CHAPTER V

SURFACE WATER HYDROLOGY

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

2.0 REGIONAL SURFACE WATER HYDROLOGY 2

2.1 General Climatology 2
2.2 Drainage Basin Characteristics 3
2.3 Stream Flow 4
2.4 Surface Water Quality 4
2.5 Surface Water Use 5
2.6 Sediment Yield 5

3.0 SURFACE WATER INVESTIGATIONS AND MONITORING 6

3.1 Methods of Data Acquisition 6

3.1.1 Inventory of Watershed Parameters 6
3.1.2 Stream Flow Monitoring 6
3.1.3 Moose Creek Water Balance 8
3.1.4 Soil Sampling 9
3.1.5 Water Quality Sampling and Analysis 10

3.2 Results 11

3.2.1 Stream Hydrographs 11
3.2.2 Moose Creek Water Balance 15
3.2.3 Grain Size Analysis 18
3.2.4 Water Quality 19
3.2.5 Sediment Load 21

4.0 SURFACE WATER ANALYSIS 22

4.1 Watershed Description 22
4.2 Streamflow 24

4.2.1 Normal Flows 24
4.2.2 Estimated Peak Flows 25

4.2.2.1 Moose Creek 25
4.2.2.2 Buffalo Creek 26

TABLE OF CONTENTS
(continued)

4.2.3 Flood Plain Determination 28

4.3 Surface and Groundwater Interaction 29

4.3.1 Streams 29
4.3.2 Overland Flow 30

4.4 Water Quality 30

4.4.1 General Surface Water Chemistry 30
4.4.2 Suitability Classification 30
4.4.3 Comparison of Site and Regional Water Quality 33

4.5 Soil Loss / Sediment Yield 33

4.5.1 Measured Sediment Loads 33
4.5.2 Estimated Sediment Yield for Buffalo Creek 35

5.0 CONCLUSIONS 37

6.0 RESPONSIBLE PARTIES 38

7.0 REFERENCES 39

LIST OF TABLES

Table 2-1 Streamflow Data, Little Susitna River, Near Palmer, Alaska, 1949-1987

Table 2-2 Summary of Regional Water Quality Data

Table 3-1 Field Analytical Results of Monthly Surface Water Sampling

Table 3-2 Analytical Results of Monthly Surface Water Sampling

Table 3-3 Sediment Load and Discharge Values

Table 3-4 Stage-Discharge Relationships Stations 1 and 5: Moose Creek

Table 3-5 Comparison of Site Bridge and Station 5 Stage-Discharge Relationships

Table 4-1 Summary of Watershed Characteristics

Table 4-2 Summary of Chemical Analysis of Surface Water In and Near the Proposed Permit Area

Table 4-3 Comparison of Federal Drinking Water Quality Standards and Surface Water Quality in the Moose Creek Watershed

LIST OF FIGURES

Figure 1-1 Site Location

Figure 2-1 Location of Little Susitna River Gaging Station

Figure 3-1 Location of Surface Water Monitoring Stations

Figure 3-2 Moose Creek Station #1 (Upstream) Stage-Discharge Relationship

Figure 3-3 Moose Creek Station #5 (Downstream) Stage-Discharge Relationship

Figure 3-4 Buffalo Creek Station #4 (Flume) Stage-Discharge Relationship

Figure 3-5 Moose Creek Site Bridge Station Stage - Discharge Relationship

Figure 3-6 Discharge Hydrograph, Moose Creek, Station 1

Figure 3-7 Discharge Hydrograph, Moose Creek, Station 5

Figure 3-8 Discharge Hydrograph, Buffalo Creek, Station 4

Figure 3-9 Trilinear Diagram of Surface Water Analyses for Station 1 (July, 1988 - June, 1989)

Figure 3-10 Trilinear Diagram of Surface Water Analyses for Station2 (July,1988 - June, 1989)

Figure 3-11 Trilinear Diagram of Surface Water Analyses for Station 3 (July, 1988 - June, 1989)

Figure 3-12 Trilinear Diagram of Surface Water Analyses for Station 4 (July, 1988 - June, 1989)

Figure 3-13 Trilinear Diagram of Surface Water Analyses for Station 5 (July, 1988 - June, 1989)

Figure 3-14 Stiff Diagrams of Water Composition for Surface Water Sampling Stations

Figure 3-15 Time Trend Analyses for Surface Waters, pH vs. Time

Figure 3-16 Time Trend Analyses for Surface Waters, TDS vs. Time

Figure 3-17 Time Trend Analysis for Surface Water Turbidity vs. Time

Figure 3-18 Time Trend Analysis for Surface Water Total Suspended Solids vs. Time

Figure 3-19 Moose Creek Station #1 (Upstream) Turbidity vs. Discharge

LIST OF FIGURES (CONT.)

Figure 3-20 Moose Creek Station #5 (Downstream) Turbidity vs. Discharge

Figure 3-21 Buffalo Creek Station #4 (Flume) Turbidity vs. Discharge

Figure 3-22 Moose Creek Station #1 (Upstream) Total Suspended Solids vs. Discharge

Figure 3-23 Moose Creek Station #5 (Downstream) Total Suspended Solids vs. Discharge

Figure 3-24 Buffalo Creek Station #4 (Flume) Total Suspended Solids vs. Discharge

Figure 4-1 Moose Creek Drainage Basin

Figure 4-2 Moose Creek Channel Profile

Figure 4-3 Moose Creek Cross-Sections at Sampling Stations #1 and #5

Figure 4-4 Buffalo Creek Channel Profile

Figure 4-5 Buffalo Creek Cross Section at Location #1

Figure 4-6 Buffalo Creek Cross Section at Location #2

Figure 4-7 Buffalo Creek Cross Section at Sampling Station #3

Figure 4-8 Buffalo Creek Cross Section at Sampling Station #4

Figure 4-9 Little Susitna River, Near Palmer Total Suspended Solids vs. Discharge

LIST OF PLATES

Plate 3-1 Surface Water Drainages, Flood Plain and Monitoring Stations

LIST OF APPENDICES

Appendix A Quality Assurance Sampling Plan

Appendix B Grain Size Analyses

Appendix C Laboratory Analytical Data

Appendix D Flood Plan Calculations

Appendix E Regional Watershed Data

Appendix F Flood Analysis of Buffalo Creek

Appendix G Sediment Yield for Buffalo Creek

Appendix H Discharge Measurement Data

LIST OF ADDENDA

Addendum 1 Historical Surface Water Monitoring Data

Addendum 2 Stream Morphology Study on Buffalo Creek

Addendum 3 Comparative Analysis of Historical Surface Water Monitoring Data

1.0 INTRODUCTION

This report presents baseline surface water hydrology information in and near the permit area of the Wishbone Hill Coal Project. The project area is located approximately seven miles north of Palmer, Alaska, in the Moose Creek watershed as shown in Figure 1-1. Baseline information in the report includes regional watershed data, characterizations of site specific watersheds, stream flow data from streams in and near the permit area, stream morphology data, analytical results from monthly surface water quality monitoring, and an evaluation of baseline sediment yield conditions.

The body of this report is based on data collected during the period of July 1988 through July 1989. Additional field studies and surface water data collection programs continued through September 1992 and then again during the period of 1998 through 2001. In October 2008, surface water studies and monitoring programs were reinitiated and are currently ongoing. Addendum 1 of this report contains a compilation of all the stream flow and water quality monitoring data that has been collected in and near the permit area of the Wishbone Hill project during the last twenty years. Addendum 2 presents the results of a stream morphology study that was conducted on Buffalo Creek in October 2008 utilizing Rosgen Level II Survey methodology.

The baseline surface water monitoring program that was initiated in July 1988 included the collection of monthly water quality samples and continuous stream flow data from the two streams (Moose and Buffalo Creeks) that are situated in and adjacent to the permit area. The baseline monitoring program described in this report was developed to provide information in support of a surface mining permit application. During the scoping, design and implementation of the initial surface water hydrology characterization and baseline monitoring program, meetings were held with the Alaska Division of Mining (DOM) and the Division of Geological and Geophysical Surveys (DGGS) on June 13 and October 11, 1988. The DGGS was retained by the DOM to act as a technical advisor on the surface water hydrology investigations. The scope of the surface water hydrology characterization and baseline monitoring program reflects the comments and suggestions received from the agencies during these meetings.

2.0 REGIONAL SURFACE WATER HYDROLOGY

2.1 General Climatology

The proposed Permit Area is located within the Cook Inlet Basin on the southeast side of the Talkeetna Mountains (Figure 1-1). The Cook Inlet Basin covers an area of approximately 38,000 square miles in south-central Alaska. Within the Cook Inlet Basin the climate ranges from maritime along the coast to continental in the higher elevations near the proposed Permit Area. Based on forest types, the climate of this region is described as subarctic (Hartman and Johnson, 1978). Additional climatological data is provided in Part C, Chapter VII.

Annual temperature variations in the Cook Inlet Basin are large. The highest temperatures on record through 1987 for Anchorage (45 miles from the proposed Permit Area), Homer (170 miles from the proposed Permit Area) and Talkeetna (55 miles from the proposed Permit Area) are 85°, 80° and 91° Fahrenheit, respectively and occurred in June (NOAA, 1987). Lowest temperatures on record for the same cities are -34°, -21°, and -48° Fahrenheit, respectively. Lowest temperatures usually occur in January. Talkeetna is an exception, where the lowest temperature on record occurred in March. Annual daily maximum temperatures for all three cities are in the low 40's. Annual daily minimum temperatures are in the low to high 20's.

Precipitation within the Cook Inlet Basin also varies considerably, falling as rain in the late spring, summer and early autumn, and as snow in late autumn, winter and early spring. Mean annual precipitation values, including the water equivalent in snowfall, for Anchorage, Homer and Talkeetna are 15.2, 23.8, and 27.2 inches, respectively. Average annual snowfall for these cities is 68.6, 59.1, and 107.3 inches respectively (NOAA, 1987). The cities are in the lowlands, however. The Cook Inlet Basin also includes the Talkeetna, Chugach, and Kenai mountains, and part of the Alaska Range as well as some others. Annual precipitation (as rainfall) as high as 100 inches has been reported at the Knik River near Palmer; annual snowfall as high as 400 inches has been reported in the drainage areas of the Susitna River, the Maclaren River and the Chakachatna River in the higher elevations of the river basins. (Freethey and Scully, 1980)

Wind speeds also vary considerably throughout the Cook Inlet Basin. In the cities of Anchorage and Homer, annual wind speeds average between seven and eight miles per hour (mph), with

maximums of 64 and 44 mph, respectively. In the upland and mountain regions, limited data on wind speed are available.

