

Chuitna Coal Project Mine Site Lakes Preliminary Water Quality Assessment Summary Report



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Introduction

The Chuitna Coal Project (CCP) is a proposed surface mine located within the Chuit River drainage basin. The site is located 10 miles NW of the village of Tyonek and 45 miles west of Anchorage, on the west side of Cook Inlet in South-central Alaska. Lakes of various sizes and depth are found within the Chuitna Coal Mine boundary. Baseline environmental data has been collected in and around the mine area dating back to the early 1980's. This includes, but is not limited to, geology, surface water, ground water, vegetation, soils, wetland inventories, wildlife, fish and other aquatic life types, and climate data, to name a few. To add to this knowledge in 2009, PacRim Coal, LP (PRC) initiated a small field program to characterize the lakes within the proposed mine boundary.

Using the 2005 aerial photography and the proposed coal removal limits, 22 lakes and clusters of lakes/ponds were identified within and along the mine boundary (Figure 1). These lakes will be dewatered as they are encountered in the mining process in order to extract coal as the Chuitna Coal Project develops. Surface water characterization information is required as part of ASCMCRA regulatory program under 11 AAC 90.049. Characterizing these lakes will also help determine if special considerations may be required for water managers during mine operations if water chemistry parameters exceed permitted limits.

Field work was conducted in August of 2009. This summary report includes the approach, methods and results of the lake water quality sampling program.

Project Approach

To achieve characterization of the surface water bodies, we reviewed the aerial photography of the site and identified 22 surface water bodies within the proposed mine limits (Figure 1). These were located throughout the project site and come in a variety of sizes, shapes and apparent depths. We applied the following criteria to select appropriate sample targets:

- Divide the mine site into four quadrants;
- Assign each lake a relative size based on the water bodies present
 - Small (less than 1 acre)
 - Medium (1-5 acres)
 - Large (over 5 acres)
- Determine if any lake had a specific characteristic that would distinguish it from the other lakes (i.e. fish present, active inflow/outflow, etc.).

Using the above criteria, we selected a lake or surface water body with at least one from each size category, one from each quadrant, and any lake that had any known special characteristic. This review generated the following sample target sites (Table 1). Figure 1 is a map showing the locations of the four lakes sampled for water quality from the 22 lakes identified from the aerial imagery. Figures 2 through 5 are photos of the individual lakes sampled.

Table 1. Lakes and ponds sampled for water quality within the mine boundary

Size	Lake	Location	Total	Comments
Small	4	East quadrant	1	
Medium/shallow	6	South quadrant	1	
Large	13	West quadrant	1	
Large	16	North quadrant	1	documented with fish present
			4	

Within each lake, the sample program included determining the key physical parameters (depth, clarity), field water quality parameters, and gather samples for elemental analysis (see Methods section). The sampling was also conducted after the standard summer dry spell (during the low end of the hydrograph).

Methods

As mentioned above, four lakes of representative size within the Chuitna Coal Mine boundary were sampled on August 30th for depth, clarity and water quality with the assistance of Tom Goozmer from Tyonek. Access the sites was via helicopter. The depth of each lake was measured from the helicopter using a weighted tape measure at 3 locations in the central part of the lake. The deepest part of each lake was selected as the sample site where the secchi disk reading was collected. A secchi disk was lowered into the water column to estimate water clarity at this location. A water sample was collected at this same location 1.5 feet below the water’s surface using a sterile half gallon plastic container. An Oakton and YSI water quality reader was used to collect field parameters including pH, DO, conductivity and temperature at each lake (see Table 2, Water Quality Parameters).

The water sample was transferred into labeled sterile sample bottles. The dissolved metal samples were filtered with a 0.45 micron filter within 15 minutes of collection as per EPA sampling protocols. The water sample for low level mercury was collected separately for dissolved and total analysis. Samples were preserved and shipped on ice in coolers to Inter-Mountain Laboratories in Sheridan, Wyoming for analysis. Holding times for each analysis vary; however color and turbidity have the shortest holding time at 48 hours and the remaining analysis range from 14 days to 6 months. Chain of custody forms were completed and submitted with each sample. The analysis suite for the water samples mirror’s the suite used for other water characterization throughout the project area during prior baseline studies. The analysis is shown in Table 2, along with the methods, units and detection limits.

