		0.0075	0.1	0.0009	0.0009
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	06/06/2013	182	6.53		128	7.84	7.82	249.2	317	2.1	14.23	102.4	112.9	165	165	78.4		<0.50	0.049	76.1	<0.0050	0.0190	<0.0010	0.0318	0.65	0.0873	9.42		**1.34**	0.1	0.0051	**0.007**
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	30/08/2013	10.654	22.2		<1.0	7.95	8.24	768.7	787	9.8	11.94	92.7	149.01	447	448	221		<0.50	0.116	242	<0.0050	0.0083	<0.0010	0.0430	0.089	<0.0020	1.80		0.0033	0.1	0.0013	0.001
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	27/09/2013				3.3		8.05		490					323	304	144		<0.50	0.086	153		0.0104	<0.0010	0.0857			5.26	5.38	0.0592	0.1	0.001	0.0009
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	27/09/2013	52	1.3		3.3	7.88	8.04	532	503	1.7	11.4	91	122	324	305	152		<0.50	0.085	153		<0.0050	<0.0010	0.0861			5.15	5.30	0.0639	0.1	0.0012	0.001
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	20/10/2012	28.4	16		2.1	8.1	8.22	548.3	627	0.7	15.63	109.3	170.3	338	333	161	196	<0.50		169	<0.00050	0.015	<0.050	<0.20	0.26	0.006	6.61		0.0142	0.1	0.0141	0.0015
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	07/06/2013				3.4	7.53	7.71	271.5	322	11.4	9.28	84.7	58.9	169	170	82.1		<0.50	0.051	76.5	<0.0050	0.0075	<0.0010	<0.0050	0.358	0.0135	11.9		0.0676	0.1	0.0053	0.00150
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	29/08/2013	16.821	2		2.8	8.08	8.20	494.1	491	10.3	9.58	84.9	190.1	263	259	124		<0.50	0.083	157	<0.0050	0.0113	<0.0010	0.0052	0.340	0.0078	6.81		0.0545	0.1	0.0170	0.0018
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	27/09/2013	40	23.3		<3.0	7.71	8.27	508.3	434	4.9	7.6	66	27.2	272	268	108		<0.50	0.083	154		<0.0050	<0.0010	<0.0050			6.08	6.29	0.0198	0.1	0.0150	0.0012
KL-12	Ladue Creek d/s Gambler Gulch	19/10/2012				<1.0	7.89	8.14	603.8	548	0.3	14.24	98.4	69.4	282	283	138	168	<0.50		146	<0.00050	0.016	<0.050	<0.20	0.3	0.0038	4.56		0.0119	0.1	0.0066	0.0009
KL-12	Ladue Creek d/s Gambler Gulch	07/06/2013	399	1.46		11.2	7.48	7.63	223.5	266	7.4	10.85	87.4	56.7	139	139	66.6		<0.50	0.048	61.9	<0.0050	0.0062	<0.0010	0.0257	0.41	0.0177	12.3		**0.256**	0.1	0.0029	0.0017
KL-12	Ladue Creek d/s Gambler Gulch	07/06/2013				10.6		7.69		266					133	133	68.4		<0.50	0.049	62.1	<0.0050	0.0065	<0.0010	0.0270	0.47	0.0179	12.4		**0.172**	0.1	0.0028	0.0015
KL-12	Ladue Creek d/s Gambler Gulch	30/08/2013	43.196	26.8		<1.0	7.89	8.20	502	508	6.4	10.73	86.5	157.5	272	269	114		<0.50	0.065	154	<0.0050	<0.0050	<0.0010	0.0733	0.199	0.0036	4.23		0.0111	0.1	0.0061	0.0008
KL-12	Ladue Creek d/s Gambler Gulch	27/09/2013	208	1.8		<3.0	7.73	7.86	388.1	362	3	11.6	96	89.1	224	221	94.1		<0.50	0.061	119		<0.0050	<0.0010	0.0990			7.66	7.65	0.0267	0.1	0.0051	0.0007
KL-13	Ladue Creek u/s confluence w Ladue Lake	19/10/2012	75.0	10		<1.0	7.65	8.06	435.5	393	0	13.92	96.2	73.2	200	202	106	129	<0.50		92.8	<0.00050	0.017	<0.050	<0.20	0.3	0.0052	8.63		0.0075	0.1	0.003	0.0006
KL-13	Ladue Creek u/s confluence w Ladue Lake	06/06/2013	602	1.8		1.6	7.61	7.76	257.4	310	10.3	10.6	93.8	73.3	162	160	76.8		<0.50	0.049	72.7	<0.0050	<0.0050	<0.0010	<0.0050	0.322	0.0082	11.4		0.0251	0.1	0.0019	0.0008
KL-13	Ladue Creek u/s confluence w Ladue Lake	30/08/2013	6.165	0.7		<1.0	7.64	8.15	286	284	7.4	10.2	83.8	155.1	155	154	100		<0.50	0.049	50.4	<0.0050	0.0056	<0.0010	<0.0050	0.354	0.0064	11.2		0.0078	0.1	0.0005	0.00070
KL-14	Gambler Gulch	20/10/2012																													[1]		
KL-14	Gambler Gulch	06/06/2013																													[1]		
KL-14	Gambler Gulch	29/08/2013	19.762	6.4		<1.0	7.75	8.18	285.3	515	1.6	12.6	89.8	188.6	282	275	123		<0.50	0.053	153	<0.0050	<0.0050	<0.0010	0.143	0.085	<0.0020	2.45		0.0066	0.1	0.0001	0.0004
KL-14	Gambler Gulch	27/09/2013	88	20.9		<3.0	7.37	7.97	424.6	391	1.5	12	96	64	251	236	104		<0.50	0.065	131		<0.0050	<0.0010	0.215			3.87	4.01	0.0428	0.1	0.0001	0.0006
KL-15	Sadie Ladue 600 discharge at KHSD boundary	20/10/2012				<1.0	7.9	8.13	510.7	594	0	13.75	93.9	124.3	307	306	172	210	0.62		148	<0.00050	0.011	<0.050	<0.20	<0.20	<0.0020	0.58		0.0011	0.1	0.0044	0.0005
KL-15	Sadie Ladue 600 discharge at KHSD boundary	06/06/2013				18.2	7.61	7.85	257.7	304	3.8	13.62	103.2	220.8	156	153	74.3		<0.50	0.027	75.9	<0.0050	<0.0050	<0.0010	0.0653	0.43	0.0243	9.71		**0.319**	0.1	0.0077	0.0028
KV-35	Sadie Ladue Adit	10/10/2012				<1.0	6.95	8.17	662.1	565	1.1	13.12	92.9	202.5	329	295														<0.010	0.1	0.0043	0.004
KV-35	Sadie Ladue Adit	20/10/2012				<1.0	7.75	8.07	486.7	557	1.1	13.54	96.8	141	287	290	157	191	<0.50		141	<0.00050	0.011	<0.050	<0.20	<0.20	<0.0020	<0.50		0.0011	0.1	0.0038	0.0038
KV-35	Sadie Ladue Adit	16/11/2012				<1.0		8.14		554					277	282														<0.010	0.1	0.0035	0.0035
KV-35	Sadie Ladue Adit	16/11/2012				<1.0	7.29	8.25	584	552	1.2	12.2	91	361	289	292														<0.010	0.1	0.0037	0.0038
KV-35	Sadie Ladue Adit	06/12/2012				<1.0	7.45	8.15	623	549	1.23			127.7	311	296														<0.010	0.1	0.0041	0.004
KV-35	Sadie Ladue Adit	11/01/2013				<1.0	6.99	8.18	609	569	1.12	13.29	94.1		286	304														<0.010	0.1	0.0038	0.004
KV-35	Sadie Ladue Adit	11/01/2013				<1.0		8.21		568					286	303														<0.010	0.1	0.0037	0.0039
KV-35	Sadie Ladue Adit	12/02/2013				<1.0	7.86	8.33	270.4	569	1.2	13.7	101.3	178.1	305	305														<0.010	0.1	0.0038	0.0034
KV-35	Sadie Ladue Adit	07/03/2013				<1.0	7.71	8.3	350	572	0.8	15.28	112	-18.3	314	315														<0.010	0.1	0.004	0.0031
KV-35	Sadie Ladue Adit	13/04/2013				<1.0	8.09	8.10	387.6	551	1.2	13.57	98.4	120.4	319	320														0.0040	0.1	0.0042	0.0033
KV-35	Sadie Ladue Adit	04/05/2013				<1.0	7.48	8.27	576.6	563	1.3	11.69	86.2	111.3	314	310														<0.030	0.1	0.0043	0.0031
KV-35	Sadie Ladue Adit	01/06/2013				296	6.91	7.71	287.3	259	2.4	10.44	78.7	21.7	298	139														**4.51**	0.1	0.0080	**0.0159**
KV-35	Sadie Ladue Adit	06/06/2013				1.0	7.14	7.67	344.5	420	2.1	13.67	102.5	209.8	230	220	104		<0.50	0.028	106	<0.0050	<0.0050	<0.0010	0.0297	0.190	0.0065	6.03		0.0483	0.1	0.0101	0.0029
KV-35	Sadie Ladue Adit	03/07/2013				<1.0	7.46	8.05	712.5	622	2.2	12.11	91.2	81.4	352	350														<0.030	0.1	0.0075	0.0032
KV-35	Sadie Ladue Adit	07/08/2013				<1.0	7.64	7.99	656.2	615	1.9	13.55	100.5	175.6	348	343														<0.030	0.1	0.0055	0.0031
KV-35	Sadie Ladue Adit	30/08/2013				<1.0	7.6	8.19	558.9	566	1.8	11.81	87.8	168.8	310	308	175		<0.50	0.039	135	<0.0050	<0.0050	<0.0010	0.0965	<0.050	<0.0020	<0.50		<0.030	0.1	0.0047	0.0037
KV-35	Sadie Ladue Adit	03/09/2013				<1.0	7.37	7.80	568.4	534	1.5	12.82	94.8	181.7	328	331														<0.030	0.1	0.0043	0.0038
KV-35	Sadie Ladue Adit	03/10/2013				<1.0	7.31	8.13	787.5	554	1.4	10.21	75.3	188.3	375	390														<0.030	0.1	0.0051	0.0032
UL-W1	Wernecke Lake NE of tailings fan	27/09/2013			0.7	<3.0	8.05	8.32	476.1	451					280	271	111		<0.50	0.084	157		<0.0050	<0.0010	<0.0050			5.75	5.77	0.0118	0.1	0.0154	0.0011
UL-W2	Wernecke Lake NW of tailings fan	27/09/2013			0.7	<3.0	8.13	8.35	472.3	443					283	271	110		<0.50	0.084	157		<0.0050	<0.0010	<0.0050			5.75	5.79	0.0098	0.1	0.0168	0.0012
GL-1-1m	Gambler Lake at a 1 m depth	27/09/2013				<3.0	7.91	8.10	324.9	320					192	187	93.9		<0.50	0.062	88.2		0.0062	<0.0010	<0.0050			8.26	8.55	0.0065	0.1	0.003	0.0008
GL-1-3m	Gambler Lake at a 3 m depth	27/09/2013				<3.0	7.88	8.12	324.5	318					201	183	93.9		<0.50	0.063	88.1		<0.0050	<0.0010	<0.0050			8.40	8.50	0.0147	0.1	0.0031	0.0019