Much of the Cook Inlet Basin is free of permafrost, particularly those areas bordering Cook Inlet. In the uplands and the mountains, however, areas of isolated or discontinuous permafrost are present (Hartman and Johnson, 1978).

2.2 Drainage Basin Characteristics

The entire Cook Inlet Basin was glaciated in Pleistocene time, and glaciers exist in mountainous areas of the Cook Inlet Basin today. Estimates of the extent of current glaciation in the Cook Inlet Basin range from zero percent for over half of the watersheds to 54 percent of the area in the Knik River watershed, near Palmer (Hartman and Johnson, 1978). Glaciation is responsible for the current topography, including the U-shaped valley cross sections and many of the glacial and sedimentary deposits found at lower elevations.

The Matanuska River drains approximately 2070 square miles of the southern Talkeetna mountains in the east central portion of the Cook Inlet Basin. The proposed Permit Area is located along Moose Creek, a tributary to the Matanuska River. The mean elevation of the Matanuska River watershed is 4,000 feet above mean sea level (msl). Approximately 14 percent of the watershed is forested, predominantly at lower elevations, and 12 percent is presently glaciated.

The Matanuska River has a relatively steep average slope of approximately 80 feet per mile. Watersheds of streams tributary to the Matanuska River are also steep and relatively long and narrow. They form a predominantly parallel drainage system pattern, structurally controlled by the mountain landforms.

The dominant erosion mechanisms within the basin are mass wasting and mechanical erosion processes associated with freeze/thaw activity acting on bare rock on high, steep, unforested mountain slopes. In the forested areas at lower elevations, erosion of surficial soils by rainfall and snow melt runoff occurs. The amount of erosion is limited by the relatively thick vegetative cover that exists at the lower elevations.

2.3 Stream Flow

Typical stream flow in this region is generated from precipitation, snowmelt and glacial meltwaters. Flows vary seasonally, with peak flows occurring in spring and early summer due to snowmelt and breakup, and in late summer and early autumn due to rain storms. Periods of lowest flow occur in winter when precipitation falls as snow, and when little surface runoff occurs. Mid-summer low flows due to a lack of rain are sustained by effluent ground water flows and melt water from the perennial snow pack. The flows fall to levels typically seen in winter only during extended periods without rainfall (Freethey and Scully, 1980).

There are no permanent steam gaging stations on Moose Creek, and historical point measurement data are sparse. However, the adjacent basin of the Little Susitna River has a similar size, orientation, topography, and distribution of forested and glaciated areas. Its hydrologic response is expected to be similar to that of Moose Creek. The U.S. Geological Survey (USGS) has 40 years of stream flow data for the Little Susitna River near Palmer at a gaging station six miles west of the proposed Permit Area. The gage location is shown in Figure 2-1. Data from this station are presented in Table 2-1. The drainage area above this gaging station is 61.9 sq. mi. Average annual discharge for the river at this station is 211 cfs. Stream flow in the Little Susitna River typically ranges in the summer from 300 to 700 cfs and in the winter from 10 to 100 cfs. Highest flows usually occur in June from snowmelt or in the late summer/early fall from heavy rains (Carrick, et al., 1988).

2.4 Surface Water Quality

Natural surface waters in the Cook Inlet Basin have generally good quality, with few impurities or contaminants. Historical data published by the U.S. Geological Survey (USGS, 1971) indicates near neutral pH, moderate hardness and alkalinity, low concentrations of dissolved salts (calcium, magnesium, sodium and potassium), and few nutrients.

Water quality measurements have been made of the Little Susitna River near Palmer sporadically between 1948 and 1972. The parameters measured and their range of values are summarized in Table 2-2 from USGS data (presented in Carrick et al., 1988).

In general, the water quality on the Little Susitna River is good. The average pH is slightly basic, the dissolved oxygen is usually near saturation, and specific conductance varies inversely with discharge (snowmelt and rainfall having lower conductance than baseflow from groundwater).

Turbidity and suspended sediment concentrations in the Little Susitna River vary seasonally. In the winter, stream flow is usually clear. After breakup, the river is milky from snow/glacier melt or rainfall runoff. Suspended solids at this time are usually in the range of 10 to 200 mg/l. Suspended sediment concentration can increase significantly as a result of summer storm runoff (Carrick et al., 1988).

2.5 Surface Water Use

Some surface waters in the Cook Inlet Basin currently provide a salmon fisheries resource, are suitable for recreation, and provide a drinking and irrigation water source for single family homes and small farms.

2.6 Sediment Yield

The major rivers draining the Cook Inlet Basin carry significant sediment loads. Observation of the Matanuska River near the Moose Creek confluence, for example, indicate high quantities of sediment. The channel is braided, and water in the river is highly turbid. These conditions are consistent with an actively eroding environment. Active glaciers within the Matanuska River drainage basin, coupled with freeze/thaw and other mass wasting processes, both above and below tree line, provide large quantities of material which become available for river transport. In addition, steep river gradients provide for both erosion and deposition within the braided channel systems.

Tributary streams such as Moose Creek which drain relatively small areas do not generate sufficiently high discharges to carry the consistently high sediment loads observed in the Matanuska River. High sediment loads typically occur only during periods of high discharge. While the mass wasting processes are present in smaller basins, flows of significant magnitude to transport large sediment loads occur only during seasonal rainstorms and periods of high snow and glacier melt.

Longer duration rainstorms and storms of short duration and high intensity generate some runoff derived erosion both above and below tree line. However, rainfall/runoff erosion is limited in smaller watersheds such as Moose Creek by frozen conditions in winter and by heavy vegetative cover at lower elevations, which stabilize soils and reduce erosion.

Runoff and snow/ice melt flows also generate significant channel bed and bank erosion. Inundation of the flood plain and undercutting of stream banks in deeply incised channel reaches contribute significantly to the sediment loads transported at high flows.

3.0 SURFACE WATER INVESTIGATIONS AND MONITORING

3.1 Methods of Data Acquisition

3.1.1 Inventory of Watershed Parameters

An inventory of Moose Creek watershed parameters was developed by a review of the literature and by field survey. Sources included USGS topographic maps and publications, NOAA precipitation and climate data, and numerous field reconnaissance trips (USGS, 1951, NOAA, 1987, USGS, 1971). Field data collected included size and location of tributaries, measurements of selected channel slopes and channel cross sections, estimates of the expected range of stream flows, collection of stream morphology data, estimates of the type, density and areal extent of vegetation, sampling and grain size analysis of both surface and subsurface soil samples, preliminary water quality sampling, and an estimate of the magnitude of surface and groundwater interaction. In addition, the field surveys provided information used in selection of permanent stream gaging and water quality monitoring station locations.

3.1.2 Stream Flow Monitoring

Three continuous stream flow monitoring stations, numbered 1, 4, and 5 on Figure 3-1 and Plate V-1, were established on the mine site in August, 1988, and are still operational today. Two stations were located on Moose Creek, and a third was located on Buffalo Creek. Stations were located at points in the channel which displayed characteristics of being stable cross sections, with no observed indications of long term scour or deposition. These stations also served as water quality

monitoring stations. Stream flow monitoring was achieved by measuring water depth (stage) with a pressure transducer, and recording the measured values with an electronic data logging system. In addition, staff gages were installed at each station to confirm the proper functioning of the pressure transducers by allowing simultaneous manual stage and pressure transducer readings during periodic field monitoring of the stations. Stage values were converted to discharge values using a stage-discharge relationship calibrated for each monitoring station.

Stage-discharge relationships were developed for stations on Moose Creek by measuring the discharge with a current meter at periodic intervals over a range of flow depths. Two types of current meters were used: a Type-1 Gurley current meter for larger flows and a Pygmy current meter for lower flows.

Discharge measurements were obtained by wading the stream and recording velocity and depth measurements at two foot intervals across the channel, well within limits recommended by the USGS (USGS, 1982). Because stream depth was typically less than 2.5 feet, velocities were measured at a 0.6 foot depth in accordance with USGS recommendations (USGS, 1982). Discharge was computed as the summation of the incremental velocity measurements multiplied by the corresponding incremental area of flow. These calculations are included in Appendix H. During each field measurement of discharge, the flow depth over the pressure transducer was also measured to confirm the function and the calibration of the electronic data logging system. This resulted in three independent measurements of stage for each discharge measurement: the pressure transducer value, the fixed staff gage value, and a handheld measurement directly over the transducer. The procedure is described in the Quality Assurance Plan presented in Appendix A.

The flow of Buffalo Creek was normally too low to be accurately measured by a Pygmy current meter. To measure the flows, a calibrated metal Parshall flume with an eighteen inch throat width and a fifteen inch depth was installed in the creek bed on August 24, 1988. The flume was sized and placed so that all of the stream flow within the channel banks passed through the device and was carefully leveled to assure accurate flow measurement. A stilling basin and pressure transducer were located adjacent to the flume, together with a staff gage. The stage-discharge relationship for the leveled flume was provided by the manufacturer.

At each monitoring station, stream stage was measured by a calibrated pressure transducer located

on the streambed. At the Moose Creek stations, the transducer was held in place and protected from damage within a PVC pipe, which was placed on the streambed with the open end facing downstream. The transducer was prevented from moving by filling the annulus around the transducer with foam rubber and anchoring the PVC pipe by wiring it to a section of rebar driven into the streambed. The transducer itself was left free near the open end of the pipe. At the Buffalo Creek station, due to the small discharge of the stream, the pressure transducer was located at the bottom of a stilling basin which was constructed along the side of the flume. As indicated above, a permanent staff gage, mounted on steel fence rails, was installed at each gaging station.