Table 2. Water quality parameters

Parameters	Detection Limit	Units	Method
General Parameters			
pH	0.1	s.u.	EPA 150.1
Specific Conductance	5	µmhos/cm ²	SM2510B
Total Dissolved Solids	10	mg/L	SM2540
Total Suspended Solids	5	mg/L	SM2540
Total Alkalinity as CaCO ₃	5	mg/L	SM2320B
Hardness, Calcium/Magnesium CaCO ₃	10	mg/L	SM 2340B
Nitrogen Ammonia, N	0.1	mg/L	EPA 350.1
Nitrogen Nitrate, N	0.1	mg/L	EPA 300.0
Nitrogen Nitrite, N	0.1	mg/L	EPA 300.0
Phosphorus, Orthophosphate as P	0.1	mg/L	EPA 300.0
Color	5	C.U.	SM 2120B
Cyanide	0.01	mg/L	SM4500 CN1
Total Organic carbon	1	mg/L	SM 5310B
Turbidity	0.1	NTU	SM 2130
Anions			
Bicarbonate as HCO ₃	5	mg/L	SM 2320 B
Carbonate as CO ₃	5	mg/L	SM 2320 B
Hydroxide as OH	5	mg/L	SM 2320 B
Chloride	1	mg/L	EPA 300.0
Fluoride	0.1	mg/L	SM 4500FC
Nitrate+Nitrite as N	0.1	mg/L	EPA 300.0
Sulfate	1	mg/L	EPA 300.0

Table 2. Water quality parameters continued

Parameters	Detection Limit	Units	Method
Cations			
Calcium	1	mg/L	EPA 200.7
Magnesium	1	mg/L	EPA 200.7
Potassium	1	mg/L	EPA 200.7
Sodium	1	mg/L	EPA 200.7
Dissolved Metals			
Aluminum	0.02	mg/L	EPA 200.7
Antimony	0.003	mg/L	EPA 200.8
Arsenic	0.005	mg/L	EPA 200.8
Barium	0.1	mg/L	EPA 200.8
Beryllium	0.002	mg/L	EPA 200.7
Boron	0.03	mg/L	EPA 200.7
Cadmium	0.00009	mg/L	EPA 200.8
Chromium	0.01	mg/L	EPA 200.7
Cobalt	0.01	mg/L	EPA 200.8
Copper	0.001	mg/L	EPA 200.8
Iron	0.02	mg/L	EPA 200.7
Lead	0.0003	mg/L	EPA 200.8
Lithium	0.01	mg/L	EPA 200.7
Manganese	0.01	mg/L	EPA 200.7
Mercury	0.00005	mg/L	EPA 1631
Molybdenum	0.01	mg/L	EPA 200.8
Nickel	0.01	mg/L	EPA 200.7
Selenium	0.003	mg/L	EPA 200.8
Silicon	0.1	mg/L	EPA 200.7
Silver	0.0002	mg/L	EPA 200.8
Strontium	0.01	mg/L	EPA 200.8
Thallium	0.001	mg/L	EPA 200.8
Titanium	0.01	mg/L	EPA 200.8
Vanadium	0.01	mg/L	EPA 200.8
Zinc	0.005	mg/L	EPA 200.7
Total Recoverable Metals			
Aluminum	0.02	mg/L	EPA 200.7
Antimony	0.003	mg/L	EPA 200.8
Arsenic	0.005	mg/L	EPA 200.8
Barium	0.1	mg/L	EPA 200.8
Beryllium	0.002	mg/L	EPA 200.7
Boron	0.03	mg/L	EPA 200.7
Cadmium	0.00009	mg/L	EPA 200.8
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Manganese	0.01	mg/L	EPA 200.7
Mercury	0.00005	mg/L	EPA 1631
Molybdenum	0.01	mg/L	EPA 200.8
Nickel	0.01	mg/L	EPA 200.7
Selenium	0.003	mg/L	EPA 200.8
Silicon	0.1	mg/L	EPA 200.7
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Strontium	0.01	mg/L	EPA 200.8
Thallium	0.001	mg/L	EPA 200.8
Titanium	0.01	mg/L	EPA 200.8
Vanadium	0.01	mg/L	EPA 200.8
Zinc	0.005	mg/L	EPA 200.7