Notes: [1]pH not recorded for this sample

[2]Hardness is 0 or not recorded for this sample

Red Exceeds CCME Guidelines

Station Name	Description	Barium (Ba), total	Beryllium (Be), total	Bismuth (Bi), total	Boron (B), total	Cadmium (Cd), total	Calculated Cd-T CCME PAL	Calcium (Ca), total	Chromium (Cr), total	Cobalt (Co), total	Copper (Cu), total	Calculated Cu-T CCME PAL	Iron (Fe), total	Lead (Pb), total	Calculated Pb-T CCME PAL	Lithium (Li), total	Magnesium (Mg), total	Manganese (Mn), total	Mercury (Hg), total	Molybdenum (Mo), total	Nickel (Ni), total	Calculated Ni-T CCME PAL	Phosphorus (P), total	Potassium (K), total	Selenium (Se), total	Silicon (Si), total	Silver (Ag), total	Sodium (Na), total
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CCME Guidelines - Protection of Aquatic Life					1.5	*			0.001		*		0.3	*					0.000026	0.073	*				0.001		0.0001	
CCME Guidelines - Protection of Aquatic Life vs. Dissolved Metals																												
Keno District Background Water Quality (Minnow, 2013)		0.082	0.000015	0.000007	0.05	0.000156		126	0.00088	0.00029	0.0028		0.41	0.0058		0.0054	18	0.243	0.00001	0.00035	0.0015		0.02	0.66	0.00109	4.1	0.00047	1.95
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.0452	<0.000010	<0.0000050	<0.050	**0.00304**	0.000107	114	<0.00010	0.000178	0.000361	0.004	**0.319**	0.000565	0.007	0.00468	25.5	0.178	<0.000010	0.000746	0.000993	0.15	0.0021	0.577	**0.00212**	3.36	0.000022	1.77
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.0662	<0.00010	<0.00050	<0.010	**0.00910**	0.0000509	45.6	**0.00254**	0.00162	**0.0110**	0.00363	**5.77**	**0.0967**	0.00602	0.00372	12.4	0.927	**0.000048**	0.00117	0.00724	0.140	0.170	0.68	0.00090	3.58	**0.00366**	0.818
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.0498	<0.00010	<0.00050	<0.010	**0.00278**	0.000120	130	<0.00010	0.00021	<0.00050	0.004	0.207	0.000346	0.007	0.00385	29.5	0.203	<0.000010	0.000857	0.00124	0.15	<0.050	0.60	**0.00207**	3.06	<0.000010	1.91
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.0447	<0.00010	<0.00050	<0.010	**0.00269**	0.0000908	92.5	0.00019	0.00020	0.00114	0.004	**0.335**	0.00159	0.007	0.00314	22.4	0.128	<0.000010	0.000663	0.00149	0.15	<0.050	0.43	**0.00169**	2.99	0.000026	1.42
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.0440	<0.00010	<0.00050	<0.010	**0.00283**	0.0000910	92.7	0.00024	0.00021	0.00120	0.004	**0.385**	0.00320	0.007	0.00338	22.4	0.145	<0.000010	0.000817	0.00152	0.15	<0.050	0.45	**0.00173**	2.95	0.000072	1.53
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.0443	<0.000010	<0.0000050	<0.050	**0.000327**	0.0000944	95.4	<0.00010	0.000047	0.000829	0.004	0.111	**0.00992**	0.007	0.00428	24.2	0.0509	<0.000010	0.00103	0.00125	0.15	<0.0020	0.436	**0.00143**	2.47	0.000092	1.74
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.0342	<0.00010	<0.00050	<0.010	**0.00331**	0.0000520	48.5	0.00020	0.00015	0.00252	0.00370	**0.372**	**0.0198**	0.00620	0.00199	11.6	0.118	<0.000010	0.000863	0.00194	0.142	<0.050	0.71	0.00047	1.92	**0.000429**	0.793
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.0452	<0.00010	<0.00050	<0.010	**0.000201**	0.0000761	69.6	0.00011	<0.00010	0.00101	0.004	0.142	**0.0117**	0.007	0.00245	21.6	0.0841	<0.000010	0.00148	0.00136	0.15	<0.050	0.33	0.00060	0.627	**0.000317**	1.34
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.0405	<0.00010	<0.00050	<0.010	**0.000391**	0.0000783	74.6	0.00016	<0.00010	0.00107	0.004	0.095	**0.00911**	0.007	0.00323	20.9	0.0425	<0.000010	0.00112	0.00142	0.15	<0.050	0.34	0.00073	1.02	**0.000170**	1.43
KL-12	Ladue Creek d/s Gambler Gulch	0.0497	<0.000010	<0.0000050	<0.050	**0.000172**	0.0000808	78.3	<0.00010	0.000099	0.000636	0.004	0.118	0.00235	0.007	0.00288	21.1	0.0517	<0.000010	0.000808	0.00165	0.15	<0.0020	0.371	**0.00133**	2.41	0.000026	1.39
KL-12	Ladue Creek d/s Gambler Gulch	0.0337	<0.00010	<0.00050	<0.010	**0.00162**	0.0000440	39.5	0.00057	0.00045	**0.00326**	0.00313	**0.855**	**0.0117**	0.00484	0.00144	9.91	0.0805	<0.000010	0.000667	0.00361	0.123	<0.050	0.53	0.00064	1.99	**0.000237**	0.590
KL-12	Ladue Creek d/s Gambler Gulch	0.0347	<0.00010	<0.00050	<0.010	**0.00171**	0.0000423	37.0	0.00042	0.00031	0.00299	0.00302	**0.563**	**0.00895**	0.00457	0.00132	9.86	0.0734	<0.000010	0.000645	0.00313	0.119	<0.050	0.55	0.00060	1.84	**0.000208**	0.649
KL-12	Ladue Creek d/s Gambler Gulch	0.0528	<0.00010	<0.00050	<0.010	**0.000085**	0.0000783	72.6	0.00013	<0.00010	0.00073	0.004	0.113	0.00148	0.007	0.00146	22.2	0.0554	<0.000010	0.000905	0.00148	0.15	<0.050	0.33	**0.00115**	1.50	0.000024	1.28
KL-12	Ladue Creek d/s Gambler Gulch	0.0402	<0.00010	<0.00050	<0.010	**0.000235**	0.0000663	60.2	0.00015	0.00012	0.00108	0.004	0.138	0.00255	0.007	0.00236	17.9	0.0430	<0.000010	0.000648	0.00253	0.15	<0.050	0.28	**0.00104**	1.93	0.000050	1.04
KL-13	Ladue Creek u/s confluence w Ladue Lake	0.0363	<0.000010	<0.0000050	<0.050	0.000024	0.0000601	55.6	<0.00010	0.000045	0.00101	0.004	0.0619	0.000239	0.007	0.00227	14.9	0.0423	<0.000010	0.000569	0.00188	0.15	0.0051	0.356	0.000642	1.44	0.000005	0.979
KL-13	Ladue Creek u/s confluence w Ladue Lake	0.0327	<0.00010	<0.00050	<0.010	**0.000266**	0.0000501	45.1	0.00011	<0.00010	0.00124	0.00357	0.132	0.000935	0.00588	0.00184	12.1	0.0342	<0.000010	0.000531	0.00212	0.138	<0.050	0.44	0.00046	1.45	0.000035	0.787
KL-13	Ladue Creek u/s confluence w Ladue Lake	0.0363	<0.00010	<0.00050	<0.010	0.000019	0.0000483	42.7	<0.00010	<0.00010	<0.00050	0.00344	0.116	0.000079	0.00556	0.00114	11.8	0.0232	<0.000010	0.000307	0.00144	0.133	<0.050	0.36	0.00023	1.93	<0.000010	0.671
KL-14	Gambler Gulch						[2]					[2]			[2]							[2]						
KL-14	Gambler Gulch						[2]					[2]			[2]							[2]						
KL-14	Gambler Gulch	0.0613	<0.00010	<0.00050	<0.010	**0.000111**	0.0000808	75.4	<0.00010	0.00013	0.00056	0.004	0.055	<0.000050	0.007	0.00105	22.9	0.0533	<0.000010	0.000617	0.00171	0.15	<0.050	0.33	**0.00153**	2.35	<0.000010	1.26
KL-14	Gambler Gulch	0.0501	<0.00010	<0.00050	<0.010	**0.000187**	0.0000731	66.6	0.00018	0.00026	0.00107	0.004	0.108	0.000083	0.007	0.00253	20.7	0.0373	<0.000010	0.000526	0.00376	0.15	<0.050	0.29	**0.00155**	2.53	<0.000010	1.14
KL-15	Sadie Ladue 600 discharge at KHSD boundary	0.0316	<0.000010	<0.0000050	<0.050	**0.00966**	0.0000869	82.1	<0.00010	0.000047	0.000306	0.004	0.0196	0.000506	0.007	0.00268	24.7	0.0282	<0.000010	0.00223	0.00385	0.15	<0.0020	0.591	0.000519	3.17	0.000009	1.83
KL-15	Sadie Ladue 600 discharge at KHSD boundary	0.0232	<0.00010	<0.00050	<0.010	**0.0298**	0.0000485	40.7	0.00068	0.00048	**0.00769**	0.00346	**3.28**	**0.0803**	0.00560	0.00168	13.2	0.808	**0.000040**	0.00140	0.00630	0.134	<0.050	0.66	0.00053	2.06	**0.00224**	0.664
KV-35	Sadie Ladue Adit	0.0127	<0.00020	<0.0010	<0.10	**0.00227**	0.0000922	85.8	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.00109	0.007	<0.010	27.8	0.0097	**<0.00020**	0.0041	0.0114	0.15	<0.040	<1.0	0.00081	3.7	<0.00010	2.1
KV-35	Sadie Ladue Adit	0.0105	<0.000010	<0.0000050	<0.050	**0.00176**	0.0000820	78.5	<0.00010	0.000071	0.000494	0.004	0.0058	0.0008	0.007	0.00324	22.2	0.00848	<0.000010	0.00345	0.00866	0.15	<0.0020	0.609	0.000647	3.39	0.000015	1.84
KV-35	Sadie Ladue Adit	0.0099	<0.00020	<0.0010	<0.10	**0.00158**	0.0000795	72.6	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.00082	0.007	<0.010	23.2	0.0121	**<0.00020**	0.0032	0.0082	0.15	<0.040	<1.0	<0.00080	3.2	<0.00010	1.9
KV-35	Sadie Ladue Adit	0.0106	<0.00020	<0.0010	<0.10	**0.00171**	0.0000825	75.7	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.00097	0.007	<0.010	24.3	0.0134	**<0.00020**	0.0036	0.0095	0.15	<0.040	<1.0	<0.00080	3.4	<0.00010	2
KV-35	Sadie Ladue Adit	0.0114	<0.00020	<0.0010	<0.10	**0.00181**	0.0000879	80.4	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0011	0.007	<0.010	26.7	0.0171	**<0.00020**	0.0035	0.0098	0.15	<0.040	<1.0	<0.00080	3.7	<0.00010	2.2
KV-35	Sadie Ladue Adit	0.0113	<0.00020	<0.0010	<0.10	**0.00188**	0.0000817	74.1	**<0.0020**	<0.00050	0.0011	0.004	0.033	0.00282	0.007	<0.010	24.6	0.0274	**<0.00020**	0.0029	0.009	0.15	<0.040	<1.0	<0.00080	3.2	<0.00010	2.1
KV-35	Sadie Ladue Adit	0.0111	<0.00020	<0.0010	<0.10	**0.00181**	0.0000817	73.9	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.00126	0.007	<0.010	24.6	0.0171	**<0.00020**	0.0028	0.0087	0.15	<0.040	<1.0	<0.00080	3.2	<0.00010	2.1
KV-35	Sadie Ladue Adit	0.0114	<0.00020	<0.0010	<0.10	**0.00173**	0.0000864	75.6	**<0.0020**	<0.00050	<0.0010	0.004	0.027	0.00097	0.007	<0.010	28.3	0.0138	**<0.00020**	0.0032	0.0087	0.15	<0.040	<1.0	<0.00080	3.2	<0.00010	2.5
KV-35	Sadie Ladue Adit	0.012	<0.00020	<0.0010	<0.10	**0.00188**	0.0000886	81.6	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.00084	0.007	<0.010	26.7	0.0147	**<0.00020**	0.003	0.0089	0.15	<0.040	<1.0	<0.00080	3.1	<0.00010	2.4
KV-35	Sadie Ladue Adit	0.0119	<0.00010	<0.00050	<0.010	**0.00199**	0.0000898	81.3	0.00018	<0.00010	0.00108	0.004	0.019	0.00190	0.007	0.00252	28.0	0.0166	<0.000010	0.00280	0.00852	0.15	<0.050	0.70	0.00054	3.04	0.000036	2.38
KV-35	Sadie Ladue Adit	0.0120	<0.0010	<0.0050	<0.10	**0.00193**	0.0000886	82.0	<0.0010	<0.0010	**<0.0050**	0.004	0.018	0.00175	0.007	<0.0050	26.6	0.0135	**<0.000050**	0.00275	0.0084	0.15	<0.050	0.63	<0.0010	3.04	<0.00010	2.20
KV-35	Sadie Ladue Adit	0.235	<0.0010	<0.0050	<0.10	**0.0130**	0.0000847	75.5	**0.0060**	0.0104	**0.0574**	0.004	**11.9**	**0.0692**	0.007	<0.0050	26.5	0.939	**<0.000050**	0.00172	0.0399	0.15	3.70	1.23	<0.0010	6.83	**0.00097**	0.69
KV-35	Sadie Ladue Adit	0.0110	<0.00010	<0.00050	<0.010	**0.00756**	0.0000678	59.2	0.00016	0.00021	**0.00953**	0.004	0.085	**0.00982**	0.007	0.00174	19.9	0.0566	0.000017	0.00208	0.0140	0.15	<0.050	0.69	0.00090	1.67	**0.000437**	0.858
KV-35	Sadie Ladue Adit	0.0130	<0.0010	<0.0050	<0.10	**0.00525**	0.0000977	87.9	<0.0010	<0.0010	**<0.0050**	0.004	0.011	0.00174	0.007	<0.0050	32.1	0.0181	**<0.000050**	0.00336	0.0143	0.15	<0.050	0.60	**0.0011**	2.49	<0.00010	1.75
KV-35	Sadie Ladue Adit	0.0122	<0.0010	<0.0050	<0.10	**0.00308**	0.0000968	89.2	<0.0010	<0.0010	**<0.0050**	0.004	<0.010	0.00103	0.007	<0.0050	30.4	0.0194	**<0.000050**	0.00321	0.0113	0.15	<0.050	0.66	<0.0010	3.12	<0.00010	2.06
KV-35	Sadie Ladue Adit	0.0118	<0.0010	<0.0050	<0.10	**0.00256**	0.0000876	79.8	<0.0010	<0.0010	**<0.0050**	0.004	<0.010	0.00114	0.007	<0.0050	26.8	0.0219	**<0.000050**	0.00332	0.0093	0.15	<0.050	0.62	<0.0010	2.96	<0.00010	1.94
KV-35	Sadie Ladue Adit	0.0135	<0.0010	<0.0050	<0.10	**0.00271**	0.0000920	83.5	<0.0010	<0.0010	**<0.0050**	0.004	0.011	0.00134	0.007	<0.0050	28.9	0.0244	**<0.000050**	0.00360	0.0100	0.15	<0.050	0.61	<0.0010	3.03	<0.00010	1.98
KV-35	Sadie Ladue Adit	0.0141	<0.0010	<0.0050	<0.10	**0.00301**	0.000103	97.7	<0.0010	<0.0010	**<0.0050**	0.004	<0.010	0.00096	0.007	<0.0050	31.9	0.0104	**<0.000050**	0.00351	0.0124	0.15	<0.050	0.62	<0.0010	2.96	<0.00010	1.98
UL-W1	Wernecke Lake NE of tailings fan	0.0422	<0.00010	<0.00050	<0.010	**0.000420**	0.0000803	77.0	0.00011	<0.00010	0.00088	0.004	0.062	**0.00895**	0.007	0.00311	21.3	0.0274	<0.000010	0.00112	0.00129	0.15	<0.050	0.34	0.00075	1.16	0.000094	1.42
UL-W2	Wernecke Lake NW of tailings fan	0.0414	<0.00010	<0.00050	<0.010	**0.000373**	0.0000810	77.7	0.00012	<0.00010	0.00092	0.004	0.062	**0.00826**	0.007	0.00310	21.7	0.0243	<0.000010	0.00113	0.00128	0.15	<0.050	0.35	0.00078	1.13	**0.000106**	1.39
GL-1-1m	Gambler Lake at a 1 m depth	0.0355	<0.00010	<0.00050	<0.010	0.000018	0.0000580	53.1	0.00011	<0.00010	0.00105	0.004	<0.010	0.000134	0.007	0.00180	14.5	0.00241	0.000020	0.000686	0.00207	0.15	<0.050	0.36	0.00059	0.944	<0.000010	0.917
GL-1-3m	Gambler Lake at a 3 m depth	0.0379	<0.00010	<0.00050	<0.010	0.000028	0.0000604	55.5	0.00013	<0.00010	0.00133	0.004	0.048	0.000526	0.007	0.00180	15.2	0.0182	**0.000041**	0.000826	0.00215	0.15	<0.050	0.37	0.00061	1.03	0.000015	0.960