A battery powered electronic data logger was connected by a data transmission wire to each pressure transducer. The Omnidata Datapod II electronic data logger and Instrumentation Northwest PS7001-2 pressure transducer were used. Calibrations were performed in the laboratory in accordance with manufacturers recommendations. Transducers and data pods were calibrated in pairs and were not interchanged at any time. The data logger was placed in a weather proof utility box, mounted to a four by four inch post located at the side of the stream at each station. The data logger sampled the pressure transducer once each minute. Once every fifteen minutes, the most recent pressure value was recorded and stored on an Extended Programmable Read Only Memory (EPROM) chip in the data logger. In addition, if two consecutive one minute readings differed by more than one tenth of a foot, the data logger recorded the more rapidly changing data in a separate location for later analysis.

The EPROM in each data logger converted pressure data to an equivalent head of water, resulting in continuous stage data at fifteen minute intervals. Approximately every two weeks, before the storage capacity of the data logger was exceeded, a field engineer visited each station and exchanged the Data Storage Module (DSM), containing the EPROM, with a fresh unit. Data logging was not interrupted by this process. A computer and a DSM reader were used to read the EPROM and transfer the stage data from the EPROM to computer disk for analysis.

3.1.3 Moose Creek Water Balance

To address the concern that Moose Creek may be a significant source of groundwater recharge to local stream alluvium, glacial sediments or bedrock, order of magnitude estimates of the amount of stream water loss to, or gain from, local channel deposits and/or the near surface groundwater

system were made on Moose Creek using a water balance approach. Several intermediate, temporary stream gaging stations were established on the selected reach of Moose Creek to provide data for the analysis. The length of the reach between the upstream and downstream stations used for this estimate was selected such that all of the Moose Creek stations, and all of the tributaries located between them could be gaged in a relatively short time period. This reduced the potential for changes in stream flow during the seepage estimate measurements.

Intermediate gaging stations were established at the Premier Creek confluence and at two additional tributary confluences, all of which lie between the Moose Creek stations (see Plate V-1). The permanent gaging station on Buffalo Creek was used to measure inflow from this stream. Measurement techniques were selected to provide a rapid, convenient means of estimated flow magnitudes. Due to the small flows on the other tributaries, some flow velocities were estimated by measuring the length of time required for a float placed in the stream to travel a known distance. Where possible, a pygmy meter was used to gage the flow. The stream cross sections were then established by field survey.

An approximate water balance was calculated by comparing the sum of inflows from the upstream Moose Creek station and all of the tributary inflows with the combined measured outflow at the downstream Moose Creek station. The result is an estimate of the net gain to or loss from Moose Creek over the entire selected reach. In addition, values obtained at intermediate stations were evaluated to estimate gains to or losses from specific reaches of Moose Creek between tributary junctions. Due to the measurement error involved in sampling the smaller inflows, the discharge values obtained for the tributaries were estimated to be accurate to within 20 percent (USGS, 1982). The USGS indicates that a 2 percent error is typical for discharge measurements (USGS, 1982). However, due to site conditions (i.e., icing and braiding) discharge values for the Moose and Buffalo Creek stations had estimated accuracies of 5 percent.

3.1.4 Soil Sampling

Soil samples from old stockpiles remaining on the site from previous mining operations, and drill cutting samples taken from both shallow and deep wells were collected. The point data was collected to enable a preliminary erosion analysis for materials likely to be exposed during mining operations, based upon properties of materials previously exposed (stockpile samples) and materials

targeted for excavation (drill cuttings). Grain size analyses using standard methods (ASTM D422-63) were conducted on the soil samples. A detailed discussion of sampling procedures and results follows in Section 3.2.3. Results provide point measurement data for use in determining soil erodability (Wischmeier, et al., 1971). The mean of the computed soil erodability factors and the variation in the individual values were used in conjunction with soil survey data for the site (Nyenhuis, 1988) in the design of the drainage and erosion control system for the mine.

3.1.5 Water Quality Sampling and Analysis

Seven water quality sampling stations were established to monitor surface water quality in and near the proposed Permit Area. Four stations were located on Moose Creek, two on Buffalo Creek and one on Premier Creek (see Figure 3-1 and Plate V-1). Three stations at which both water quality and sediment sampling were conducted coincide with the stream flow monitoring stations discussed above (Stations 1, 4 and 5). Two additional stations for water quality and sediment sampling were established, one on Premier Creek near its confluence with Moose Creek (Station 2) and one on Buffalo Creek near the outlet of Wishbone Lake (Station 3). Finally, two additional stations at which only field parameters and sediment samples were taken, were established on Moose Creek near potential locations for pond outfalls (Stations 6 and 7). The latter four stations were located in the field by flagged survey stakes. No permanent monitoring equipment was installed at these locations.

Water samples were taken from each of the seven sampling stations once each month. The samples were collected and sent within 24 hours to Inter-Mountain Laboratories, Inc. of Sheridan, Wyoming for analysis. A Quality Assurance Plan describing the sample acquisition, transportation and analysis procedures is presented in Appendix A.

Samples taken at the five water quality stations were analyzed for a comprehensive suite of parameters, as described in Appendix A. At the two additional sediment collection stations, samples were collected for laboratory analysis of total suspended solids, total dissolved solids, and settleable solids concentrations.

Field measurements were made at the time each water quality sample was taken. These measurements include pH, conductivity, dissolved oxygen, alkalinity, temperature, and turbidity.

Measurements were made with portable electronic field meters.

3.2 Results

3.2.1 Stream Hydrographs

Stream discharge hydrographs were developed for the Moose Creek and Buffalo Creek gaging stations by applying a station specific stage-discharge relationship to the stage data for each station. Stage-discharge relationships were determined for Moose Creek (gaging Stations 1 and 5) by plotting the log of measured stage values versus the log of measured discharge values for each station. A best fit curve was determined by applying a least squares linear regression of the data in log space. The curve fit resulted in an estimate of the two parameters a and b relating stage to discharge in the form: $Q = ah^b$

where for the upstream station (Station 1): a = 13.64 and b = 4.74
and for the downstream station (Station 5):

Prior to Winter 1988/1989- - - - a = 1.524 and b = 4.864

After Winter 1988/1989- - - - - a = 1.635 and b = 3.829

The initial stage-discharge relationships were defined on the basis of seven flow measurements at Station 1 and upon six flow measurements at Station 5. Following ice breakup in mid-April, 1989, the stage-discharge relationship at Station 5 was found to have changed significantly. Thus, a different relationship was developed.

Snow and glacial melt flows rose to over 500 cubic feet per second (cfs) by late June as expected. Because it was not physically possible to gage these flow magnitudes at Station 5, a substitute gaging station was established in late April at the Site Bridge, where an unimproved road crosses Moose Creek.

Discharges values measured between late April and early June at the Site Bridge compare very well with corresponding measurements made at Station 5, as shown in Table 3-5. While not all of the comparison measurements were made at similar times on the same day, flow magnitudes are nearly identical at the two stations. The incremental increase in contributing drainage area between the

two stations is negligibly small. As a result, the similarity of measurements obtained at the two stations is good.

A new stage-discharge relationship was developed for Station 5 on the basis of three flow measurements made between late April and early June. Measured flow values ranged between 40 and 160 cfs during this period. Because no flow measurements exceeding 160 cfs were available at Station 5 the high flow measurement at the Site Bridge was used to extend the stage-discharge relationship at that station. This was accomplished by associating the data pod stage value at Station 5 with the discharge value measured at the Site Bridge at the time the measurement was made.

As a result, the current stage-discharge relationship for Station 5 is based on four measurements of discharge ranging between 40 and 550 cfs.

Discharge measurements taken at the Site Bridge between late April and late June also allow the development of a stage-discharge relationship at this section, where:

$$a = 11.663 \text{ and } b = 3.804.$$

While no continuous stage recording equipment is located at this station, the relationship is useful due to the easy access to the station and the ease of obtaining continued discharge measurements, especially at high flows. These measurements may be used to supplement and verify data collected at other stations and to help recalibrate stage-discharge relationships, at this station and others, as more data become available.

The stage-discharge relationship for the Parshall flume on Buffalo Creek was provided by the manufacturer. Because the flume is calibrated and was leveled when installed, the translation of stage data to discharge data is exact, and is not dependant upon the development of a best fit relationship based on a limited number of field measurements. In this case the stage discharge relationship has the same form as those for Moose Creek, where:

$$a = 6.00 \text{ and } b = 1.54$$

The stage-discharge relationships are shown graphically in Figures 3-2 through 3-5, for Stations 1, 5, and 4, and the Site Bridge, respectively. The discharge measurement data for each station are included in Appendix H.

The fifteen minute stage values for each gaging station were converted to discharge values using the relationships defined above and plotted as discharge hydrographs, as shown in Figures 3-6 through 3-8.

The original placement of the downstream gaging station on Moose Creek (Station 5) under modest flow conditions at the end of summer resulted in problems (i.e., excessive fluctuation at low flow) with the pressure transducer at lower flows experienced in middle autumn. As a result, the gaging station was moved a distance of approximately ten feet upstream on September 30, 1988. Stage data used in generating the stage discharge relationship that were collected prior to this time were adjusted by adding 0.65 feet to be consistent with the data collected after the station was moved. No other corrections to the data were required due to the short distance of the move. All other channel parameters within the vicinity of the station remained constant, both before and after the move, and apply equally well to both locations.

A storm event on September 22, 1988, resulted in the overtopping of the flume on Buffalo Creek (Station 4). This probably resulted in a small error in the estimation of the actual discharge when applying the stage discharge relationship due to the increased roughness and width encountered by the flow on the floodplain. The flow depth was outside the range for which the flume is calibrated. The measured depth would indicate a greater discharge in a smooth metal flume than over a rough floodplain. The width of the natural channel bank increases significantly with increased depth (see Figure 4-8). However, a thin flow moving across a vegetated floodplain moves slowly, providing only a minor error in discharge estimation (see Figure 4-8).