Results

A map illustrating the four sample lake sites and aerial photos taken the day of sampling are included in Figures 1 through 5. The deepest lake sampled was Lake 16, with a mean depth of 15.5 feet. This was also the lake documented with fish present (OASIS, 2007). Lake 13 was the shallowest, although largest lake sampled, with a mean depth of 5.8 feet. Lakes 4, 6 and 13 had relatively high color readings of 10-11 C.U. (Table 5) with low secchi disk readings (5.4 to 7.4) (Table 3). These lakes are characteristic of a eutrophic lake system, which includes low secchi depth readings (13 feet and less) and high suspended and dissolved particles (Kevern et al., 2004); Lake 16 may be partly mesotrophic compared to the other three lakes sampled due to the lower color readings (5 C.U.) and higher secchi disk depth (10.8 feet).

Table 3. Lake depth, clarity and surface area measurements in mine boundary

Lake	Depth (A)	Depth (B)	Depth (C)	Secchi disk	Surface Area (acre)
4	13	14.4	NA	6.2	0.69
6	5	15	17.8	7.4	1.90
13	5.4	6.3	5.6	5.4	7.29
16	17.5	21.6	7.3	10.8	6.42

NA - No measurement taken

Field collection parameters included water temperature, conductivity and dissolved oxygen. Water temperatures collected were consistent among lakes sampled (14.1-15.4 °C), The dissolved oxygen levels were very consistent among the lakes with a mean reading of 8.6 mg/L. Conductivity readings of all four lakes had a mean of 34.5 uS/cm (Table 4).

Table 4. Lake field water quality parameter measurements

Lake	Temp (°C)	Conductivity (uS/cm)	DO (mg/L)
4	14.1	35.4	8.37
6	14.7	36.0	8.72
13	14.9	30.3	8.46
16	15.4	36.1	8.72

Most of the general parameters listed in Table 2 were below detection limit in the samples. The exceptions were pH, electrical conductivity, total dissolved solids, color, total organic carbon and turbidity. Table 5 shows the water quality results for the general parameters found to be above detection limit. The mean pH of all four lakes was neutral (6.65) and similar to what is exhibited in the surface waters (6.1-8.2) and ground waters (6.0-7.8) in the area (Riverside 2009, Riverside 2010). Electrical conductivity was low, ranging from 18-20 umhos/cm. The lake waters are similar in that they possess low levels of organic carbon (4-6 mg/L), which is similar to the levels in the surrounding streams (2-7 mg/L; Riverside 2009). Turbidity levels are low, with Lake 13 at the highest turbidity value of 1.0 NTU (Table 5).

Table 5. General Parameters of four lakes sampled within the Chuitna Mine boundary

Lake	pH	Electrical Conductivity (umhos/cm)	Color (C.U.)	TOC (mg/L)	Turbidity NTU
4	6.4	19	11	6	0.5
6	6.6	20	10	5	0.8
13	6.8	18	10	5	1.0
16	6.8	19	5	4	0.7

ND - not detected at the reporting limit

Major Ions and Dissolved Solids

Major ions and dissolved solids detected from analysis of the four lakes sampled include calcium and sodium as cations and bicarbonate and sulfate are the major anions. All other major ions were undetected at the reporting limits. Hardness is very low (<10mg/L) in all lakes sampled. Total dissolved solid concentrations were generally low, ranging from no detection to 30 mg/L (Table 6). Concentrations of calcium and sodium were either non detect or at 1mg/L. Bicarbonate (HCO₃) was the dominant anion in the lakes which ranged from no detection to 6 mg/L. Sulfate was the next most abundant anion. When comparing the cation/anion milliequivalent balance in each lake, Lakes 4, 6, and 13 are slightly positive (cation dominant) and Lake 16 is slightly negatively charged (anion dominant). Major cation and anion concentrations were minimal overall.

Table 6. Major Ion and dissolved solids concentrations (mg/L) detected in four lakes sampled

Lake	Dissolved Solids	Calcium	Sodium	Bicarbonate	Sulfate
4	20	ND	1	ND	ND
6	30	ND	1	ND	1
13	ND	1	ND	5	1
16	ND	ND	ND	6	1

ND - not detected at the reporting limit
 Bicarbonate and Sulfate – anions

Figure 6a presents a Piper Diagram showing the major anions and cations for the lake samples. The clustering shown on the Piper Diagram indicates that there is not much spatial variability in the lake water quality for this sampling event. The pattern demonstrated by the Piper Diagram is consistent with the surface waters and ground waters in the area (Riverside 2009, Riverside 2010). Results of past surface water samples is shown on the Piper Diagram in Figure 6b for comparison.