Notes:
[1]pH not recorded for this sample
[2]Hardness is 0 or not recorded for this sample
Red Exceeds CCME Guidelines

Station Name	Description	Strontium (Sr), total	Sulphur (S), total	Thallium (Tl), total	Tin (Sn), total	Titanium (Ti), total	Uranium (U), total	Vanadium (V), total	Zinc (Zn), total	Zirconium (Zr), total	Aluminum (Al), dissolved	Calculated Al-D CCME PAL	Antimony (Sb), dissolved	Arsenic (As), dissolved	Barium (Ba), dissolved	Beryllium (Be), dissolved	Bismuth (Bi), dissolved	Boron (B), dissolved	Cadmium (Cd), dissolved	Calculated Cd-D CCME PAL	Calcium (Ca), dissolved	Chromium (Cr), dissolved	Cobalt (Co), dissolved	Copper (Cu), dissolved	Calculated Cu-D CCME PAL	Iron (Fe), dissolved	Lead (Pb), dissolved	Calculated Pb-D CCME PAL	Lithium (Li), dissolved	Magnesium (Mg), dissolved	Manganese (Mn), dissolved
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CCME Guidelines - Protection of Aquatic Life				0.0008			0.015		0.03																						
CCME Guidelines - Protection of Aquatic Life vs. Dissolved Metals											*			0.005				1.5	*			0.001		*		0.3	*				
Keno District Background Water Quality (Minnow, 2013)		0.35	89	0.000034	0.00033	0.0048	0.0033	0.0005	0.014	0.0003																					
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.332	73	0.000003	<0.00020	<0.00050	0.0031	<0.00020	**0.377**	<0.00010	0.0015	0.1	0.00094	0.0006	0.0438	<0.000010	<0.0000050	<0.050	**0.0021**	0.000106	112	<0.00010	0.000188	0.0005	0.004	0.0318	5E-05	0.007	0.0047	25.8	0.174
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.138	24.1	0.000030	<0.00010	0.035	0.00141	0.0039	**0.957**	<0.00080	0.0107	0.1	0.00205	0.0008	0.0303	<0.00010	<0.00050	<0.010	**0.00356**	0.0000509	46.5	<0.00010	0.00015	0.0022	0.0036	0.110	0.0018	0.006	0.0016	12.0	0.0417
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.386	80.2	<0.000010	<0.00010	<0.010	0.00329	<0.0010	**0.381**	<0.00080	0.0020	0.1	0.00129	0.0009	0.0497	<0.00010	<0.00050	<0.010	**0.00253**	0.000120	130	<0.00010	0.00021	0.0003	0.004	0.042	8E-05	0.007	0.0037	29.9	0.201
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.242	51.6	<0.000010	<0.00010	<0.010	0.00210	<0.0010	**0.330**		0.0085	0.1	0.00100	0.0007	0.0408	<0.00010	<0.00050	<0.010	**0.00234**	0.0000862	87.0	<0.00010	0.00015	0.0008	0.004	0.141	0.0004	0.007	0.0033	21.1	0.113
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	0.260	52.2	<0.000010	<0.00010	<0.010	0.00231	<0.0010	**0.352**		0.0084	0.1	0.00098	0.0007	0.0410	<0.00010	<0.00050	<0.010	**0.00237**	0.0000864	87.4	<0.00010	0.00015	0.0008	0.004	0.138	0.0003	0.007	0.00310	21.0	0.112
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.295	63	0.000002	<0.00020	<0.00050	0.00285	<0.00020	**0.0844**	<0.00010	0.012	0.1	0.0138	0.0013	0.0431	<0.000010	<0.0000050	<0.050	**0.000131**	0.0000932	92.9	<0.00010	0.000025	0.0009	0.004	0.0201	0.0015	0.007	0.0044	24.6	0.0207
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.139	25.3	<0.000010	<0.00010	<0.010	0.000909	<0.0010	**0.423**	<0.00080	0.0076	0.1	0.00465	0.0011	0.0340	<0.00010	<0.00050	<0.010	**0.00259**	0.0000523	49.0	0.00010	<0.00010	0.0018	0.0037	0.143	**0.0081**	0.0063	0.00140	11.6	0.0706
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.236	50.8	<0.000010	<0.00010	<0.010	0.00212	<0.0010	**0.0328**	<0.00080	0.0105	0.1	0.0171	0.0017	0.0461	<0.00010	<0.00050	<0.010	0.000041	0.0000751	68.9	<0.00010	<0.00010	0.0007	0.004	0.030	0.0028	0.007	0.0026	21.2	0.0523
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	0.231	50.9	<0.000010	<0.00010	<0.010	0.00204	<0.0010	**0.136**		0.0053	0.1	0.0149	0.001	0.0411	<0.00010	<0.00050	<0.010	**0.000185**	0.0000773	73.2	<0.00010	<0.00010	0.0007	0.004	0.020	0.00220	0.007	0.003	20.6	0.0202
KL-12	Ladue Creek d/s Gambler Gulch	0.251	54	<0.0000020	<0.00020	<0.00050	0.00207	<0.00020	**0.0379**	<0.00010	0.0066	0.1	0.00656	0.0008	0.0483	<0.000010	<0.0000050	<0.050	**0.000116**	0.0000810	78.3	<0.00010	0.000073	0.0007	0.004	0.0597	0.001	0.007	0.0029	21.2	0.0422
KL-12	Ladue Creek d/s Gambler Gulch	0.114	20.5	<0.000010	<0.00010	<0.010	0.000664	<0.0010	**0.190**	<0.00080	0.0181	0.1	0.00258	0.0009	0.0306	<0.00010	<0.00050	<0.010	**0.00140**	0.0000440	39.3	0.00018	0.00012	0.0021	0.0031	0.163	0.0037	0.0048	0.001	9.89	0.0460
KL-12	Ladue Creek d/s Gambler Gulch	0.111	20.0	<0.000010	<0.00010	<0.010	0.000613	<0.0010	**0.197**	<0.00080	0.0195	0.1	0.00262	0.0009	0.0306	<0.00010	<0.00050	<0.010	**0.00133**	0.0000423	37.4	<0.00010	0.00012	0.0021	0.003	0.157	0.004	0.0046	0.0016	9.75	0.0470
KL-12	Ladue Creek d/s Gambler Gulch	0.243	50.3	<0.000010	<0.00010	<0.010	0.00166	<0.0010	0.0156	<0.00080	0.0060	0.1	0.00622	0.0008	0.0531	<0.00010	<0.00050	<0.010	0.000065	0.0000776	71.5	<0.00010	<0.00010	0.00060	0.004	0.073	0.0007	0.007	0.0017	21.9	0.0511
KL-12	Ladue Creek d/s Gambler Gulch	0.196	40.0	<0.000010	<0.00010	<0.010	0.00138	<0.0010	**0.0620**		0.0139	0.1	0.00491	0.0006	0.0391	<0.00010	<0.00050	<0.010	**0.000172**	0.0000655	59.5	<0.00010	0.00010	0.001	0.004	0.086	0.0009	0.007	0.00230	17.7	0.0351
KL-13	Ladue Creek u/s confluence w Ladue Lake	0.17	36	<0.0000020	<0.00020	<0.00050	0.00113	<0.00020	0.008	<0.00010	0.0066	0.1	0.003	0.0006	0.0358	<0.000010	<0.0000050	<0.050	0.000023	0.0000606	56.4	0.00011	0.00004	0.0011	0.004	0.0474	0.0003	0.007	0.0024	14.8	0.0329
KL-13	Ladue Creek u/s confluence w Ladue Lake	0.132	24.4	<0.000010	<0.00010	<0.010	0.000709	<0.0010	**0.0410**	<0.00080	0.0089	0.1	0.00178	0.0006	0.0314	<0.00010	<0.00050	<0.010	**0.000179**	0.0000496	44.9	<0.00010	<0.00010	0.001	0.0035	0.073	0.0003	0.0058	0.0013	11.7	0.0251
KL-13	Ladue Creek u/s confluence w Ladue Lake	0.129	16.4	<0.000010	<0.00010	<0.010	0.000322	<0.0010	0.0073	<0.00080	0.0054	0.1	0.00051	0.0007	0.0368	<0.00010	<0.00050	<0.010	0.000017	0.0000480	42.5	<0.00010	<0.00010	0.0003	0.0034	0.077	7E-05	0.0055	0.0012	11.5	0.0173
KL-14	Gambler Gulch											[1]								[2]					[2]			[2]			
KL-14	Gambler Gulch											[1]								[2]					[2]			[2]			
KL-14	Gambler Gulch	0.259	51.3	<0.000010	<0.00010	<0.010	0.00143	<0.0010	0.0098	<0.00080	0.0048	0.1	0.00012	0.0004	0.0608	<0.00010	<0.00050	<0.010	**0.000105**	0.0000790	73.8	<0.00010	0.00012	0.0005	0.004	0.044	<0.00005	0.007	0.0011	22.0	0.0514