The Manning equation was applied to obtain another estimate of the actual peak discharge resulting from this storm. Channel slope was taken from site topographic maps at a scale of one inch to 500 feet, with a five foot contour interval (Plate 3-1). Two intervals over a distance of 200 feet were used to determine the average local slope for this order of magnitude check. Channel section parameters were estimated from photographs taken soon after the storm. Roughness coefficients were estimated for the flume and for the channel bank. The resulting calculated discharge was within 2 cfs of that provided by the stage discharge relationship. Therefore, the estimate of the peak storm discharge shown on Figure 3-7 is considered reasonable.

Icing conditions, which are a normal occurrence on Moose and Buffalo Creeks, disrupted the continuous gaging data at all three stations during the winter months. Station 1 on Moose Creek was least effected by the formation of boundary ice along the stream banks and by slush ice formation on the channel bottom. However, in January and February, 1989, the stream at Station 1 froze over and staff gage readings could not be taken.

The data pod at Station 1 was removed during January due to the possibility of damage occurring from a potential ice buildup similar to that occurring at Station 5. At that time, it was discovered that the instrument had ceased functioning on January 1, 1989, and that the data pod itself was damaged by the extreme cold. The data pod was serviced by the manufacturer.

Repair included upgrading of the power supply and face panel to withstand greater environmental extremes. The data pod was reinstalled when conditions permitted on April 21, 1989, at which time continuous monitoring resumed. A survey of the cross section and gaging of the stream using a Price Type A current meter were also completed at this time. This data provides an additional point on the stage versus discharge curve for this station and indicates little change to the section during the winter.

Freezing conditions began affecting the pressure transducer at Station 4 on Buffalo Creek on November 4, 1988. The quiescent water in the stilling basin in which the transducer was placed began freezing at that time. As a result, erroneous data were recorded until November 19, 1988. At this time the stilling well was frozen solid, and significant ice had formed in the flume. Monthly observations of water depth and approximate cross section shape were maintained throughout the winter months. However, because ice buildup disrupted the control section of the flume, reliable estimates of discharge are not available during the period November, 1988 to January, 1989. By January, the channel was completely frozen and there was no measurable flow in Buffalo Creek at this station.

Measurable amounts of water began flowing in Buffalo Creek in March. The flume and stilling well were still ice bound, however. The transducer was removed during the March site visit for servicing and repair of suspected ice damage. The data pod was serviced at the same time, receiving the same upgrades as the data pod at Station 1. Enough ice remained in the flume and stilling well to prevent reinstallation of the transducer and data pod until April 28, 1989.

Continuous monitoring resumed at this time. A cross section survey and stream gaging with a Pygmy type current meter were completed to confirm section geometry. The survey indicated that the flume heaved relative to the stilling well approximately 0.05 ft. Because the potential damage to the flume exceeded the marginal benefit of being perfectly level, the flume was not releveled. Errors in the accuracy of flow measurements due to this small amount of heaving are not significant. Local gaging was completed to estimate potential flow losses under or around the flume due to ice heaving. No significant losses were detected.

Formation of boundary ice along the margins of the stream, slush ice along the streambed upstream of Station 5, and formation of an ice dam downstream of the station began affecting the data at this station on November 2, 1988. Ice redirected the flow and changed the shape of the cross section significantly, invalidating the stage versus discharge relationship upon which discharge at this station had been calculated previously. In addition, the ice dam downstream created a backwater condition at Station 5, which was also not accounted for in the initial stage versus discharge calibration. Severe ice conditions and the presence of the ice dam dominated the cross section until mid-April, 1989. As a result, the discharge hydrograph for the period of November 2 through April 27 was estimated from station 1 data and two stream gauging measurements in March and April, 1989.

The data pod at Station 5 was removed during January, 1989, because several feet of ice buildup was threatening the instrument. Upgrades of the power supply and main panel were made in addition to routine servicing at this time. The data pod was reinstalled on April 21, 1989. Continuous monitoring began at this time.

3.2.2 Moose Creek Water Balance

Two sets of discharge measurements were completed for a reach of Moose Creek which borders the proposed Permit Area. The measurements were used in a water balance analysis to estimate local losses from or gains to sub-reaches of the channel along the proposed permit boundary. The first set was completed in November, 1988, and included measurements at Stations A and B, braid B, tributaries C and D, and Stations on Buffalo and Premier Creeks (see Plate V-1). The second measurements were completed in April, 1989, at Stations I, II, III, IV, at tributaries C and D, and at permanent Stations 2 and 4 (also shown on Plate V-1).

Both sets of discharge measurements were made during periods of relatively low flow, and represent base flow conditions on Moose Creek. Icing conditions were just beginning to affect flows measured in November, 1988, and snow had begun to accumulated on the ground. The majority of ice and snow along Moose Creek had recently melted in the two weeks preceding the April, 1989, measurements leaving bare ground from the stream channel to the ridge top, excepting nivation hollows and some ice along the stream margins. No precipitation fell on either occasion, and the diurnal flux in stage at Station IV was observed to be less that 0.2 feet during the April measurements.

The November, 1988, measurements were used to estimate the net gain to, or loss from, a 1.7 mile reach of Moose Creek. The sum of inflow from Moose Creek Station B, Buffalo Creek, Premier Creek and tributaries C and D was estimated to be 66 cfs. The sum of outflow leaving Moose Creek Station A and Braid B was estimated to be 59 cfs. The difference was a net loss of 7 cfs over a distance of approximately 1.7 miles. During these stream flow measurements, an error percent of 7 percent or 4 to 5 cfs, was estimated for conditions existing in early November.

The April, 1989, measurements were taken to estimate gain to, or loss from, an overall 1.95 mile reach of Moose Creek and to estimate net gain, or loss from, three sub-reaches measuring approximately 2770, 1580, and 5940 feet, respectively. Measurements of inflow at Station IV, Buffalo Creek, Premier Creek and tributaries C and D totaled approximately 45 cfs. An additional 4.5 cfs of non-point inflow between Stations I and II increased the total inflow to 49.5 cfs. Outflow at Station III was approximately 47 cfs, indicating a net loss of 2.5 cfs over the 1.95 mile reach of Moose Creek. Estimated error in stream flow measurements is on the order of 4 cfs.

Measurements taken at intermediate Stations I and II indicated both local gains and losses within the overall reach. From Station IV to Station I, flow increased from 36 to 37 cfs. Since the inflow from Buffalo Creek along this reach was approximately 1 cfs, this sub-reach had no measurable net gain or loss. From Station I to Station II, flow increased from 37 to 42 cfs. Inflows from tributaries C and D were estimated to total 0.3 cfs, resulting in a net gain through this sub-reach of over 4.5 cfs from non-point inflows. From Station II to Station III, flow increased from 42 to 47 cfs. However, the inflow from Premier Creek along this sub-reach was approximately 8 cfs, which indicated a net loss of approximately 3 cfs through the sub-reach.

Observations of inflow to Moose Creek from springs, seeps and non-point sources was very difficult in November due to snow cover and icing conditions on the stream. In April, snow had melted from most of the area over the previous several weeks. The ground was still frozen below a depth of two to five inches, and the top soil layer varied in moisture content from quite damp to almost dry to the touch.

During the April sampling, several springs or seeps were noted flowing into tributaries feeding Moose Creek from the bank opposite the mine site. In the case of tributaries C and D, there were multiple sources of this flow. Inflow was observed flowing downhill from the higher elevations of the drainage basin to the northwest. In addition, water was observed flowing into the tributaries from alluvial gravels lying between the tributary and Moose Creek, on the outboard, down gradient side of a broad bend in Moose Creek. The source of this inflow was most likely Moose Creek itself. No point sources of inflow to Moose Creek were observed on the mine site side of Moose Creek, and no significant tributaries entered Moose Creek from this direction with the exception of Buffalo Creek.

Field observation and gaging measurements indicate that Moose Creek both gains water from and loses water to the alluvial sands and gravels lining its bed as it flows through the reach bordering the proposed permit boundary. Both sets of flow measurements were made under base flow dominated conditions. Neither measurement indicated that Moose Creek gains or loses significant quantities of water along its reach adjacent to the proposed mine area. Buffalo Creek inflows were a small portion (between three and four percent) of the flow in the upper reach during both sets of measurements.

The upper portions of the reach apparently gained water from tributary, spring, and non-point inflows, as indicated by April, 1989 flow measurements. April measurements showed a five percent net loss in the lower portion of the reach, between Stations II and III, and a similar overall loss for the entire reach. November, 1988 measurements showed slightly higher flows, with corresponding higher loss of approximately 10 percent through the entire reach. With respect to the estimated error in the measurements, the magnitude of the loss is small. Based on observations made in the field, Moose Creek locally gains or loses flow to the adjacent stream alluvium. Thus, it is possible that the apparent losses observed in the water balance measurements are to stream

alluvium and may therefore re-enter Moose Creek further downstream.

These observations and conclusions are consistent with groundwater data (see Part C, Chapter IV) which showed the groundwater table to be above the elevation of Moose Creek in the upper sub-reach and below the streambed in the lower sub-reach.

3.2.3 Grain Size Analysis

Sieve and hydrometer grain size analyses (ASTM D422-63) were completed on five samples from old stockpiles (S-1 through S-5), two composite samples from shallow well cuttings (two discrete samples each from H88-21 and 22), and four discrete cuttings samples from each of two deep wells (H88-10 and 12). The locations for each sample are shown on Plate V-1. The grain size distributions vary widely, from mostly gravel to mostly silts, and are included in Appendix B.

The surficial samples were taken from five separate locations on weathered stockpile material left from previous mining efforts on the site. Grab samples were taken by hand after the weathered surface material (2 to 10 cm depth) had been scraped away. A minimum of five subsamples were composited to form each of the five samples taken.

Four of the old stockpile samples were predominantly well sorted sands, with small amounts of silt and less gravel. The fifth sample was similar, but had a more uniformly graded sand distribution.

The samples of both shallow (i.e., glacial sediments) and deep (i.e., sedimentary bedrock) well cuttings were taken after drilling operations had been completed. A description of the drilling operations is provided in Part C, Chapter IV. Efforts were made to penetrate the cuttings piles, and remove interior samples.

The two shallow well composite samples of glacial sediments were quite different from one another: one was 65 percent gravel, 23 percent sand, and 12 percent silt and clay; the other had very little gravel, 50 percent sand and 45 percent silt and clay. The two wells were on opposite sides of the mine site.