Figure 7 presents Stiff diagrams for the lake samples. The ion concentrations are low in all samples, but the waters appear to be bicarbonate with very low levels of calcium and sodium. There is little to no variation between the lakes for this sampling event. The lake water for this sampling event demonstrates lower ion concentrations than typically found in the surface waters and ground waters in the area (Riverside 2009, Riverside 2010).

Total and Dissolved Metals

Twenty five metals were analyzed under the EPA water quality standards for total and dissolved concentrations (Table 2). Metals detected above the reporting limit are included in Table 7. Aluminum, Iron and Silicon were detected above the reporting limits in each lake sampled. Strontium was detected in all lakes except the dissolved concentration in Lake 13 was below the detection limit. Mercury, Copper and Boron were detected in Lake 13 only; Manganese was present only in Lake 6.

Table 7. Dissolved and Total recoverable metals concentrations (mg/L) detected in four lakes¹

Lake	Aluminum D/T	Boron D/T	Copper D/T	Iron D/T	Manganese D/T	Mercury D/T	Silicon D/T	Strontium D/T
4	0.12/0.16	ND	ND	0.11/0.15	ND	ND	0.9/0.9	0.01/0.01
6	0.07/0.09	ND	ND	0.12/0.2	0.02/ND	ND	0.9/0.9	0.02/0.02
13	0.06/0.09	ND/0.05	0.001/0.001	0.11/0.23	ND	0.000002/ND	0.2/0.3	ND/0.01
16	0.02/0.05	ND	ND	0.11/0.21	ND	ND	0.4/0.5	0.01/0.01

D - dissolved

T - total

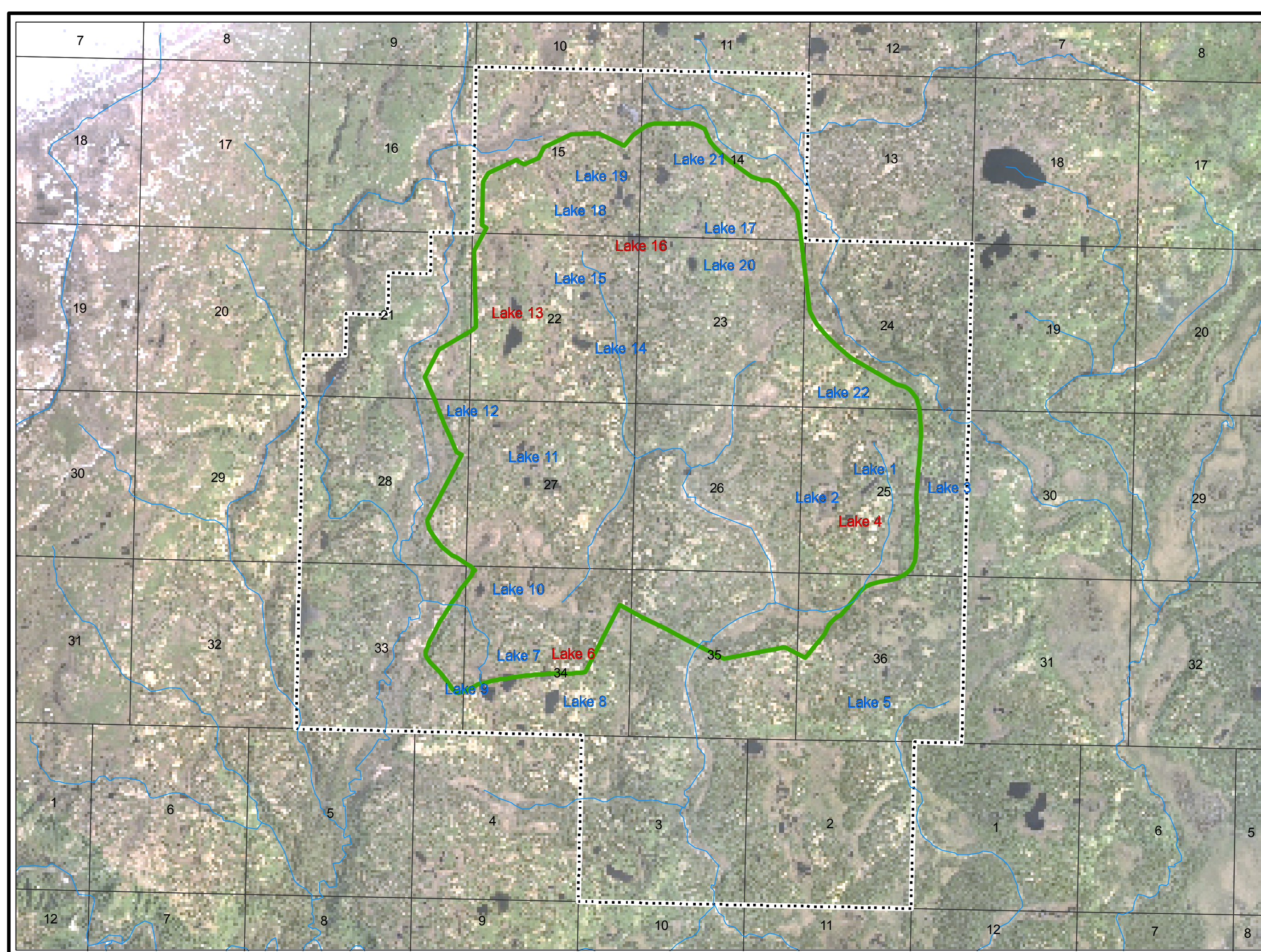
ND - not detected at the reporting limit