KL-14	Gambler Gulch	0.223	43.9	<0.000010	<0.00010	<0.010	0.00134	<0.0010	0.0216		0.0136	0.1	0.00013	0.00040	0.0499	<0.00010	<0.00050	<0.010	**0.000175**	0.0000693	62.7	<0.00010	0.00020	0.0008	0.004	0.035	<0.00005	0.007	0.00250	19.3	0.0314
KL-15	Sadie Ladue 600 discharge at KHSD boundary	0.321	51	0.000003	<0.00020	<0.00050	0.0061	<0.00020	**1.12**	<0.00010	0.0013	0.1	0.00439	0.0006	0.0317	<0.000010	<0.0000050	<0.050	**0.00956**	0.0000866	81.7	<0.00010	0.000037	0.0005	0.004	0.0079	0.0003	0.007	0.0027	24.7	0.0272
KL-15	Sadie Ladue 600 discharge at KHSD boundary	0.146	25.0	0.000019	<0.00010	<0.010	0.00206	0.0011	**3.39**	<0.00080	0.0135	0.1	0.00531	0.0009	0.0179	<0.00010	<0.00050	<0.010	**0.0261**	0.0000477	40.2	0.00014	0.00013	**0.0048**	0.00340	0.049	**0.0078**	0.0055	0.0013	12.7	0.0293
KV-35	Sadie Ladue Adit	0.417	<60	<0.000050	<0.0050	<0.010	0.00996	<0.0050	**0.368**	<0.0020	<0.010	0.1	0.00379	0.0036	0.0108	<0.00020	<0.0010	<0.10	**0.0019**	0.0000840	78.2	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0006	0.007	<0.010	24.3	0.0071
KV-35	Sadie Ladue Adit	0.344	47	0.000013	<0.00020	<0.00050	0.00879	<0.00020	**0.301**	<0.00010	0.001	0.1	0.00383	0.0038	0.0107	<0.000010	<0.0000050	<0.050	**0.00177**	0.0000827	78.3	<0.00010	0.000086	0.0003	0.004	0.0031	0.0006	0.007	0.0034	22.9	0.0084
KV-35	Sadie Ladue Adit	0.348	<60	<0.000050	<0.0050	<0.010	0.00764	<0.0050	**0.29**	<0.0020	<0.010	0.1	0.00385	0.0039	0.0108	<0.00020	<0.0010	<0.10	**0.00165**	0.0000808	73	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0005	0.007	<0.010	24.3	0.0129
KV-35	Sadie Ladue Adit	0.365	<60	<0.000050	<0.0050	<0.010	0.00803	<0.0050	**0.309**	<0.0020	<0.010	0.1	0.00391	0.0039	0.0108	<0.00020	<0.0010	<0.10	**0.00161**	0.0000832	76.5	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0004	0.007	<0.010	24.6	0.0129
KV-35	Sadie Ladue Adit	0.388	<60	<0.000050	<0.0050	<0.010	0.00829	<0.0050	**0.358**	<0.0020	<0.010	0.1	0.0039	0.0037	0.011	<0.00020	<0.0010	<0.10	**0.00174**	0.0000842	76.1	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0003	0.007	<0.010	25.8	0.0139
KV-35	Sadie Ladue Adit	0.36	<60	<0.000050	<0.0050	<0.010	0.00739	<0.0050	**0.371**	<0.0020	<0.010	0.1	0.00408	0.0042	0.0117	<0.00020	<0.0010	<0.10	**0.00167**	0.0000862	77.8	**<0.0020**	<0.00050	<0.0010	0.004	0.048	0.0003	0.007	<0.010	26.7	0.0174
KV-35	Sadie Ladue Adit	0.362	<60	<0.000050	<0.0050	<0.010	0.00754	<0.0050	**0.366**	<0.0020	<0.010	0.1	0.00445	0.0038	0.0129	<0.00020	<0.0010	<0.10	**0.00167**	0.0000859	77.4	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0004	0.007	<0.010	26.6	0.0147
KV-35	Sadie Ladue Adit	0.381	<60	<0.000050	<0.0050	<0.010	0.00749	<0.0050	**0.358**	<0.0020	<0.010	0.1	0.00399	0.0033	0.0115	<0.00020	<0.0010	<0.10	**0.00156**	0.0000864	79.1	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.0003	0.007	<0.010	26.1	0.0132
KV-35	Sadie Ladue Adit	0.434	<60	<0.000050	<0.0050	<0.010	0.00823	<0.0050	**0.375**	<0.0020	<0.010	0.1	<0.00050	0.0007	0.0821	<0.00020	<0.0010	<0.10	**0.00101**	0.0000888	90.9	**<0.0020**	<0.00050	<0.0010	0.004	<0.020	0.001	0.007	<0.010	21.3	0.0025
KV-35	Sadie Ladue Adit	0.435	46.0	0.000018	<0.00010	<0.010	0.00791	<0.0010	**0.358**		0.0022	0.1	0.00420	0.0029	0.0114	<0.00010	<0.00050	<0.010	**0.00152**	0.0000900	82.0	<0.00010	<0.00010	0.0008	0.004	<0.010	0.0004	0.007	0.0025	27.9	0.0087
KV-35	Sadie Ladue Adit	0.461	48.6	<0.00010	<0.0010	<0.10	0.00795	<0.010	**0.349**	<0.0080	<0.010	0.1	0.0042	0.0027	0.0117	<0.0010	<0.0050	<0.10	**0.00160**	0.0000876	81.1	<0.0010	<0.0010	<0.0020	0.004	<0.010	<0.00050	0.007	<0.0050	26.1	0.0069
KV-35	Sadie Ladue Adit	0.188	22.2	<0.00010	<0.0010	<0.10	0.00314	0.013	**1.35**	<0.0080	0.053	0.1	0.0080	0.0017	0.0158	<0.0010	<0.0050	<0.10	**0.00449**	0.0000440	35.7	<0.0010	<0.0010	**0.0091**	0.0031	0.051	0.0046	0.0048	<0.0050	12.2	0.0515
KV-35	Sadie Ladue Adit	0.202	37.9	0.000022	<0.00010	<0.010	0.00367	<0.0010	**1.11**	<0.00080	0.0249	0.1	0.00975	0.00270	0.0105	<0.00010	<0.00050	<0.010	**0.00730**	0.0000652	57.2	<0.00010	0.00017	**0.0069**	0.004	0.024	**0.00710**	0.007	0.0017	18.7	0.0488
KV-35	Sadie Ladue Adit	0.368	55.6	<0.00010	<0.0010	<0.10	0.00817	<0.010	**0.699**	<0.0080	<0.010	0.1	0.0075	0.0032	0.0129	<0.0010	<0.0050	<0.10	**0.00521**	0.0000973	87.7	<0.0010	<0.0010	<0.0020	0.004	<0.010	0.0016	0.007	<0.0050	31.9	0.0183
KV-35	Sadie Ladue Adit	0.426	54.3	<0.00010	<0.0010	<0.10	0.00910	<0.010	**0.489**	<0.0080	<0.010	0.1	0.0063	0.0031	0.0122	<0.0010	<0.0050	<0.10	**0.00315**	0.0000956	86.3	<0.0010	<0.0010	<0.0020	0.004	<0.010	0.0009	0.007	<0.0050	30.9	0.0192
KV-35	Sadie Ladue Adit	0.354	43.9	<0.00010	<0.0010	<0.10	0.00738	<0.010	**0.439**	<0.0080	<0.010	0.1	0.0048	0.0038	0.0123	<0.0010	<0.0050	<0.10	**0.00259**	0.0000871	79.7	<0.0010	<0.0010	<0.0020	0.004	<0.010	0.0009	0.007	<0.0050	26.5	0.0216
KV-35	Sadie Ladue Adit	0.378	46.2	<0.00010	<0.0010	<0.10	0.00746	<0.010	**0.438**	<0.0080	<0.010	0.1	0.0044	0.0038	0.0133	<0.0010	<0.0050	<0.10	**0.00271**	0.0000927	84.3	<0.0010	<0.0010	<0.0020	0.004	<0.010	0.00090	0.007	<0.0050	29.4	0.0223
KV-35	Sadie Ladue Adit	0.436	60.5	<0.00010	<0.0010	<0.10	0.0107	<0.010	**0.495**	<0.0080	<0.010	0.1	0.0050	0.0030	0.0138	<0.0010	<0.0050	<0.10	**0.00290**	0.000107	102	<0.0010	<0.0010	<0.0020	0.004	<0.010	0.0008	0.007	<0.0050	33.0	0.0102
UL-W1	Wernecke Lake NE of tailings fan	0.235	52.5	<0.000010	<0.00010	<0.010	0.00222	<0.0010	**0.134**		0.0043	0.1	0.0155	0.001	0.0401	<0.00010	<0.00050	<0.010	**0.000283**	0.0000780	74.4	<0.00010	<0.00010	0.0007	0.004	0.019	0.0028	0.007	0.003	20.6	0.0138
UL-W2	Wernecke Lake NW of tailings fan	0.237	53.0	<0.000010	<0.00010	<0.010	0.00219	<0.0010	**0.123**		0.0040	0.1	0.0158	0.001	0.0393	<0.00010	<0.00050	<0.010	**0.000222**	0.0000780	74.6	<0.00010	<0.00010	0.0007	0.004	0.018	0.0024	0.007	0.0029	20.6	0.0101
GL-1-1m	Gambler Lake at a 1 m depth	0.159	29.4	<0.000010	<0.00010	<0.010	0.000931	<0.0010	0.0094		0.0053	0.1	0.00294	0.00080	0.0361	<0.00010	<0.00050	<0.010	0.000020	0.0000567	51.6	<0.00010	<0.00010	0.001	0.004	<0.010	0.0002	0.007	0.0017	14.1	0.0023
GL-1-3m	Gambler Lake at a 3 m depth	0.163	30.4	<0.000010	<0.00010	<0.010	0.000980	<0.0010	0.0106		0.0055	0.1	0.00286	0.0009	0.0352	<0.00010	<0.00050	<0.010	0.000026	0.0000557	50.4	<0.00010	<0.00010	0.0011	0.004	0.015	0.0003	0.007	0.0017	13.9	0.00270