A marked difference also existed between the deep well cuttings size distributions. However, the

four discrete samples for each well had size distributions which closely paralleled one another throughout the entire particle size range. The results may be considered as composite samples, one from each well. The wells are also on opposite sides of the mine site. One sample was almost uniformly graded between fine gravel and fine silt. The other was 85 percent uniformly graded silt and clay with the remaining 15 percent uniformly graded from fine sand to fine gravel.

3.2.4 Water Quality

Laboratory analyses of surface water samples were conducted by Inter-Mountain Laboratories, Inc. The original laboratory reports of analytical data are presented in Appendix C along with laboratory QA/QC procedures and detection limits.

Field parameters for the monthly surface water sampling are presented in Table 3-1. Results of the laboratory analyses of monthly surface water samples are presented in Table 3-2.

Field measurements and laboratory analyses of surface water samples collected from July, 1988 through June, 1989, indicate that Moose, Buffalo, and Premier Creeks all have good water quality (i.e., acceptable for all or most uses such as drinking, agriculture, or fisheries). The waters have near neutral pH, low hardness (15 to 59 mg/l), moderate alkalinity (11-113 mg/l), and almost no acidity.

Field conductivity measurements ranged from 40 to 189 µmhos/cm, indicating low salinity content. (The 241 µmhos/cm value, measured at Station #4, Buffalo Creek, was anomalous with respect to other measurements of specific conductance made at this station.) Measurements in Buffalo Creek generally ranged from 40 to 70 µmhos/cm, and were slightly lower than measurements for the other stations.

Dissolved oxygen concentrations in surface waters were typically above 10 mg/l, and ranged from 6.3 to 14.8 mg/l. These values were at or near the maximum solubility limit for oxygen in water.

Nutrient content was low. Total organic phosphorous concentrations were less than 0.083 mg/l, and total Kjeldahl nitrogen concentrations were less than 1.6 mg/l. Nitrate concentrations were also low, less than 0.94 mg/l, and nitrite not detected above the detection limit of 0.01 mg/l.

Calcium, magnesium, sodium and potassium were present at concentrations typical of natural waters. Chloride and sulfate were present at concentrations up to 9 and 18 mg/l, respectively. Calcium and bicarbonate were the predominant dissolved chemical constituents in the surface waters, while sodium, potassium and magnesium were of secondary importance. Surface waters from the Buffalo Creek sampling stations contained relatively higher amounts of sodium, potassium, and magnesium than waters from the other sampling stations.

The concentrations of trace metals in surface water samples were generally quite low. Dissolved arsenic, barium, chromium, mercury, and selenium were not detected in any of the monthly surface water samples at concentrations above the detection limits. Dissolved cadmium at a concentration equal to the detection limit of 0.002 mg/l was detected once in Buffalo Creek. Dissolved aluminum, copper, lead, iron, manganese, and zinc were detected in several samples as indicated in Table 3-2, but concentrations were always at or near the detection limits for these constituents.

Results of analysis for total chromium, iron, and manganese are also shown in Table 3-2. Total chromium was not detected in any of the surface water samples. Total manganese was detected in five samples at or near the detection limit. Total iron was detected in surface waters at concentrations up to a maximum of 2.43 mg/l. Total iron concentration in Moose Creek was relatively low (<0.05 to 0.30 mg/l). Iron concentrations in Premier Creek were higher (0.06 to 1.42 mg/l) and Buffalo Creek contained concentrations ranging from 0.09 to 2.43 mg/l.

Surface waters from the study site can be classified based on the predominant dissolved ionic species using the graphical representations of Stiff (1951) and Piper (1944). Based on the analytical results, the compositions of the monthly surface water samples for each of the five stations were plotted on a trilinear diagram (Figures 3-9 through 3-13). The trilinear diagrams indicate that all surface waters at the site were predominantly calcium-bicarbonate in composition. Minor variations in water composition can also be identified. Buffalo Creek had a more dominant bicarbonate composition than the other streams. Surface waters at Moose Creek Stations 4 and 5 had relatively less bicarbonate and relatively more sulfate than waters from the other streams. Station 3 in Buffalo Creek showed a wider variability in the calcium-magnesium composition than the other sampling stations.

Stiff diagrams were plotted for the surface water sampling stations located on Moose, Buffalo and Premier Creeks (Figure 3-14). Stiff diagrams were constructed using average values for each individual anion and cation at each station. These diagrams illustrate the difference in water composition at each of the sampling locations in addition to the predominant calcium-bicarbonate character of the surface waters in general.

Figures 3-15 and 3-16 present trend analyses which compare the concentrations of selected parameters with time. Field pH values shown in Figure 3-15 are neutral to very slightly acidic for all surface waters and show very minor changes with time. Total dissolved solids (TDS) are seen in Figure 3-16 to increase in Moose Creek with time during the record of measurement from July, 1988 to May, 1989, then decrease rapidly in late summer. Values for TDS in Buffalo Creek are generally lower than values measured at the other sampling sites.

3.2.5 Sediment Load

Sediment concentrations were analyzed during the monitoring period from July, 1988 to June, 1989. Sediment concentrations prior to April, 1989, were relatively low. However, turbidity and total suspended solids (TSS) in April and May indicated an increase in the sediment concentrations, most likely due to the larger icemelt and snowmelt flows during those months. Data presented in Tables 3-1 and 3-2. TSS were measured up to 48 mg/l, but were generally from 1 to 10 mg/l. Settleable solids were at or near the detection limit of 0.1 mg/l. Turbidity measurements ranged from 0.24 to 20.0 NTU, and were highest during the September, 1988 and April, 1989 sampling events.

Low sediment loads are probably typical of the flows sampled over the November, 1988 to March, 1989 period. Low flows were predominate from November through March, resulting in a minimum of streambed and bank erosion. Snow cover and freezing conditions which began in October kept sediment delivery to streams at a minimum. Turbidity and TSS measurements made during the spring runoff indicated a large increase in sediment load. Turbidity values typically increased an order of magnitude, 0.50 NTU to 8 NTU or greater, between the March and April, 1989 sampling rounds for Premier and Moose Creeks, and distinct peaks were evident during August and September, 1988. Spring runoff and storm events in late summer and early autumn are expected to carry higher sediment loads resulting primarily from bank erosion and possibly

overland flow.

Time trend analyses for turbidity (Figure 3-17) indicate that maximum values were observed during April, 1989 at all the stations except Station 3 on Buffalo Creek and Station 5 on Moose Creek. The maximum value measured at Station 3 was during August, 1988, while the maximum value measured at Station 5 was during September, 1988. Prior to the spring runoff, maximum turbidity values were observed in September, 1988 with the exception of Station 4, which was not sampled at that time due to equipment malfunctions, and Station 3 as mentioned above.

The concentration of TSS versus time is graphed in Figure 3-18. TSS values for Premier Creek were generally higher than values measured at sampling stations along the other streams.

Table 3-3 contains a list of turbidity, TSS and settleable solids values from Stations 1, 4, and 5, and corresponding discharge measurements from the gaging stations. These data were used to correlate turbidity and TSS with discharge for Stations 1 and 5 on Moose Creek and Station 4 on Buffalo Creek. The turbidity verses discharge plots are shown in Figures 3-19 through 3-21, while TSS verse discharge plots are shown in Figures 3-22 through 3-24.

4.0 SURFACE WATER ANALYSIS

4.1 Watershed Description

Moose Creek drains an area of approximately 49.6 square miles, and flows into the Matanuska River six miles upstream from the city of Palmer (see Figure 4-1). The watershed is approximately 15 miles long and 4 miles wide, with its long axis oriented north-south. The terrain has high relief, with elevations between 325 and 6800 feet (MSL), and several small glaciers cap the ridges on the east side of the watershed. Based on the USGS 1:63360 scale quadrangle map D-6 (Anchorage Quad) the watershed is estimated to have approximately two percent of its area covered by glaciers. The majority of the watershed is characterized by steep unforested rocky slopes of the Talkeetna Mountains. The lower elevations at the south end of the watershed are characterized by kettle lakes and surface depressions left by retreating glaciers. Moose Creek is deeply incised as it crosses these lowlands, forming Tsadaka Canyon, before flowing into the Matanuska River at approximately 325 feet elevation, (MSL). The streambed is comprised mainly of large boulders, cobbles and gravels,

and some sections of the channel are braided.

The Moose Creek watershed is located on a boundary between transitional and continental climate zones as defined by Searby (Hartman and Johnson, 1978). The area has a mean minimum January temperature of 4° Fahrenheit, and a mean maximum summer temperature of 68° Fahrenheit, which occurs in July (NOAA, 1987).

Average annual precipitation and snowfall for the Matanuska River Station at Palmer, six miles downstream from the Moose Creek confluence, are 35 inches and 80 inches, respectively (USGS, 1980). The Little Susitna River watershed borders the Moose Creek watershed to the west, and drains 62 square miles. Average annual precipitation and snowfall for this watershed are both 50 inches. More detailed meteorological data are presented in Part C, Chapter VII.

The Little Susitna River watershed is hydrologically similar to the Moose Creek watershed. The USGS (1980) reports that the Little Susitna River has a channel length of 15 miles, an average slope of 187 feet per mile, a mean elevation of 3,700 feet (MSL), with 16 percent of its area covered by forest and 5 percent covered by glaciers. Table 4-1 contains a summary of drainage basin characteristics for Moose Creek, the Little Susitna River and the Matanuska River basins.

The proposed Permit Area occupies approximately 2.5 square miles in the lower portion of the Moose Creek watershed, approximately three miles upstream from the Matanuska River. The northwest portion of the proposed Permit Area boundary parallels Moose Creek. A channel profile of Moose Creek, from the Glenn Highway below the proposed Permit Area to Station 1 above the proposed Permit Area, is included in Figure 4-2. Typical channel cross sections surveyed at Stations 1 and 5 on Moose Creek are shown in Figure 4-3.