The majority of the metals present in the four lakes sampled were also found in the surface water quality results for the Chuit River drainage (RTi, 2009). The exceptions to this are silicon and strontium were detected in the lakes but not in the surrounding streams; and nickel, silver and zinc were detected in the streams but not detected in the lakes. Sediment movement is high in a fluvial system, and dissolved oxygen levels are high, whereas lakes are calm with much less mixing and therefore have lower dissolved oxygen concentrations. These attributes may explain differences in water quality between a lake and a fluvial system

References

- Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 264 p.
- Kevern, Niles R., Darrell L. King and Robert Ring. 2004. Lake Classification Systems – Part 1. The Michigan Riparian February 1996.
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- Riverside Technology inc., 2010. Chuitna Coal Project Groundwater Baseline Report - Draft 1982 through December 2008. Fort Collins, CO.
- Riverside Technology inc., 2009. Chuitna Coal Project Surface Water Component Baseline Report Draft Historical Data Summary. Fort Collins, CO.

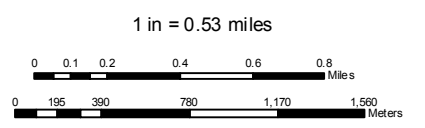
¹ Metals not detected at the reporting limit are not included in the table



Legend

- WQ Water Quality Sampling Sites
- Identified Lakes

Notes:
 Datum/Coordinate system:
 NAD83, Alaska State Plane
 Zone 4, US Foot
 Topo and Land Cover Data from:
 MSL_Chuitna400-ACAD2000.dwg
 Data Version
 Geodatabase obtained from Riverside
 Technology, Inc. 7/14/2009
 AutoCadd Dwg
 -Conveyor & Road Draft 7/10/2009
 -Nakacheba Corridor 2004