Notes: [1]pH not recorded for this sample

[2]Hardness is 0 or not recorded for this sample

Red Exceeds CCME Guidelines

ACCESS

Station Name	Description	Mercury (Hg), dissolved	Molybdenum (Mo), dissolved	Nickel (Ni), dissolved	Calculated Ni-D CCME PAL	Phosphorus (P), dissolved	Potassium (K), dissolved	Selenium (Se), dissolved	Silicon (Si), dissolved	Silver (Ag), dissolved	Sodium (Na), dissolved	Strontium (Sr), dissolved	Sulphur (S), dissolved	Thallium (Tl), dissolved	Tin (Sn), dissolved	Titanium (Ti), dissolved	Uranium (U), dissolved	Vanadium (V), dissolved	Zinc (Zn), dissolved	Zirconium (Zr), dissolved	Ion Balance	Total Anion Sum	Total Cation Sum
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		meq/L	meq/L
CCME Guidelines - Protection of Aquatic Life																							
CCME Guidelines - Protection of Aquatic Life vs. Dissolved Metals		0.000026	0.073	*				0.001		0.0001				0.0008			0.015		0.03				
Keno District Background Water Quality (Minnow, 2013)																							
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	<0.000010	0.000858	0.0012	0.15	<0.0020	0.573	**0.00216**	3.3	<0.0000050	1.83	0.336	71	0.000003	0.00022	<0.00050	0.00306	<0.00020	**0.36**	<0.00010			
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	<0.000010	0.000806	0.0019	0.140	<0.050	0.50	0.00069	1.80	0.000027	0.751	0.133	24.5	<0.000010	<0.00010	<0.010	0.00114	<0.0010	**0.579**	<0.00080	1.03	3.15	3.38
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	<0.000010	0.000801	0.0012	0.15	<0.050	0.57	**0.00229**	3.06	<0.000010	1.89	0.367	78.7	<0.000010	<0.00010	<0.010	0.00323	<0.0010	**0.383**	<0.00080	0.98	9.47	9.06
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	<0.000010	0.000694	0.0013	0.15	<0.050	0.41	**0.00160**	2.77	<0.000010	1.44	0.252	49.9	<0.000010	<0.00010	<0.010	0.00231	<0.0010	**0.311**		1.01	6.09	6.17
KL-10	Ladue Creek u/s "Wernecke Tailings" Unnamed Lake	<0.000010	0.000666	0.0012	0.15	<0.050	0.38	**0.00166**	2.74	<0.000010	1.40	0.244	50.0	<0.000010	<0.00010	<0.010	0.00221	<0.0010	**0.318**		0.99	6.24	6.18
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	<0.000010	0.00111	0.0012	0.15	0.0021	0.438	**0.00133**	2.38	0.000008	1.77	0.298	64	<0.0000020	<0.00020	<0.00050	0.0029	<0.00020	**0.0712**	<0.00010			
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	<0.000010	0.000767	0.0017	0.143	<0.050	0.66	0.00046	1.80	0.000069	0.743	0.128	25.1	<0.000010	<0.00010	<0.010	0.00082	<0.0010	**0.385**	<0.00080	1.03	3.24	3.47
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	<0.000010	0.00140	0.0012	0.15	<0.050	0.30	0.00059	0.517	0.000019	1.34	0.234	50.6	<0.000010	<0.00010	<0.010	0.00204	<0.0010	0.0205	<0.00080	0.95	5.75	5.25
KL-11	Ladue Ck d/s "Wernecke Tailings" Lake u/s GamblerG	<0.000010	0.00105	0.00130	0.15	<0.050	0.34	0.00070	0.987	0.000010	1.30	0.226	50.3	<0.000010	<0.00010	<0.010	0.00198	<0.0010	**0.114**		1	5.37	5.42
KL-12	Ladue Creek d/s Gambler Gulch	<0.000010	0.00081	0.0015	0.15	<0.0020	0.356	**0.00154**	2.39	0.000008	1.4	0.252	51	<0.0000020	0.00028	<0.00050	0.00205	<0.00020	**0.0359**	<0.00010			
KL-12	Ladue Creek d/s Gambler Gulch	<0.000010	0.000570	0.0026	0.123	<0.050	0.54	0.00059	1.62	0.000030	0.636	0.109	20.2	<0.000010	<0.00010	<0.010	0.00057	<0.0010	**0.183**	<0.00080	1.04	2.62	2.84
KL-12	Ladue Creek d/s Gambler Gulch	<0.000010	0.000610	0.0025	0.119	<0.050	0.48	0.00067	1.59	0.000045	0.649	0.110	20.1	<0.000010	<0.00010	<0.010	0.0006	<0.0010	**0.203**	<0.00080	1.01	2.66	2.73
KL-12	Ladue Creek d/s Gambler Gulch	<0.000010	0.000869	0.00140	0.15	<0.050	0.33	**0.00117**	1.48	<0.000010	1.24	0.244	49.5	<0.000010	<0.00010	<0.010	0.00163	<0.0010	0.0138	<0.00080	0.99	5.50	5.44
KL-12	Ladue Creek d/s Gambler Gulch	<0.000010	0.000608	0.0025	0.15	<0.050	0.25	0.00098	1.89	<0.000010	1.07	0.195	38.8	<0.000010	<0.00010	<0.010	0.00130	<0.0010	**0.0567**		1.01	4.37	4.49
KL-13	Ladue Creek u/s confluence w Ladue Lake	<0.000010	0.000663	0.0019	0.15	0.0021	0.345	0.000668	1.43	0.000006	1.01	0.171	34	<0.0000020	0.00031	<0.00050	0.00114	<0.00020	0.0086	<0.00010			
KL-13	Ladue Creek u/s confluence w Ladue Lake	<0.000010	0.000452	0.0019	0.137	<0.050	0.40	0.00049	1.38	0.000013	0.773	0.125	23.5	<0.000010	<0.00010	<0.010	0.000640	<0.0010	**0.0374**	<0.00080	1.03	3.05	3.26
KL-13	Ladue Creek u/s confluence w Ladue Lake	<0.000010	0.000275	0.0015	0.133	<0.050	0.34	0.00020	1.91	<0.000010	0.669	0.123	16.3	<0.000010	<0.00010	<0.010	0.00031	<0.0010	0.0053	<0.00080	1.01	3.06	3.11
KL-14	Gambler Gulch				[2]																		
KL-14	Gambler Gulch				[2]																		
KL-14	Gambler Gulch	<0.000010	0.000570	0.0016	0.15	<0.050	0.31	**0.00158**	2.29	<0.000010	1.23	0.252	49.3	<0.000010	<0.00010	<0.010	0.00141	<0.0010	0.0079	<0.00080	0.99	5.66	5.56
KL-14	Gambler Gulch	<0.000010	0.000498	0.0035	0.15	<0.050	0.28	**0.00148**	2.35	<0.000010	1.10	0.212	42.6	<0.000010	<0.00010	<0.010	0.00125	<0.0010	0.0195		0.99	4.84	4.77
KL-15	Sadie Ladue 600 discharge at KHSD boundary	<0.000010	0.00225	0.0038	0.15	<0.0020	0.583	0.000616	3.15	<0.0000050	1.87	0.32	50	0.000003	<0.00020	<0.00050	0.00613	<0.00020	**1.12**	<0.00010			
KL-15	Sadie Ladue 600 discharge at KHSD boundary	<0.000010	0.00116	0.0052	0.132	<0.050	0.57	0.00058	1.59	**0.000115**	0.659	0.133	24.6	0.000012	<0.00010	<0.010	0.00187	<0.0010	**3.61**	<0.00080	1.02	3.07	3.22
KV-35	Sadie Ladue Adit	**<0.00020**	0.0037	0.0099	0.15	<0.040	<1.0	0.00085	3.5	<0.00010	1.9	0.355	<60	<0.000050	<0.0050	<0.010	0.00812	<0.0050	**0.331**	<0.0020			
KV-35	Sadie Ladue Adit	<0.000010	0.0036	0.0089	0.15	<0.0020	0.619	0.000798	3.34	0.000005	1.9	0.351	47	0.000013	0.00028	<0.00050	0.00907	<0.00020	**0.309**	<0.00010			
KV-35	Sadie Ladue Adit	**<0.00020**	0.0035	0.0088	0.15	<0.040	<1.0	<0.00080	3.4	<0.00010	2.2	0.374	<60	<0.000050	<0.0050	<0.010	0.00812	<0.0050	**0.32**	<0.0020			
KV-35	Sadie Ladue Adit	**<0.00020**	0.0036	0.0089	0.15	<0.040	<1.0	<0.00080	3.4	<0.00010	2.2	0.372	<60	<0.000050	<0.0050	<0.010	0.00809	<0.0050	**0.321**	<0.0020			
KV-35	Sadie Ladue Adit	**<0.00020**	0.0031	0.0087	0.15	<0.040	<1.0	<0.00080	3.2	<0.00010	2.2	0.38	<60	<0.000050	<0.0050	<0.010	0.00767	<0.0050	**0.372**	<0.0020			
KV-35	Sadie Ladue Adit	**<0.00020**	0.003	0.0099	0.15	<0.040	<1.0	<0.00080	3.4	<0.00010	2.3	0.39	<60	<0.000050	<0.0050	<0.010	0.00802	<0.0050	**0.434**	<0.0020			
KV-35	Sadie Ladue Adit	**<0.00020**	0.0033	0.0096	0.15	<0.040	<1.0	0.00093	3.4	<0.00010	2.3	0.415	<60	<0.000050	<0.0050	<0.010	0.00851	<0.0050	**0.361**	<0.0020			
KV-35	Sadie Ladue Adit	**<0.00020**	0.0028	0.0091	0.15	<0.040	<1.0	<0.00080	3.5	<0.00010	2.3	0.389	<60	<0.000050	<0.0050	<0.010	0.00683	<0.0050	**0.392**	<0.0020			
KV-35	Sadie Ladue Adit	**<0.00020**	<0.0010	<0.0010	0.15	<0.040	<1.0	**0.00156**	3.4	<0.00010	2.2	0.19	66	<0.000050	<0.0050	<0.010	0.00626	<0.0050	**0.061**	<0.0020			
KV-35	Sadie Ladue Adit	<0.000010	0.00275	0.0083	0.15	<0.050	0.69	0.00057	2.96	<0.000010	2.37	0.417	44.9	0.000012	<0.00010	<0.010	0.00786	<0.0010	**0.351**				
KV-35	Sadie Ladue Adit	**<0.000050**	0.00264	0.0081	0.15	<0.050	0.63	<0.0010	2.96	<0.00010	2.12	0.432	46.9	<0.00010	<0.0010	<0.10	0.00743	<0.010	**0.345**	<0.0080			
KV-35	Sadie Ladue Adit	**<0.000050**	0.00092	0.0084	0.123	<0.050	0.66	<0.0010	1.13	**0.00017**	0.51	0.111	22.4	<0.00010	<0.0010	<0.10	0.00130	<0.010	**0.787**	<0.0080			
KV-35	Sadie Ladue Adit	0.000011	0.00189	0.0129	0.15	<0.050	0.62	0.00098	1.57	**0.000150**	0.796	0.188	55.0	0.000019	<0.00010	<0.010	0.00348	<0.0010	**1.16**	<0.00080	1.02	4.29	4.49
KV-35	Sadie Ladue Adit	**<0.000050**	0.00330	0.0139	0.15	<0.050	0.58	**0.0012**	2.49	<0.00010	1.70	0.361	54.1	<0.00010	<0.0010	<0.10	0.00787	<0.010	**0.722**	<0.0080			
KV-35	Sadie Ladue Adit	**<0.000050**	0.00349	0.0110	0.15	<0.050	0.61	<0.0010	3.07	<0.00010	2.06	0.478	52.7	<0.00010	<0.0010	<0.10	0.0101	<0.010	**0.509**	<0.0080			
KV-35	Sadie Ladue Adit	**<0.000050**	0.00331	0.0093	0.15	<0.050	0.58	<0.0010	2.97	<0.00010	1.94	0.353	43.3	<0.00010	<0.0010	<0.10	0.00761	<0.010	**0.455**	<0.0080	0.99	6.33	6.27
KV-35	Sadie Ladue Adit	**<0.000050**	0.00353	0.0097	0.15	<0.050	0.62	<0.0010	3.10	<0.00010	1.96	0.394	45.3	<0.00010	<0.0010	<0.10	0.00721	<0.010	**0.451**	<0.0080			
KV-35	Sadie Ladue Adit	**<0.000050**	0.00327	0.0121	0.15	<0.050	0.64	<0.0010	3.04	<0.00010	1.95	0.412	58.9	<0.00010	<0.0010	<0.10	0.0103	<0.010	**0.497**	<0.0080			
UL-W1	Wernecke Lake NE of tailings fan	<0.000010	0.00104	0.0012	0.15	<0.050	0.34	0.00076	1.12	0.000016	1.35	0.235	51.1	<0.000010	<0.00010	<0.010	0.00211	<0.0010	**0.125**		1	5.51	5.48
UL-W2	Wernecke Lake NW of tailings fan	<0.000010	0.00103	0.0013	0.15	<0.050	0.32	0.00069	1.07	0.000017	1.35	0.226	51.1	<0.000010	<0.00010	<0.010	0.00208	<0.0010	**0.110**		1	5.48	5.49
GL-1-1m	Gambler Lake at a 1 m depth	**0.000029**	0.000641	0.0021	0.15	<0.050	0.37	0.00056	0.934	<0.000010	0.884	0.157	28.6	<0.000010	<0.00010	<0.010	0.000920	<0.0010	0.0082		1.01	3.72	3.79
GL-1-3m	Gambler Lake at a 3 m depth	**0.000087**	0.000736	0.002	0.15	<0.050	0.36	0.00052	0.927	<0.000010	0.895	0.154	28.4	<0.000010	<0.00010	<0.010	0.0009	<0.0010	0.0078		1	3.71	3.71

Notes:
[1] pH not recorded for this sample
[2] Hardness is 0 or not recorded for this sample
Red — Exceeds CCME Guidelines

APPENDIX C

LOWER KENO LADUE WATER SAMPLING RAW DATA

4715 Innovation Dr., Ste. 110
Fort Collins, CO 80525
Phone: 970.225.8222

Draft Technical Memorandum

TO: ERDC Project File

FROM: Interralogic, Inc.

DATE: November 14, 2013

SUBJECT: Reclamation Description and Costing for Wernecke Tailings Areas off Claim Sites, Keno Hill Silver District, Elsa, YT

Introduction

At the request of Elsa Reclamation and Development Company, Ltd. (ERDC), this memorandum has been prepared by Interralogic, Inc. (Interralogic) to describe reclamation activities being considered for the off claim Wernecke tailings areas, in the Keno Hill Silver District near Elsa, YT. Provided for each activity is a Level 3 cost estimate considered accurate to -30% / +50% of actual cost. Closure-related issues have been previously described in Site Investigation and Improvements, Special Projects Mackeno and Wernecke Tailings Assessment, March 31, 2009; prepared by Access Consulting Group (ACG).

As shown in the attached exhibits, the off claim tailings are concentrated in seven dispersed "Pods" as well as one depositional delta, located in the lake. For the sake of clarity, Pods 6 and 7 shall be referred to as the "Upland tailings", Pods 1-5 shall be referred to as the "Lowland tailings", and the tailings in the depositional delta shall be referred to as the "Delta tailings". The primary creek and drainage from the hillside down to the pond shall be referred to as Sadie Ladue Creek.

Document Review

Closure options for tailings areas in the vicinity were previously evaluated by ACG (2009). In this report two closure strategies are discussed.

- Cover in place
- Consolidation and stabilization of tailings

Cover and re-vegetation of the tailings was recommended for all alternatives.

The volume of tailings contained in the Wernecke off claim deposits are summarized in the table below.

Wernecke off-claim Tailings Quantity Assumptions			
Location	**Area (m^2)**	**Average Depth (m)**	**Volume (m^3)**
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
Pod 4	142	1	142
Pod 5	487	0.7	341
Pod 6	15,021	0.7	10,515
Pod 7	18,933	0.5	9,467
Total for all Pods	**35,847**		**21,924**
Delta (with over excavation)	**97,257**	**0.9**	**87,531**
Grand Total	**133,104**		**109,456**

Wernecke off claim tailings Reclamation Alternatives

Costs were estimated for three reclamation alternatives:

Alternative 1 – Cover in Place (Exhibit 1)

Alternative 1 includes covering all of the tailings, in their current configurations, with a 1 meter thick soil cover. The soil covers will include borrow material from local sources as well as imported organics, fertilizer, and seed. The entire volume of tailings would be treated with lime at the assumed rate of 6 kg/tonne.

Sadie Ladue Creek would be rerouted to a new alignment that is further to the west. The proposed alignment is approximately 947 meters long, designed to direct flow around and away from the Lowland and Delta tailings deposits.

Two haul roads would be constructed for site access, one from the Hansen McQuesten road to access the Delta and Lowland tailings; the second from the Gambler Gulch trail to access the Upland tailings. It was assumed that all hauling borrow material would be conducted at an average distance of 5,000 meters.

Alternative 2 – Consolidate and Cover (Exhibit 2)

Tailings would be removed from all Pods and the upper 0.9 meters of the Delta tailings would be removed. All removed tailings would be consolidated into an unlined facility, stacked to a height of approximately 3 meters, and treated with lime at a rate of 6 kg/tonne. The consolidated area would be covered with a 1.0 meter thick soil cover. A 0.3 meter thick soil cover would be placed over the Upland and Lowland tailings pods, following the removal of the tailings pods. Soil covers would include borrow material from local sources as well as imported organics, fertilizer and seed. Delta tailings would be covered by water from the lake.

Sadie Ladue Creek would be rerouted along a new alignment that is further to the west. The proposed alignment is approximately 947 meters long, designed to direct flow around and away from the Lowland and Delta tailings deposits.

Two haul roads would be constructed for site access, one from the Hansen McQuesten road to access the Delta and Lowland tailings; the second from the Gambler Gulch trail to access the Upland tailings. It was assumed that all hauling would be conducted at an average distance of 5,000 meters; inherent to this assumption is that the Upland tailings will be consolidated in a different location from the Delta and Lowland tailings. All costs were produced based on volumetric rates; therefore the number of consolidation areas does not significantly impact this level of cost estimation.

Alternative 3 – Enhance Natural Recovery (Exhibit 3)

The intent of this alternative is to minimize construction disturbance and to enhance the natural recovery process in the area.

Sadie Ladue Creek would be rerouted just before the Delta Tailings. The proposed alignment would be approximately 308 meters long.