Two tributaries are located in or near the proposed Permit Area: Buffalo Creek, which originates in Wishbone Lake and crosses the proposed Permit Area to flow into Moose Creek; and, Premier Creek which flows into Moose Creek from the north and is not within the proposed Permit Area boundary. A channel profile of Buffalo Creek from Moose Creek to Wishbone Lake is shown in Figure 4-4. Cross sections surveyed at locations 1 and 2 (See Plate V-1) and Sampling Stations 3 and 4 are shown in Figures 4-5 through 4-8, respectively.

Numerous smaller unnamed tributaries flow into Moose Creek along the proposed Permit Area boundary. These unnamed tributaries enter Moose Creek from the north and do not drain the proposed Permit Area.

The surface drainage pattern within the proposed Permit Area is delineated in Plate V-1. Topographically, the proposed Permit Area is marked by many closed depressions as a result of the glacial features (e.g.,eskers) which occur in the area. Surface runoff within these closed drainage basins flows into depressions and then infiltrates into the soil and recharges groundwater.

Buffalo Creek is the only significant tributary of Moose Creek that crosses the proposed Permit Area. The drainage area of Buffalo Creek (as measured from site maps at a scale of 1 inch to 500 feet, supplemented by USGS maps (USGS, 1951)) is 0.89 sq. mi. Buffalo Creek originates at the outlet to Wishbone Lake. The channel composition varies from Wishbone Lake to Moose Creek, but is typically composed of gravels, sands, and some silt. The creek flows through steep rock lined ravines to the broad and thickly vegetated floodplain of Moose Creek.

4.2 Streamflow

4.2.1 Normal Flows

Stream flow in the watershed generally followed the seasonal fluctuations described in Section 2.3. During the baseline monitoring period discharges occurred in the late spring, due to snow melt runoff coupled with mild rainfall, and also in the late summer and early autumn, due to seasonal rainstorms. In the latter case, peak discharge resulted from storms lasting several days, under wet antecedent conditions. Late summer low flows, which were fed by continued snow melt, did not reach the low flow levels of winter, when snow melt was not a factor.

Three stream gaging stations have been in operation on Moose and Buffalo Creeks since August 31, 1988, with exceptions noted due to winter conditions (see Section 3.2.1). Flows were observed to be steadily decreasing in Moose Creek from this time until late April, 1989, with the exception of several storm events in September, 1988. The largest observed autumn discharge was the result of a three to four day precipitation event. Rain fall was not particularly intense, but was steady for much of the storm duration.

Winter low flows dominated Moose Creek from November, 1988 through April, 1989, and were most probably sustained by seasonal recession of groundwater into the stream. The lowest flows were observed in February and March, 1989, when extremely cold temperatures and precipitation occurred in the form of snow.

Following breakup in late April, 1989, flows in Moose Creek steadily increased with melt waters until late June, 1989, at which point flows began to decrease towards the late summer low flows.

4.2.2 Estimated Peak Flows

4.2.2.1 Moose Creek

Historical stream flow data for Moose Creek do not exist. The gaging data collected during baseline monitoring, from August, 1988 to July, 1989, are insufficient to estimate peak discharge for floods of various recurrence intervals. A regional analysis was attempted following the procedures in Dunne and Leopold (1978). However, there are an insufficient number of basins for which gaging data exist similar enough to the Moose Creek basin, therefore, a valid regional flood frequency curve could not be developed. This was determined by the failure of a homogeneity test which was applied to five of the basins in the Cook Inlet region.

As a result of the lack of applicable gaging data, the best available estimate of peak flows was attained by making use of stream gage data for the Little Susitna River. This watershed is adjacent to the Moose Creek watershed and has a similar area, orientation, slope, climate, vegetation and geology. Little Susitna River and Moose Creek watershed data are compared in Table 4-1.

Twenty-eight years of discharge data are available for the Little Susitna River through water year 1976. Based on these data, estimates of peak discharge for floods with 2-, 5-, 10-, and 50-year recurrence intervals (return periods) were made for the Little Susitna River near Palmer, Alaska (Freethey and Scully, 1980). The flood frequency values were plotted and a line of best fit was drawn to extrapolate the 100-year recurrence interval (r.i.) flood discharge. From the curve of best fit, the station's Mean Annual Flood (MAF) was taken as the discharge with a 2.33-year r.i. This MAF was used to normalize the peak discharge values by dividing the flood discharge for each r.i. by the MAF. The ratio of peak discharge to MAF was then plotted against recurrence interval.

Because of the similarity between the Moose Creek and Little Susitna River watersheds, it is appropriate to use the ratio of the Little Susitna River's MAF to its drainage area to estimate the MAF for Moose Creek. The MAF for the Little Susitna River is 2,090 cfs, and the drainage area is 61.9 square miles. The drainage area of the Moose Creek watershed is 49.6 square miles, resulting in a MAF of 1,675 cfs. By applying this MAF for Moose Creek to the ratio of peak discharges (Qpk) to MAF at different recurrence intervals described above for the Little Susitna River, it is possible to estimate the peak discharge for Moose Creek at each of these recurrence intervals. The following flood frequency values for Moose Creek were estimated:

Recurrence Interval (Year)

	2	5	10	25	50	100
Ratio of Qpk to MAF	0.943	1.450	1.862	2.484	3.025	3.631
Estimated Peak Flows (cfs)	1580	2430	3120	4160	5065	6080

4.2.2.2 Buffalo Creek

Buffalo Creek is an ungaged sub-basin within the Moose Creek watershed, comprising approximately 580 acres, extending from, and including Wishbone Lake to its confluence with Moose Creek. The creek crosses the mine permit boundary in the vicinity of planned pit excavations. Because the sub-basin is so small (less than one square mile), a regional analysis for determining peak flows on Buffalo Creek is inappropriate. In addition, there are no similarly sized catchments in the area for which stream gage data exist. Therefore, to estimate peak flows, the HEC-1 Flood Hydrograph Package, a numerical computer model, was applied to the Buffalo Creek sub-basin.

Developed by the U.S. Army Corps of Engineers, HEC-1 is commonly used to evaluate storm runoff, develop discharge hydrographs, route flows downstream, and route flows through reservoirs and dams. The program is well accepted in the engineering community and is used in all aspects of surface water flow and flood design engineering.

As applied to Buffalo Creek, the model used the Soil Conservation Service (SCS) Curve Number

(CN) method to compute run-off volumes for discrete time steps throughout the design storm. A rainfall time distribution was specified for the site as Type I (SCS 1972), which applies to Alaska. This distribution specifies the fraction of the storm volume which falls in each time increment.

The Buffalo Creek sub-basin was broken down into three components: Wishbone Lake and its contributing drainage area, a similar area just north of the lake which is a "dry arm" or marshy area with its contributing drainage area, and the channel of Buffalo Creek which accepts flow from both of the previous areas. While the area draining into the Buffalo Creek channel can be further subdivided based on topography and vegetation, average flow lengths were used to characterize the region as a single area.

The incremental runoff volumes for each area were routed to Wishbone Lake by the SCS Dimensionless Unit Hydrograph and to the dry arm and to Buffalo Creek by the kinematic wave method. Typical lengths and slopes were computed using topographic maps at a scale of 1 inch to 500 feet. Travel time for the Wishbone Lake area was computed using the SCS Upland Method. Flow was routed through Wishbone Lake using storage routing based on topographic map data. Outflow from Wishbone Lake was assumed to behave as flow across a broad crested weir ten feet wide with a discharge coefficient of 3.087. Flows from Wishbone Lake and the dry arm were summed to develop a discharge hydrograph. This hydrograph and the additional runoff from the Buffalo Creek channel area were routed down the Buffalo Creek channel to its confluence with Moose Creek. The routed hydrograph was the final output from the model.

The primary input data to the model were drainage area, rainfall distribution, SCS Curve Number, the time of concentration and surface roughness for overland flow, and storm volume.

Three storm events were modeled for Buffalo Creek: the 2-year, 24-hour storm (2 inches precipitation); the 25-year, 24-hour storm (3 inches); and the 100-year, 24-hour storm (4 inches). The results indicated significant attenuation of flow through Wishbone Lake. Runoff volumes and peak discharge values at the confluence with Moose Creek were consistent with the drainage area when compared with Moose Creek peak flows for the same recurrence interval storms. The results are summarized in the following table:

Recurrence Interval	2	25	100
Peak Discharge (cfs)	47	147	245

Detailed model input and complete model output for each storm analysis are included in Appendix F.

4.2.3 Flood Plain Determination

The 100-year floodplain for Moose Creek within the proposed Permit Area was evaluated using the U.S. Army Corps of Engineers HEC-2 computer model (U.S. Army Corps of Engineers, 1982). The estimated 100-year discharge of 6080 cfs was used as steady inflow through the stream. No lateral or tributary inflows were considered in the analysis. This simplification is consistent with the use of the peak discharge as inflow to the reach.

Eighteen cross sections, spaced 1,000 feet apart, were used to describe the stream channel and adjacent floodplain. The cross sections were developed from a site topographic map with a scale of 1 inch equals 500 feet and a contour interval of five feet. The topographic information was supplemented by interpolating elevations between contours to reflect local topographic highs and lows. Because the slope of the channel is in excess of 200 feet per mile, super-critical flow was assumed. The Manning's coefficient for channel roughness was selected as 0.05 to represent a mountain stream with no vegetation in the channel and a channel bottom of cobbles with large boulders. The floodplain roughness coefficient was selected as 0.10 to represent medium to dense brush in summer or a heavy stand of trees, a few down trees, with little undergrowth (Chow, 1959).

Model results include the water surface elevations, water depth, starting and ending stations of the flooding, and top width of the inundated portion of the floodplain. These values were used to delineate the 100-year floodplain at the selected cross sections. Between cross sections, the flooding was delineated using interpolated water surface elevations.

The HEC-2 program can model flooding associated with discharge in a stream which has a prescribed ice cover. It cannot model flooding associated with the formation of ice cover and ice dams, nor can it model flooding associated with breakup. Therefore, the floodplain delineated on Plate V-1 represents the extent of flooding associated with storm water runoff only, as could be

expected to occur in late summer. It does not represent potential flooding associated with ice damming on Moose Creek.