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Chuitna Coal Project

Figure 1. Lake Water Quality Sampling Sites

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Figure 2 - Lake 4

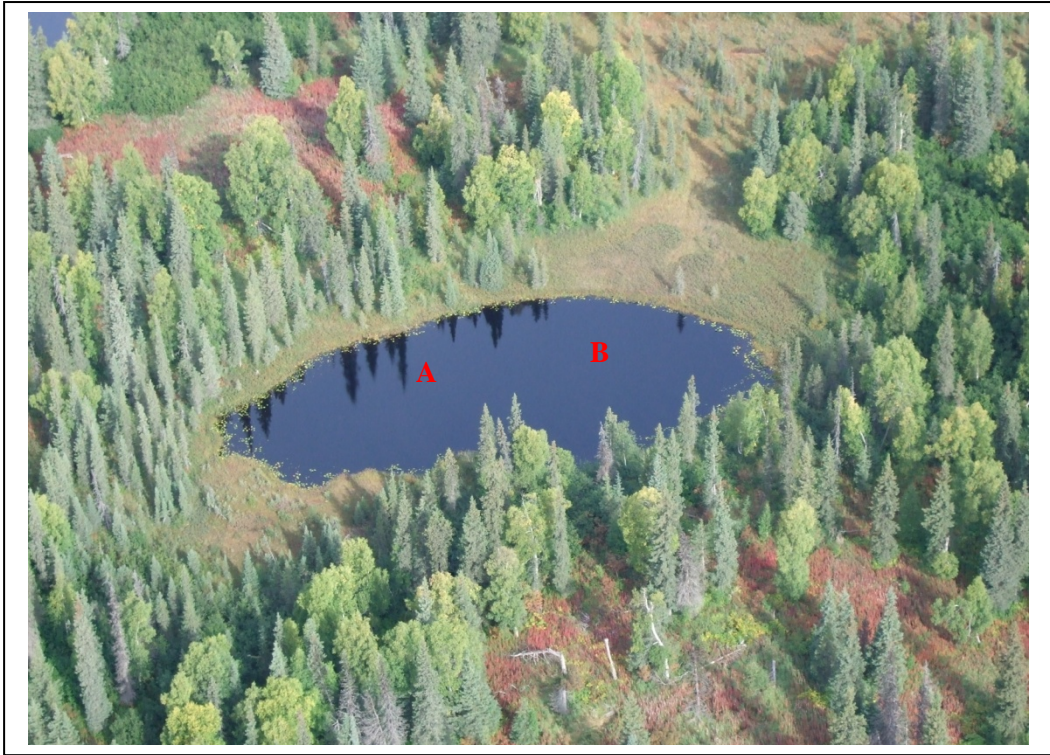


Figure 3 - Lake 6

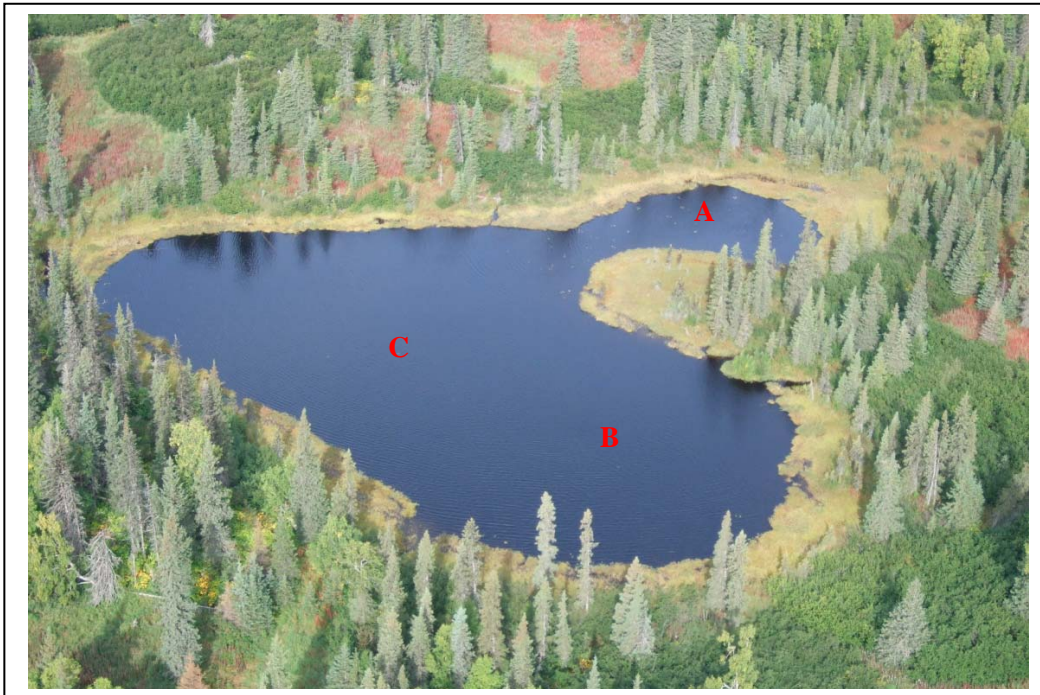


Figure 4 - Lake 13

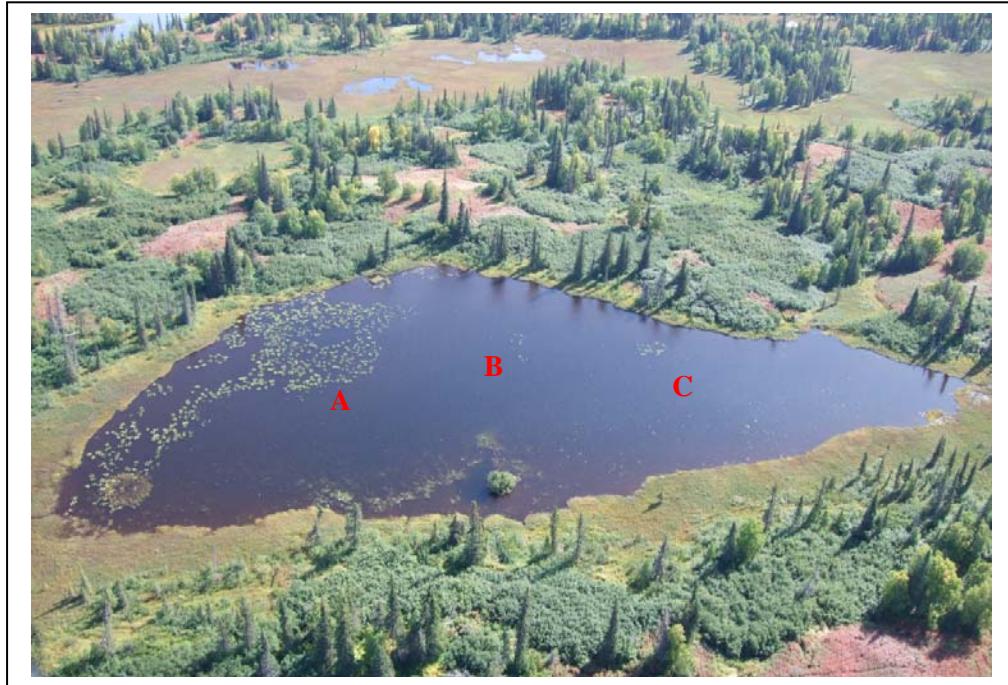


Figure 5 - Lake 16

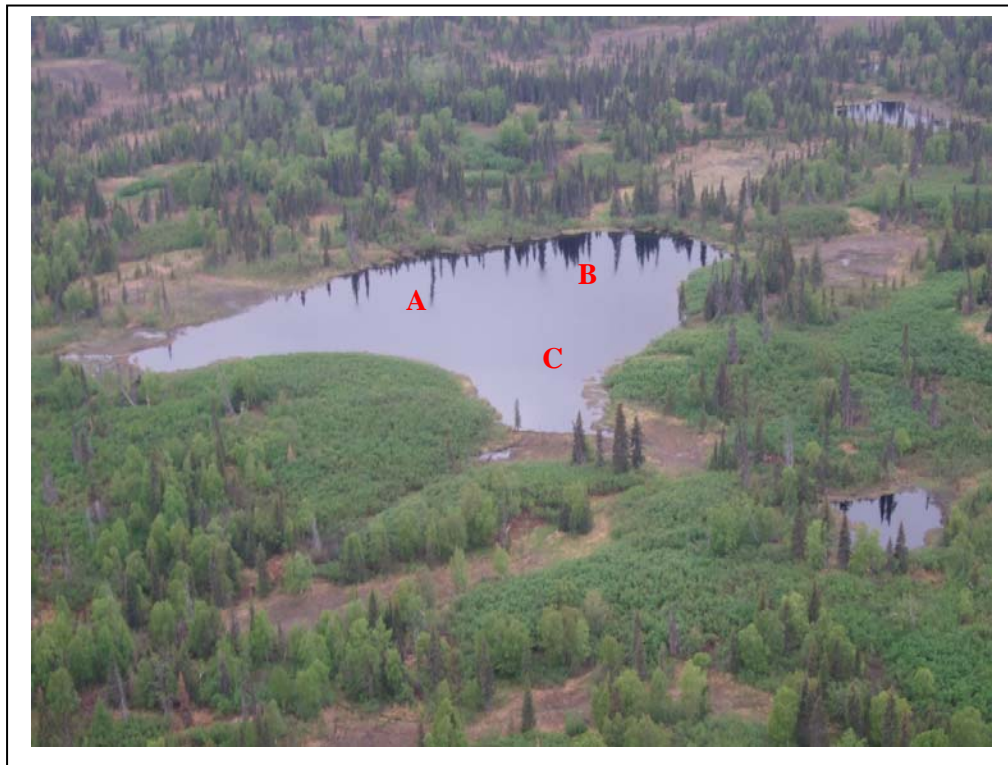