Reclamation activities would be conducted using small, low impact, equipment and would target areas that natural vegetation as not started to reclaim. It was assumed that 50% of the existing tailings surface area would require treatment during the first field session and that 50% of that area would require a second treatment. Treatment would include the addition of lime at 6 kg/tonne in the top 0.25 meter, as well as spreading seed, fertilizer and amending the top 0.05 meter with organics. Due to the use of small equipment, the cost for lime application was considered to be $3 per cubic meter whereas $1 per cubic meter was used for the other options.

One road light vehicle access road would be constructed, from the Hansen McQuesten road to access the Delta area. Access to the Upland tailings would be via existing two-track roads; it is assumed that this access would require minimal improvements. It was assumed that all hauling was conducted at an average distance of 5000 meters.

Cost Estimate

The final engineering cost estimates are as follows:

Wernecke Tailings	Alternative 1 - Cover in Place	Alternative 2 - Consolidation	Alternative 3 - Enhance Natural Recovery
Off Claim Wernecke Tailings - Tailings Removal & Consolidation		$ 1,492,974	
Off Claim Wernecke Tailings - Borrow & Placement of Cover	$ 1,888,746	$ 795,354	
Off Claim Wernecke Tailings - Creek Rehab & Reroute	$ 69,285	$ 69,285	$ 22,534
Off Claim Wernecke Tailings - Lime Added	$ 756,338	$ 756,338	$ 277,272
Off Claim Wernecke Tailings - Organics	$ 539,071	$ 324,691	$ 404,303
Off Claim Wernecke Tailings - Site Access	$ 237,578	$ 242,622	$ 45,005
Contingency	$ -	$ -	$ -
Closure Indirect Costs	$ 1,584,922	$ 1,671,294	$ 340,098
Total	**$ 5,075,941**	**$ 5,352,559**	**$ 1,089,212**

Keno- Wernecke Tailings Off Claim Material
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KDL

Wenecke Tailings - Cover in Place, Relocate Creek, add Organics & Lime

Assumptions

Insitu Unit Weight Tails	1.97	tonnes/m3	Lime Added	6	kg/tonnes
Unit Weight of Borrow Material	1.5	tonnes/m3	Lime	500	$/tonnes
Unit Weight of Diversion Material	1.5	tonnes/m3	Rip Rap Depth	0.15	m
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1		Blasting	0.4	$/tonnes
Est. Coefficient for 3D Surface Consolidated Area	1		Water Treatment Plant	300,000	$
Tailings Depth	1	m	Water Treatment	0.5	$/m3
Cover Thickness Over Area Where tails Were Removed	0.3	m	Rip Rap Weight	2.1	tonnes/m3
Cover Thickness Over Tailings	1	m	Filter Fabric	5	$/m2 for $1.5 to buy, $3.5 to place
Stripping Depth	0.3	m	Seed, Fertilizer, Spreading	0.55	$/m2 for $0.55 Seed/Fertilizer
Unit Weight of Stripping Material	1	tonnes/m3	Lime Application	1	$/m3
Project Management & Field Supervision	7.0%		Crush & Screen	4.45	$/tonnes
Profit & Overhead	10.0%		Organics Depth	0.05	m
Insurance & Bonding	1.4%		Organics Weight	0.3	tonnes/m3
Field Engineering, QA & Surveying	7.0%		Organics Cost	81	$/m3 *Assumed as Import to site (around $10,000 per truck)*
Mob & Demob	5.0%		Over Excavation	0.5	m
Living Allowances	8.0%		Tailings Dry Weight For Lime	1.55	tonnes/m3
Taxes	7.0%		Unit Weight Over Excavated Material	1.2	tonnes/m3
Contingency	0.0%		Percent by Volume of Tails in OverEx Material	75%	
Rectangular Creek Width (3m bottom 3:1 side slope)	6	m	Haul Road A Cut	10355	m3 (ACAD Volume)
Creek Depth (3m bottom 3:1 side slope)	1	m	Haul Road B Cut	41975	m3 (ACAD Volume)

Tailings Quantity Assumptions

Location	Area (m2)	Average Depth (m)	Volume (m3)
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
Pod 4	142	1	142
Pod 5	487	0.7	341
Pod 6	15,021	0.7	10,515
Pod 7	18,933	0.5	9,467
Total for all Pods	**35,847**		**21,924**
Delta (with over excavation)	**97,257**	**0.9**	**87,531**
Grand Total	**133,104**		**109,456**

Off Claim Wernecke Tailings - Borrow & Placement of Cover					Cost						
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 27 m^3/hr	980 Loader 240 m^3/hr	Seed, Fertilizer, Spreading	
Delta Tailings	97,257	97,257	97,257	145,886	$262,593.90	$53,491.35	$120,112.40	$840,300.48	$50,087.36	$53,491.35	
Tailings Pods	35,847	35,847	35,847	53,771	$96,786.90	$19,715.85	$44,271.05	$309,718.08	$18,461.21	$19,715.85	
Totals	**133,104**	**133,104**	**133,104**	**199,656**	**$ 359,380.80**	**$ 73,207.20**	**$ 164,383.44**	**$ 1,150,018.56**	**$ 68,548.56**	**$ 73,207.20**	$1,888,745.76

Off Claim Wernecke Tailings - Creek Rehab & Reroute					Cost						
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen	
Reroute Creek	947	5,682	852	5,682	$21,591.60	$715.93	$7,363.87	$3,238.74	$28,410.00	$7,964.74	
Totals	**947**	**5,682**	**852**	**5,682**	**$21,591.60**	**$715.93**	**$7,363.87**	**$3,238.74**	**$28,410.00**	**$7,964.74**	$69,284.89

Off Claim Wernecke Tailings - Lime Added							Cost		
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	
Detla and Pod Tailings	133,104	133,104	109,456	215,628	1,293,765	1,294	$646,882.60	$109,455.60	
Totals	**133,104**	**133,104**	**109,456**	**215,628**	**1,293,765**	**1,294**	**$646,882.60**	**$109,455.60**	$756,338.20

Off Claim Wernecke Tailings - Organics		Cost	
Description	Organics (m3)	Organics Cost	
Compost (added to all cover)	6,655	$539,071.20	
Totals	**6655**	**$539,071.20**	$539,071.20

Off Claim Wernecke Tailings - Site Access			Cost		
Area	Volumes (m3)	Mass (tonnes)	325 Excavator 76 m^3/hr	D8 Dozer 120 m^3/hr	
Wernecke Road Site Access	52,330	103,090	$129,255.10	$108,323.10	
Totals	**52,330**	**103,090**	**$129,255.10**	**$108,323.10**	$237,578.20

Alt-1 (Cover In Place) Contingency			Cost
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$3,491,018.24	$0.00
Totals		**$3,491,018.24**	**$0.00**

Alt-1 (Cover In Place) Closure Indirect Costs			Cost
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$3,491,018.24	$244,371.28
Profit & Overhead	10.0%	$3,491,018.24	$349,101.82
Insurance & Bonding	1.4%	$3,491,018.24	$48,874.26
Field Engineering, QA & Surveying	7.0%	$3,491,018.24	$244,371.28
Mob & Demob	5.0%	$3,491,018.24	$174,550.91
Living Allowances	8.0%	$3,491,018.24	$279,281.46
Taxes	7.0%	$3,491,018.24	$244,371.28
Totals			**$1,584,922.28**

Direct Cost	**$3,491,018.24**
Indirect Cost	**$1,584,922.28**
Total Direct & Indirect	**$5,075,940.53**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$5,075,940.53**

Keno- Wernecke Tailings Off Claim Material
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KDL

Wernecke Tailings - Consolidate, Stabilize, Cover, Relocated Creek, add Organics & Lime

Assumptions

Insitu Unit Weight Tails	1.97	tonnes/m3
Unit Weight of Borrow Material	1.5	tonnes/m3
Unit Weight of Diversion Material	1.5	tonnes/m3
Est. Coefficient for 3D Surface Relocated & Undisturbed Area	1	
Est. Coefficient for 3D Surface Consolidated Area	1	
Tailings Depth	1	m
Cover Thickness Over Area Where tails Were Removed	0.3	m
Cosolidated Tailings Area	0.333	of original area (~3m stack height)
Stripping Depth	0.3	m
Unit Weight of Stripping Material	1	tonnes/m3
Project Management & Field Supervision	7.0%	
Profit & Overhead	10.0%	
Insurance & Bonding	1.4%	
Field Engineering, QA & Surveying	7.0%	
Mob & Demob	5.0%	
Living Allowances	8.0%	
Taxes	7.0%	
Contingency	0.0%	
Rectangular Creek Width (3m bottom 3:1 side slope)	6	m
Creek Depth (3m bottom 3:1 side slope)	1	m

Lime Added	6	kg/tonnes
Lime	500	$/tonnes
Channel Riprap Depth	0.15	m
Blasting	0.4	$/tonnes
Water Treatment Plant	300,000	$
Water Treatment	0.5	$/m3
Rip Rap Weight	2.1	tonnes/m3
Filter Fabric	5	$/m2 for $1.5 to buy, $3.5 to place
Seed, Fertilizer, Spreading	0.55	$/m2 for $0.55 Seed/Fertilizer
Lime Application	1	$/m3
Crush & Screen	4.45	$/tonnes
Organics Depth	0.05	m
Organics Weight	0.3	tonnes/m3
Organics Cost	81	$/m3
Over Excavation	0.5	m
Tailings Dry Weight For Lime	1.55	tonnes/m3
Unit Weight Over Excavated Material	1.2	tonnes/m3
Percent by Volume of Tails in OverEx Material	75%	
Assume low production rates on Delta due to winter/frozen excavation		

Cover Thickness of Consolidated Tailings	1	m
Haul Road A Cut	10355	m3 (ACAD Volume)
Haul Road B Cut	41975	m3 (ACAD Volume)
Haul Road C Cut	1111	m3 (ACAD Volume)
Consolidated Area Stack Height	3	m

Assumed as Import to site (around $10,000 per truck)

Tailings Quantity Assumptions			
Location	**Area (m2)**	**Average Depth (m)**	**Volume (m3)**
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
Pod 4	142	1	142
Pod 5	487	0.7	341
Pod 6	15,021	0.7	10,515
Pod 7	18,933	0.5	9,467
Total for all Pods	**35,847**		**21,924**
Delta (with over excavation)	**97,257**	**0.9**	**87,531**
Grand Total	**133,104**		**109,456**

Off Claim Wernecke Tailings - Tailings Removal & Consolidation					Cost				
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 27 m^3/hr	980 Loader 240 m^3/hr
Delta Tailings	97,257	97,257	87,531	172,437	$236,334.51	$48,142.22	$108,101.16	$756,270.43	$45,078.62
Pod Tailings	35,847	35,847	21,924	43,191	$59,195.61	$12,058.37	$27,076.51	$189,425.95	$11,291.01
Totals	**133,104**	**133,104**	**109,456**	**215,628**	**$ 295,530.12**	**$ 60,200.58**	**$ 135,177.67**	**$ 945,696.38**	**$ 56,369.63**

$1,492,974.38

Off Claim Wernecke Tailings - Borrow & Placement of Cover					Cost					
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	D9 Dozer 120 m^3/hr	D6 Dozer 320 m^3/hr	325 Excavator 76 m^3/hr	740 Truck 27 m^3/hr	980 Loader 240 m^3/hr	Seed, Fertilizer, Spreading
Consolidated Area	44,324	44,324	44,324	66,485	$119,673.81	$24,378.00	$54,739.69	$382,956.18	$22,826.67	$24,378.00
Excavated (Pod Tailings) Area	35,847	35,847	10,754	16,131	$29,036.07	$5,914.76	$13,281.31	$92,915.42	$5,538.36	$19,715.85
Totals	**80,171**	**80,171**	**55,078**	**82,617**	**$ 148,709.88**	**$ 30,292.75**	**$ 68,021.00**	**$ 475,871.60**	**$ 28,365.03**	**$ 44,093.85**

$795,354.11

Off Claim Wernecke Tailings - Creek Rehab & Reroute					Cost					
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen
Reroute Creek	947	5,682	852	5,682	$21,591.60	$715.93	$7,363.87	$3,238.74	$28,410.00	$7,964.74
Totals	**947**	**5,682**	**852**	**5,682**	**$21,591.60**	**$715.93**	**$7,363.87**	**$3,238.74**	**$28,410.00**	**$7,964.74**

$69,284.89

Off Claim Wernecke Tailings - Lime Added							Cost	
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application
Consolidated Tailings Area	44,324	44,324	109,456	215,628	1,293,765	1,294	$646,882.60	$109,455.60
Totals	**44,324**	**44,324**	**109,456**	**215,628**	**1,293,765**	**1,294**	**$646,882.60**	**$109,455.60**

$756,338.20

Off Claim Wernecke Tailings - Organics		Cost
Description	Organics (m3)	Organics Cost
Compost	4,009	$324,691.06
Totals	**4009**	**$324,691.06**

$324,691.06

Off Claim Wernecke Tailings - Site Access			Cost	
Area	Volumes (m3)	Mass (tonnes)	325 Excavator 76 m^3/hr	D8 Dozer 120 m^3/hr
Wernecke Road Site Access	53,441	80,162	$131,999.27	$110,622.87
Totals	**53,441**	**80,162**	**$131,999.27**	**$110,622.87**