4.3 Surface and Groundwater Interaction

4.3.1 Streams

Field observations, surveys and measurements indicate potential interaction between surface streams and the groundwater contained in shallow alluvial deposits in and around the stream channels. In general, the reach of Moose Creek which flows along the permit boundary is in a braided, gravel bedded channel. The gravel channel deposits are relatively shallow and rest on or near bedrock. This is consistent with the morphology of the channel which appears to be that of an oversized stream in a glaciated valley.

The water balance analyses presented in Section 3.2.2 indicate that the lower portion of the reach of Moose Creek bordering the permit boundary loses water to the streambed deposits. Upstream of this reach, Moose Creek is gaining water from local tributaries and from non-point source inflows. Measurements and observations along tributaries C and D (see Plate V-1) indicate that flow leaves the Moose Creek channel, flowing through the alluvial gravels into the tributaries and then back into Moose Creek. These observations are consistent with the observed channel morphology, and the conclusion that water is flowing out of the stream into permeable gravels and then back into the stream further down gradient.

It is possible that a small fraction of the water entering the alluvial materials may recharge the groundwater system in glacial sediments and bedrock, where hydraulic gradients permit. Based on the stream flow measurements taken to date and hydrogeological data (see Part C, Chapter IV), it is unlikely that large quantities of water are leaving Moose Creek into the groundwater system in the vicinity of the mine permit boundary. Hydrogeological data presented in Chapter IV indicate that the water levels in the old underground Premier Mine workings are below the Moose Creek channel. However, the small losses seen in this reach of Moose Creek do not support the concept of a strong hydraulic connection between the stream and the bedrock groundwater system in this location. Additional information on potential surface water and groundwater interactions is presented in Part C, Chapter IV.

4.3.2 Overland Flow

In and beyond the southern portion of the watershed, the terrain is very irregular and dominated by surface depressions. The topography is such that there are no streams draining this region. The depressions form enclosed basins, and all water loss is either due to evapotranspiration or to infiltration to groundwater.

4.4 Water Quality

4.4.1 General Surface Water Chemistry

Water quality data indicate that the surface waters of the Moose Creek watershed are of high quality when compared to most water quality standards. Ranges and means of chemical characteristics of surface waters monitored in and near the Permit Area are provided in Table 4-2.

There is no evidence of physical or biological pollution in the surface waters. Acidity and pH values show no remaining adverse effects from previous mining activities. Concentrations of all dissolved priority pollutant metals are below detection limits. Sediment concentrations are generally low.

4.4.2 Suitability Classification

Water quality criteria for the State of Alaska are promulgated in the Alaska Water Quality Standards, 18AAC.70. The water quality criteria are combined with the water use designation (e.g. drinking, agricultural, aquacultural) to determine the water quality standard for a particular water body. Alaska Water Quality Standards incorporate by reference Federal Primary and Secondary Drinking Water Standards. Table 4-3 lists Federal Drinking Water Standards along with maximum concentration of constituents measured during the baseline monitoring program from July, 1988 to June, 1989.

As indicated in Table 4-3, the streams generally met Federal Primary Drinking Water Standards for those parameters tested. Only turbidity concentrations are above the Federal Secondary Drinking Water Standards. The Secondary Standard of 5 turbidity units was exceeded once at station #1 on

Moose Creek, once at Station #7 on Moose Creek, twice at Station #3 on Buffalo Creek, and three times at Station #2 on Premier Creek (see Figure 3-12 for plots of turbidity versus time). No significant water quality problems have been identified in surface waters of the Moose Creek watershed.

Water quality standards of agricultural and irrigation uses were promulgated in Section (1) (A) (iii) of 18AAC.70. Surface waters in the proposed Permit Area meet these standards with one exception. Concentrations of boron equaled or exceeded the standard of 0.3 mg/l eleven times during the period from July, 1988 to June, 1989, at least once in Stations 1 through 5. The maximum concentration was 0.46 mg/l.

The State of Alaska applies additional water quality standards under 18AAC.70 to regulate human activities which result in alteration to waters within the jurisdiction of the State. Standards were developed for different types of water use, including:

A. Water supply
  (i) drinking, culinary and food processing
  (ii) agriculture, including irrigation and stock watering
  (iii) aquaculture
  (iv) industrial

B. Water recreation
  (i) contact recreation
  (ii) secondary recreation

C. Growth and propagation of fish, shellfish, other aquatic life, and wildlife

Unless otherwise designated, the most stringent standards applicable under each use apply to Moose Creek. Standards under particular use categories for several water quality parameters relevant to the proposed project include:

- Sediment - "No increase in concentrations of sediment, including settleable solids, above natural conditions" (water supply-drinking water).

- Dissolved Gas - "Dissolved oxygen shall be greater than 7 mg/l in waters used by anadromous and resident fish.... In no case shall dissolved oxygen above 17 mg/l be permitted." (Growth and Propagation of Fish, Shellfish and other Aquatic Life and Wildlife).

- pH - "Shall not be less than 6.5 or greater than 8.5. Shall not vary more than 0.5 pH units from natural conditions. If the natural condition pH is outside this range, substances shall not be added that cause an increase in buffering capacity of the water" (Water Recreation - contact recreation).

- Turbidity - "Shall not exceed 5 NTU above natural conditions when the natural turbidity is 50 NTU or less, and shall not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 15 NTU" (Water Recreation -contact recreation).

- Dissolved Inorganic Substances - "Total dissolved solids from all sources shall not exceed 500 mg/l. Neither chlorides nor sulfates shall exceed 200 mg/l" (Water Supply - drinking water).

The standards potentially apply to any releases of water at the site during operational and post closure periods.

Under the U.S. Department of Agriculture classification of irrigation waters with regard to sodium and salinity hazards, the waters of Moose and Buffalo Creeks are of high quality. The maximum specific conductance (a measure of salinity) measured to date in the field is 241 μmhos/cm, and the maximum sodium absorption ratio (SAR) measured by the laboratory is 0.96. Together, these measurements indicate a class C1-S1 condition or low salinity, low sodium waters. These waters may be used "...for irrigation with most crops on most soils with little likelihood that soil salinity will develop" and "...on almost all soils with little danger of development of harmful levels of exchangeable sodium" (Schwab, et al., 1971).

4.4.3 Comparison of Site and Regional Water Quality

Limited information is available on water quality in the region around the site. Some historical data, however, have been published by the U.S. Geological Survey (USGS, 1971). Chemical analyses for Moose Creek, listed under miscellaneous streams in the 1951 water year, report values for many chemical constituents of interest.

Concentrations of calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, fluoride, dissolved solids, hardness, conductivity, and pH were measured in the spring of 1951. All are of the same order of magnitude as the range of values monitored in 1988. However, the concentrations of iron for 1951 are reported in the range of 0.01 to 0.03 mg/l, which is significantly lower than the maximum values recently measured. Conversely, the concentrations of nitrate measured in the spring of 1951 are an order of magnitude higher than those recorded in the spring of 1988.

Similar measurements were made on Moose Creek monthly from February to September 1952, with the exception of August 1952. The order of magnitude of the results is consistent with those discussed above, showing little variation through the seven month period. Measurements with the same orders of magnitude were also recorded for nearby Granite Creek in the summer of 1951.

The historical measurements show a close similarity in the chemical nature of surface waters in Moose Creek in the early 1950's and at present. Of the constituents measured, only iron and nitrate differ significantly. It does not appear that the water quality at present has been significantly degraded relative to that which has existed in the past.

4.5 Soil Loss / Sediment Yield

4.5.1 Measured Sediment Loads

The turbidity and sediment concentration data collected from July, 1988 to June, 1989, have consisted of monthly grab samples. Turbidity and sediment concentrations in Moose Creek measured at four stations in and near the proposed Permit Area were relatively low during the period October, 1988 to March, 1989. Turbidity has ranged from 0.30 to 4.00 NTU and Total

Suspended Solids (TSS) from <1 to 10 mg/l. During this period, significant amounts of weathered material from higher elevations were not being transported. Sampling during high spring runoff flows indicated that higher sediment loads were being transported. Turbidity values in Moose Creek increased from <1 NTU in March, 1989 to 4.5 to 8.3 NTU in April, 1989. TSS also showed a marked increase during this period, indicating that streambed and bank erosion was occurring due to the ice and snowmelt.

Turbidity and sediment concentration in Buffalo and Premier Creeks were slightly higher than those in Moose Creek. During the July, 1988 to June, 1989 period, Buffalo Creek had turbidity levels ranging from 0.25 to 20.00 NTU. While during the same period Premier Creek had turbidity values ranging from 0.5 to 16 NTU. TSS data from the July, 1988 to June, 1989, period ranged from <1 mg/l to 48 mg/l in Buffalo Creek and 4 mg/l to 10 mg/l in Premier Creek.

Historical sediment concentration data do not exist for Moose Creek or its tributaries. However, historical data exist for the Little Susitna River at a gaging station near Palmer. Moose Creek is hydrologically similar to the Little Susitna River, as shown in Table 4-1. Both streams are predominantly oriented north-south; they are comparable in size (49.6 square miles for Moose Creek versus 61.9 square miles for the Little Susitna River); they flow over similar geologic and surface terrain conditions; and, they are adjacent drainages. Therefore, the historical sediment concentration data from the Little Susitna River is used to estimate loads in Moose Creek.

A plot of TSS concentration versus discharge in the Little Susitna River is shown in Figure 4-9. A best fit regression line has been calculated. Based on this relationship and the discharge-recurrence interval relationship in Figure 4-6, the following TSS concentrations were determined for the Little Susitna River.

Recurrence Interval (Yr)	Discharge (cfs)	TSS (mg/L
2	1970	206
5	3030	344
10	3890	465
25	5190	656
50	6320	831

It is expected that comparable TSS concentrations will occur in Moose Creek for similar storm events (i.e. storms with the same recurrence intervals). Continuing monitoring of sediment concentrations in Moose Creek will be conducted to substantiate sediment loads during storm events.

Field observations during snow melt and ice break up in April, 1989 on Moose and Buffalo Creeks indicate that turbidity rose significantly due to melt water flowing over channel banks. Little or no overland flow was observed from areas removed from the channel banks. These observations indicate the effectiveness of the vegetation, even in winter, in trapping and retaining sediment and reinforce the conclusion that the stream channel bed and banks supply most of the sediment during periods of high flow.