Figure 6a – Piper Diagram – Lake Samples

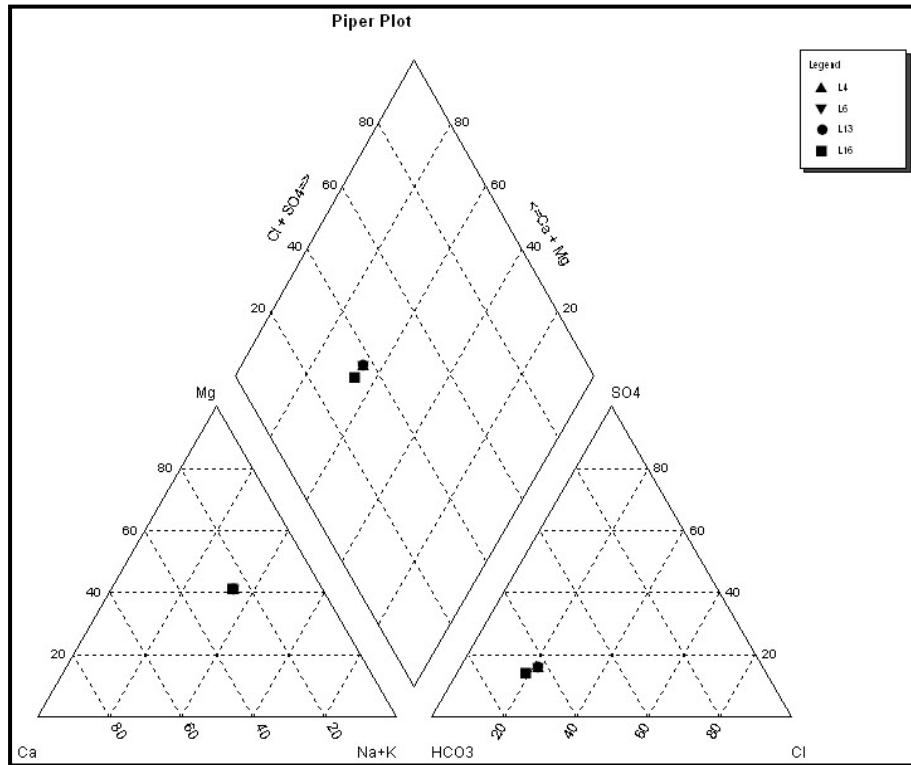


Figure 6b – Piper Diagram – Past Surface Water Samples

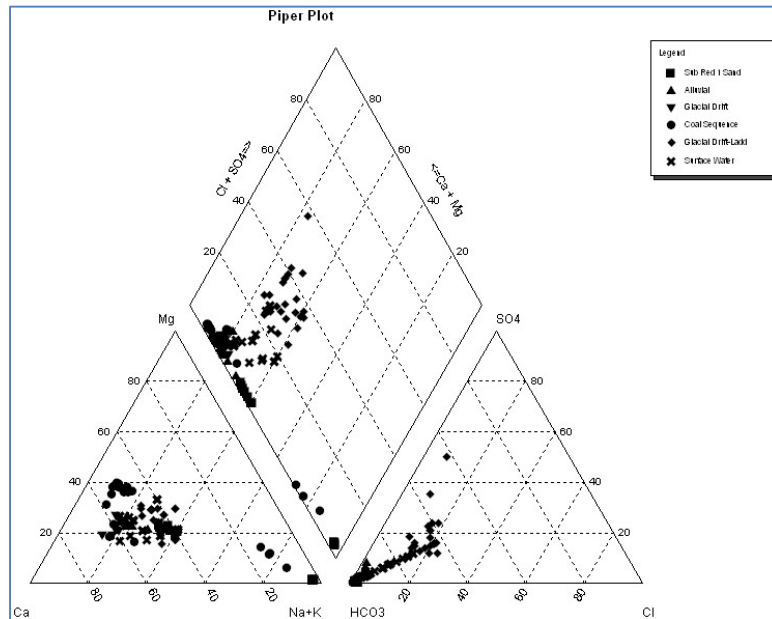


Figure 7 - Stiff Diagrams