$242,622.14

Alt-2 (Consolidate & Cover) Contingency			Cost
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$3,681,264.78	$0.00
Totals		**$3,681,264.78**	**$0.00**

Alt-2 (Consolidate & Cover) Closure Indirect Costs			Cost
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$3,681,264.78	$257,688.53
Profit & Overhead	10.0%	$3,681,264.78	$368,126.48
Insurance & Bonding	1.4%	$3,681,264.78	$51,537.71
Field Engineering, QA & Surveying	7.0%	$3,681,264.78	$257,688.53
Mob & Demob	5.0%	$3,681,264.78	$184,063.24
Living Allowances	8.0%	$3,681,264.78	$294,501.18
Taxes	7.0%	$3,681,264.78	$257,688.53
Totals			**$1,671,294.21**

Direct Cost	**$3,681,264.78**
Indirect Cost	**$1,671,294.21**
Total Direct & Indirect	**$5,352,558.99**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$5,352,558.99**

Keno- Wernecke Tailings Off Claim Material
11/14/2013
KDL

Wenecke Tailings - Enhance Natural Recovery

Assumptions

Insitu Unit Weight Tails	1.97 tonnes/m3	Lime Added	6 kg/tonnes
Unit Weight of Borrow Material	1.5 tonnes/m3	Lime	500 $/tonnes
Unit Weight of Diversion Material	1.5 tonnes/m3	Rip Rap Depth	0.15 m
Depth of Lime addition	0.25 m		
Est. Coefficient for 3D Surface Area	1	Blasting	0.4 $/tonnes
Tailings Depth	1 m	Water Treatment Plant	300,000 $
Cover Thickness Over Area Where tails Were Removed	0.3 m	Water Treatment	0.5 $/m3
Cover Thickness Over Tailings	1 m	Rip Rap Weight	2.1 tonnes/m3
Stripping Depth	0.3 m	Filter Fabric	5 $/m2 for $1.5 to buy, $3.5 to place
Unit Weight of Stripping Material	1 tonnes/m3	Seed, Fertilizer, Spreading	0.55 $/m2 for $0.55 Seed/Fertilizer
Project Management & Field Supervision	7.0%	Lime Application	3 $/m3 *Assumed to be 3x the standard cost for labor/small equipment*
Profit & Overhead	10.0%	Crush & Screen	4.45 $/tonnes
Insurance & Bonding	1.4%	Organics Depth	0.05 m
Field Engineering, QA & Surveying	7.0%	Organics Weight	0.3 tonnes/m3
Mob & Demob	5.0%	Organics Cost	81 $/m3 *Assumed as Import to site (around $10,000 per truck)*
Living Allowances	8.0%	Over Excavation	0.5 m
Taxes	7.0%	Tailings Dry Weight For Lime	1.55 tonnes/m3
Contingency	0.0%	Unit Weight Over Excavated Material	1.2 tonnes/m3
Rectangular Creek Width (3m bottom 3:1 side slope)	6 m	Percent by Volume of Tails in OverEx Material	75%
Creek Depth (3m bottom 3:1 side slope)	1 m	Haul Road A Cut	9913 m3 (ACAD Volume)
Tailings Area Requiring Enhancement	50% of total tailings area		
Tailings Area Requiring Revisting for Enhacement	50% of orginal seeded area		

Tailings Quantity Assumptions

Location	Area (m2)	Average Depth (m)	Volume (m3)
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
Pod 4	142	1	142
Pod 5	487	0.7	341
Pod 6	15,021	0.7	10,515
Pod 7	18,933	0.5	9,467
Total for all Pods	**35,847**		**21,924**
Delta (with over excavation)	**97,257**	**0.9**	**87,531**
Grand Total	**133,104**		**109,456**

Off Claim Wernecke Tailings - Creek Rehab & Reroute					Cost					
Creek	Length (m)	Estimated Excavation (m3)	Rip Rap (m3)	Filter Fabric (m2)	325 Excavator 50 m^3/hr	Blasting	740 Truck 27 m^3/hr	325 Excavator 50 m^3/hr	Filter Fabric	Crush & Screen
Reroute Creek	308	1,848	277	1,848	$7,022.40	$232.85	$2,395.01	$1,053.36	$9,240.00	$2,590.43
Totals	**308**	**1,848**	**277**	**1,848**	**$7,022.40**	**$232.85**	**$2,395.01**	**$1,053.36**	**$9,240.00**	**$2,590.43**

$22,534.05

Off Claim Wernecke Tailings - Lime Addition and Seeding, Fertilizer, Spreading							Cost		
Area	Areas (m2)	Areas + Est Coefficient (m2)	Volumes (m3)	Mass (tonnes)	Lime (kg)	Lime (tonnes)	Lime Cost	Lime Application	Seed, Fertilizier and Spreading
Detla and Pod Tailings (with revisit)	99,828	99,828	24,957	49,165	294,992	295	$147,495.87	$74,871.00	$54,905.40
Totals	**99,828**	**99,828**	**24,957**	**49,165**	**294,992**	**295**	**$147,495.87**	**$74,871.00**	**$54,905.40**

$277,272.27

Off Claim Wernecke Tailings - Organics		Cost
Description	Organics (m3)	Organics Cost
Compost (added to all cover)	4,991	$404,303.40
Totals	**4991**	**$404,303.40**

$404,303.40

Off Claim Wernecke Tailings - Site Access			Cost	
Area	Volumes (m3)	Mass (tonnes)	325 Excavator 76 m^3/hr	D8 Dozer 120 m^3/hr
Wernecke Road Site Access	9,913	19,529	$24,485.11	$20,519.91
Totals	**9,913**	**19,529**	**$24,485.11**	**$20,519.91**

$45,005.02

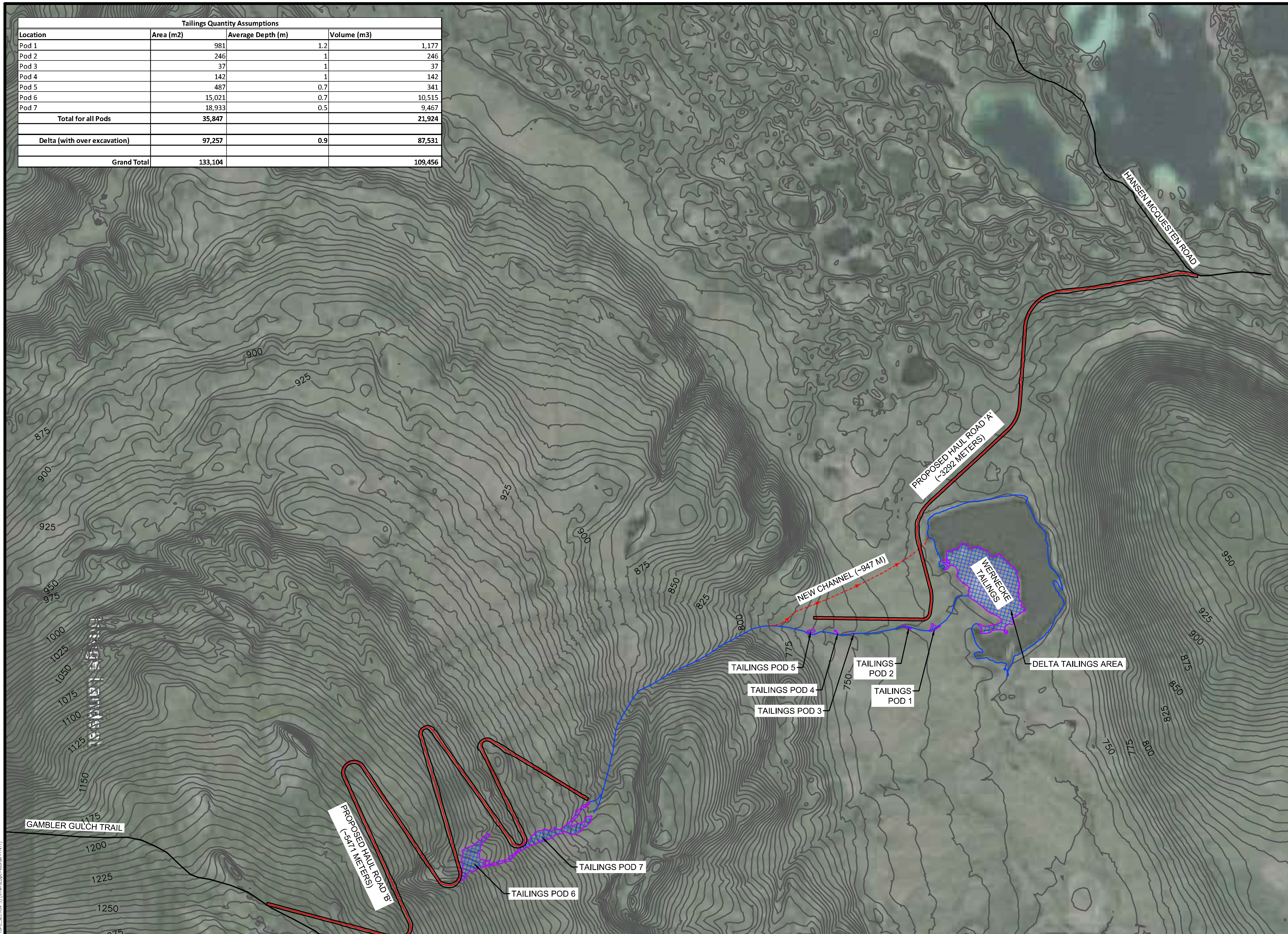
Alt-3 (Enhance Natural Recovery) Contingency			Cost
Description	Quantity	Direct Costs	Unit
Contingency	0.0%	$749,114.74	$0.00
Totals		**$749,114.74**	**$0.00**

Alt-3 (Enhance Natural Recovery) Closure Indirect Costs			Cost
Description	Percent	Direct Costs	
Project Management & Field Supervision	7.0%	$749,114.74	$52,438.03
Profit & Overhead	10.0%	$749,114.74	$74,911.47
Insurance & Bonding	1.4%	$749,114.74	$10,487.61
Field Engineering, QA & Surveying	7.0%	$749,114.74	$52,438.03
Mob & Demob	5.0%	$749,114.74	$37,455.74
Living Allowances	8.0%	$749,114.74	$59,929.18
Taxes	7.0%	$749,114.74	$52,438.03
Totals			**$340,098.09**

Direct Cost	**$749,114.74**
Indirect Cost	**$340,098.09**
Total Direct & Indirect	**$1,089,212.83**
Contingency	**$0.00**
Total Direct, Indirect & Contingency	**$1,089,212.83**

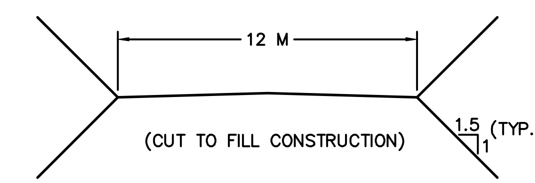
Tailings Quantity Assumptions

Location	Area (m2)	Average Depth (m)	Volume (m3)
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
Pod 4	142	1	142
Pod 5	487	0.7	341
Pod 6	15,021	0.7	10,515
Pod 7	18,933	0.5	9,467
Total for all Pods	**35,847**		**21,924**
Delta (with over excavation)	**97,257**	**0.9**	**87,531**
Grand Total	**133,104**		**109,456**

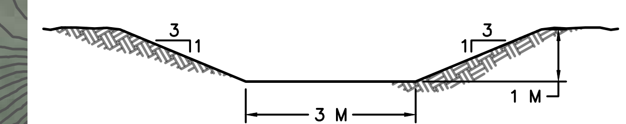


HAUL ROAD 'A'	
LENGTH	3,292 METERS
DISTURBANCE AREA	51,700 SQ. METERS
CUT	10,355 CU. METERS
FILL	6,800 CU. METERS

HAUL ROAD 'B'	
LENGTH	5,471 METERS
DISTURBANCE AREA	102,975 SQ. METERS
CUT	41,975 CU. METERS
FILL	26,465 CU. METERS

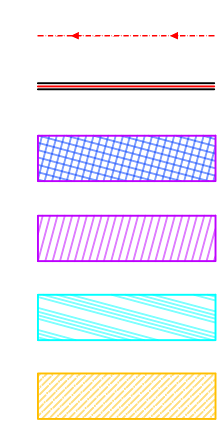


TYPICAL HAUL ROAD SECTION
N.T.S.



TYPICAL CHANNEL SECTION
N.T.S.

LEGEND



600 0 600
(In Meters)
1 cm = 200 M

DESIGNED BY	K. LOCK	11-08-2013
DRAWN BY	S. CRANK	11-08-2013
CHECKED BY	C. GREEN	11-08-2013
APPROVED BY		
PROJECT MANAGER		
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

DRAWING REFERENCE(S):
EXISTING TOPOGRAPHY PROVIDED BY ____________,
RECEIVED _____, 20__.

DATUM: NAD83 SCALE: 1 cm = 20 m

PROJECT LOCATION
KENO,YUKON, CANADA

PROJECT
KENO

TITLE
WERNECK TAILINGS RECLAMATION COVER IN PLACE

INTERRA

4715 Innovation Drive, Suite 110
Fort Collins, Co 80525
970.225.8222

DRAWING: EXHIBIT 1 REVISION:
FILE NAME: new 2013 exhibit

Tailings Quantity Assumptions			
Location	Area (m2)	Average Depth (m)	Volume (m3)
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
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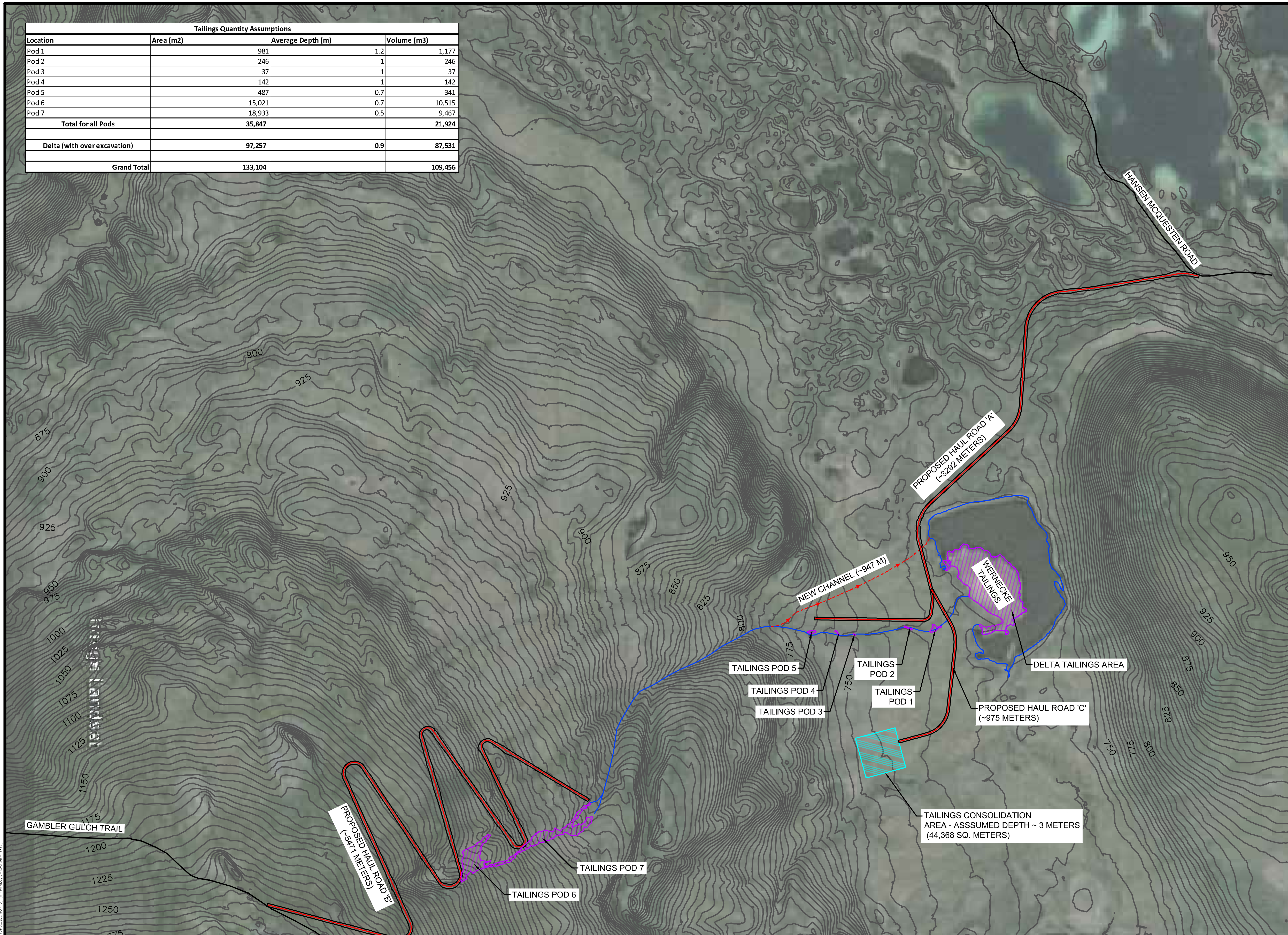
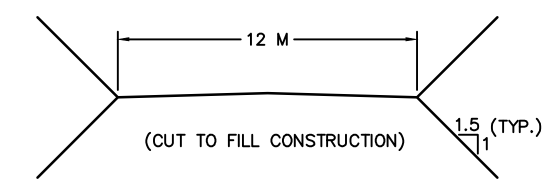
Grand Total	133,104		109,456



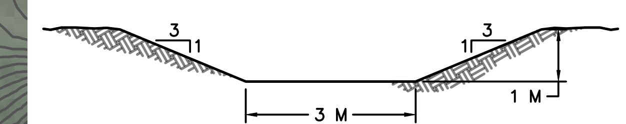
HAUL ROAD 'A'	
LENGTH	3,292 METERS
DISTURBANCE AREA	51,700 SQ. METERS
CUT	10,355 CU. METERS
FILL	6,800 CU. METERS

HAUL ROAD 'B'	
LENGTH	5,471 METERS
DISTURBANCE AREA	102,975 SQ. METERS
CUT	41,975 CU. METERS
FILL	26,465 CU. METERS

HAUL ROAD 'C'	
LENGTH	975 METERS
DISTURBANCE AREA	13,828 SQ. METERS
CUT	1,111 CU. METERS
FILL	36 CU. METERS



TYPICAL HAUL ROAD SECTION
N.T.S.



TYPICAL CHANNEL SECTION
N.T.S.

LEGEND

- PROPOSED DIVERSION CHANNEL
- PROPOSED HAUL ROAD (WITH CUT/FILL LINES)
- TAILINGS TO BE LEFT IN PLACE, PLACEMENT OF COVER AND VEGETATION.
- TAILINGS TO BE RELOCATED, PLACEMENT OF COVER AND VEGETATION.
- CONSOLIDATION AREA FOR PLACEMENT OF RELOCATED TAILS, COVER AND VEGETATION.
- ENHANCE NATURAL RECOVERY OF TAILINGS

600 0 600
(In Meters)
1 cm = 200 M

DESIGNED BY	K. LOCK	11-08-2013
DRAWN BY	S. CRANK	11-08-2013
CHECKED BY	C. GREEN	11-08-2013
APPROVED BY		
PROJECT MANAGER		
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

DRAWING REFERENCE(S):
EXISTING TOPOGRAPHY PROVIDED BY ____________, RECEIVED _____, 20__.

DATUM: NAD83 SCALE: 1 cm = 20 m

PROJECT LOCATION
KENO,YUKON, CANADA

PROJECT
KENO

TITLE
WERNECK TAILINGS RECLAMATION
CONSOLIDATE TAILINGS

INTERRA
4715 Innovation Drive, Suite 110
Fort Collins, Co 80525
970.225.8222

DRAWING EXHIBIT 2
REVISION
FILE NAME new 2013 exhibit

Tailings Quantity Assumptions			
Location	Area (m2)	Average Depth (m)	Volume (m3)
Pod 1	981	1.2	1,177
Pod 2	246	1	246
Pod 3	37	1	37
Pod 4	142	1	142
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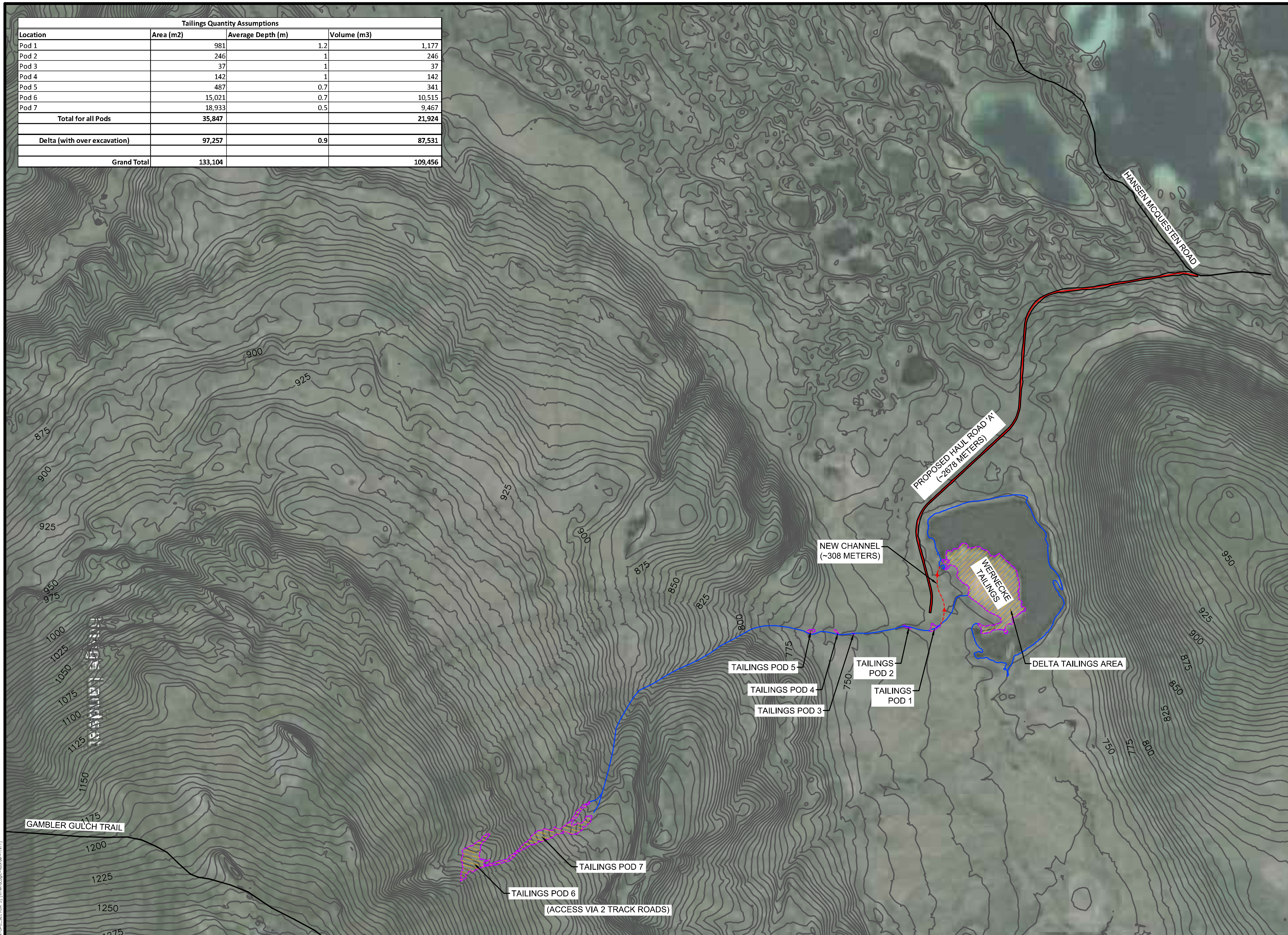
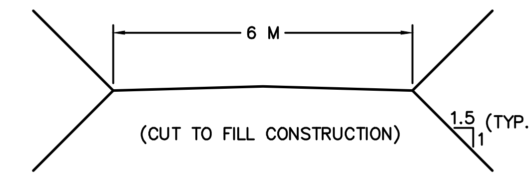
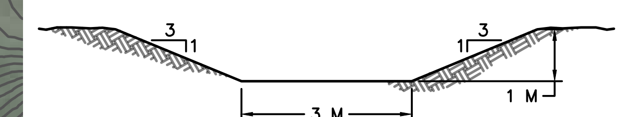


HAUL ROAD 'A'	
LENGTH	2,678 METERS
DISTURBANCE AREA	28,050 SQ. METERS
CUT	9,913 CU. METERS
FILL	15,175 CU. METERS



TYPICAL HAUL ROAD SECTION
N.T.S.



TYPICAL CHANNEL SECTION
N.T.S.

LEGEND

- PROPOSED DIVERSION CHANNEL
- PROPOSED HAUL ROAD (WITH CUT/FILL LINES)
- TAILINGS TO BE LEFT IN PLACE, PLACEMENT OF COVER AND VEGETATION.
- TAILINGS TO BE RELOCATED, PLACEMENT OF COVER AND VEGETATION.
- CONSOLIDATION AREA FOR PLACEMENT OF RELOCATED TAILS, COVER AND VEGETATION.
- ENHANCE NATURAL RECOVERY OF TAILINGS

600 0 600
(In Meters)
1 cm = 200 M

DESIGNED BY	K. LOCK	11-08-2013
DRAWN BY	S. CRANK	11-08-2013
CHECKED BY	C. GREEN	11-08-2013
APPROVED BY		
PROJECT MANAGER		
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

DRAWING REFERENCE(S):
EXISTING TOPOGRAPHY PROVIDED BY ____________, RECEIVED _____, 20__.

DATUM: NAD83 SCALE: 1 cm = 20 m

PROJECT LOCATION
KENO,YUKON, CANADA

PROJECT
KENO

TITLE
WERNECK TAILINGS RECLAMATION
ENHANCE NATURAL RECOVERY

INTERRAlogic
4715 Innovation Drive, Suite 110
Fort Collins, Co 80525
970.225.8222

DRAWING EXHIBIT 3 REVISION
FILE NAME new 2013 exhibit