4.5.2 Estimated Sediment Yield for Buffalo Creek

An estimate of average annual erosion from the Buffalo Creek watershed was made to determine which sediment yield parameters are the most important in this area and to estimate baseline sediment yield conditions in an area which is expected to be affected by the proposed mining plans. The Universal Soil Loss Equation (USLE) was applied to the basin in its original form:

$$A = (R)(K)(LS)(C)(P)$$

where A = Sediment yield (tons/acre/yr)
R = Rainfall erosivity factor
K = Soil erodibility
LS = Length slope factor
C = Conservation factor
P = Practice factor

Appendix G contains the detailed calculations and parameter estimations for the USLE applied to Buffalo Creek.

Rainfall erosivity was estimated from the 2-year, 6-hour rainfall as $R = 16.55(\text{Precip})^{2.2}$, when precip is the 2-year, 6-hour rainfall in inches for Type I storms (Hotes et al., 1973). The 2-year, 6-hour rainfall for the site was estimated at 1.1 inches from National Weather Service data for

Alaska (Miller, 1963). The resulting rainfall erosivity factor is 20.41.

Soil erodibility was taken from the Soil Survey Baseline Report (Nyenhuis, 1988) completed for the Wishbone Hill Project. The value of 0.41 is applicable for the majority of the soils on the site. This factor is fairly high, indicating the soils are moderately to highly erodible.

Length slope (LS) factors vary in different portions of the Buffalo Creek watershed. The watershed was subdivided into four areas, and a LS factor was computed from topographic maps at a scale of one inch to 500 feet for each area. Values ranged from 6.54 to 14.55. The four areas included: the "dry arm" area defined in Section 4.2.2; the steep canyon of upper Buffalo Creek; the marshy meadow section of middle Buffalo Creek; and the rolling, steep and flood plain composite area of lower Buffalo Creek, which includes the section of Buffalo Creek which flow across an old Moose Creek flood plain. The last area required use of the compound slope form of the LS computation (see Appendix G for details).

The conservation and practice factors are usually combined into a CP factor, and tabulated values for typical surfaces are included in many texts. This factor accounts for both vegetation and land use and is defined as the ratio of sediment yield from a surface in question, to a section of crop land kept in continuous fallow. Values used for the subareas of Buffalo Creek are compiled in Barfield et al. (1985). Details of the derivations of values used are shown in Appendix G. In general, the Buffalo Creek watershed is heavily vegetated, with plant canopy estimated at between 25 and 50 percent, and plant coverage estimated at 40 to 60 percent of the surface area for tall brush and undisturbed woodland.

The USLE was applied to each of the four areas and the results were added to estimate total yield for the watershed. The results are summarized below:

Area	**Yield (tons/yr)**
Wishbone Dry Arm	91 (85 acres)
Buffalo Creek Canyon	370 (40 acres)
Middle Buffalo Creek	382 (185 acres)
Lower Buffalo Creek	1088 (110 acres)
Total	**1931**

Note: No soil loss computed for Wishbone Lake drainage area (160 acres).

The watershed drains a land area of approximately 420 acres, resulting in an estimated average annual sediment yield of 4.6 tons/acre/year, which is a moderately low sediment yield. A value of 2 tons/acre/year is often used to describe revegetated areas which require minimal maintenance.

5.0 CONCLUSIONS

The proposed Permit Area occupies approximately 2.5 square miles in the southern portion of the Moose Creek watershed. Moose Creek drains approximately 49.6 square miles and flows into the Matanuska River about 3 miles downstream of the site. The streambed of Moose Creek is comprised of large boulders, cobbles and gravels typical of a high energy environment.

Two tributaries are located in or near the proposed Permit Area. Buffalo Creek drains 0.89 square miles and flows from Wishbone Lake across the proposed Permit Area into Moose Creek. Its channel is typically comprised of gravels, sands and some silts. Premier Creek flows into Moose Creek from the north and does not cross the proposed Permit Area.

The surface drainage pattern in the proposed Permit area has been significantly affected by glaciation. Much of the area is characterized by closed depressions which have no surface drainage outlet.

Seven stations have been established to monitor flow and/or water quality. During the period of record from August, 1988 to July, 1989 Moose Creek flows have ranged from approximately 10 cfs in March, 1989, to over 700 cfs during a storm in mid June, 1989. Flows in Buffalo Creek over the same period have ranged from zero in January, February and March, 1989, to about 16 cfs during a storm in September, 1988.

Flood peaks on Moose Creek are based on historical data from the adjacent Little Susitna River watershed which is hydrologically very similar. Peak flows in Moose Creek at its mouth are estimated to be 1580, 2430, 3120, 4160, 5065 and 6080 cfs for the 2, 5, 10, 25, 50 and 100-year recurrence intervals, respectively.

Existing water quality data from the Moose Creek watershed indicate that surface waters are of high quality. Surface waters are predominantly calcium bicarbonate in composition. They generally meet State and Federal standards for drinking water quality.

Turbidity and sediment concentrations in surface waters have been quite low during the period from late August, 1988 to June, 1989 for which laboratory data are available. Turbidity in Moose Creek has ranged from 0.20 to 8.3 NTU and TSS from <1 to 8 mg/l. Buffalo Creek has had turbidity levels from 0.25 to 20.00 NTU and TSS concentrations from <1 to 48 mg/l. Premier Creek has varied from 0.70 to 16.0 NTU in turbidity and from <1 to 10 mg/l in TSS.

Based on historical sediment concentration data from the adjacent Little Susitna Watershed (Carrick, et al., 1988), it is expected the sediment concentrations in Moose Creek will increase significantly during storm events. Based on a regression of TSS versus discharge in the Little Susitna River, TSS concentrations of 206, 244, 465, 656 and 831 mg/l were calculated in the Little Susitna River for recurrence intervals of 2, 5, 10, 25 and 50 years, respectively. Comparable sediment concentrations are expected in Moose Creek for similar storm events.

6.0 RESPONSIBLE PARTIES

This report was prepared by Golder Associates Inc., 200 Union Blvd., Suite 100, Lakewood, Colorado 80228. Individuals conducting field work and technical analysis for this report include the following:

Jerry Rowe, P.E.	Associate
Greg Laird	Senior Hydrologist
John Velimesis	Project Hydrologist
Greg Davis	Project Geochemist
David Hoekstra	Staff Hydrologist
Chris Pauley	Technician
Matt Werderber	Technician

7.0 REFERENCES

1. ASTM, Annual Book Of ASTM Standards, Part 19: Soil and Rock; Building Stones. 198X.

2. Barfield, B.J., Warner, R.C. and Haan, C.T. 1985. Applied Hydrology and Sedimentology for Disturbed Areas, 3rd Printing, Oklahoma Technical Press, Stillwater, OK.

3. Carrick, S., Maurer, M., Maynard, D., and Hunter, J., 1988. Preliminary Water Resources Assessment of the Proposed Hatcher Pass Alpine Ski Area Near Government Peak, Southcentral Alaska, Alaska Division of Geological and Geophysical Survey, Fairbanks.

4. Dunne, T. and L.B. Leopold, 1978. Water in Environmental Planning, W.H. Freeman and Co.

5. Freethey, G.W. and Scully, D.R., 1980. Water Resources of the Cook Inlet Basin, Alaska, Hydrologic Investigations Atlas HA- 620, U.S. Geological Survey, 1980.

6. Hartman, C.W. and Johnson, P.R., 1978. Environmental Atlas of Alaska, Institute of Water Resources, University of Alaska, Fairbanks.

7. Hotes, F.L., Ateshian, K.H., and B. Sheikh. 1973. Comparative costa of erosion and sediment control construction activities. Report No. EPA-430/9-73-016, U.S. Environmental Protection Agency, Washington, D.C.

8. Miller, John F. 1963. Technical Paper No. 47, "Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska," (For Areas to 400 Square Miles, Durations to 24 Hours, and Recurrence Intervals to 100 Years), U.S. Department of Commerce, National Weather Service, Washington, D.C.

9. National Oceanic and Atmospheric Administration (NOAA), 1987. Comparative Climate Data for the United Stages Through 1987.

10. Nyenhuis, James H., 1988. Soil Survey Baseline Report, Wishbone Hill Project, Consultant Report to McKinley Mining Consultants, December.

11. Schwab, G.O., Frevert, R.K., Barnes, K.K., and Edminster, T.W., 1971. Elementary Soil and Water Engineering, John Wiley & Sons, New York.

12. U.S. Army Corps of Engineers, 1981. HEC-1 Flood Hydrograph Package - Computer Program 723-X6-L2010. The Hydrologic Engineering Center, Davis, CA.

13. U.S. Army Corps of Engineers, 1982. HEC-2 Water Surface Profiles - Generalized Computer Program 723-X6-L202A. The Hydrologic Engineering Center, Davis California.

14. U.S. Geological Survey, 1951 (Revised 1987). Topographic Maps, Anchorage D-6 and Anchorage G-6 Quadrangles, Alaska, Scale 1:63,360, contour interval 50 feet.

15. U.S. Geological Survey, 1971. Water Resources Data for Alaska, 1971.

16. U.S. Geological Survey, 1982. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. USGS Water Supply Paper 2175, S.E. Rantz et al..

17. Wischmeier, et al., 1971. "A Soil Erodibility Nomograph for Farmland and Construction Sites", Journal of Soil Water Conservation 26(5):189-193.

TABLES

TABLE 2-1

STREAMFLOW DATA
LITTLE SUSITNA RIVER, NEAR PALMER, ALASKA
1949-1987

(Flow figures in cubic feet per second or cfs)

Average Flow:	211
Lowest Annual Flow:	96 (1969)
Highest Annual Flow:	316 (1949)

Monthly Average Flows:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	29.5	23.5	19.2	22.1	205.0	682.0	551.0	446.0	309.0	138.0	61.5	38.4

Lowest Monthly Flow:	10.0 (April 1955, March 1956)
Highest Monthly Flow:	1215 (June 1977)
Lowest Daily Flow:	8.0 (1956 and 1957)
Highest Daily Flow:	5040 (1971)

Estimated Streamflow Statistics: cfs:

	Mean	Recurrence Interval 10-Yr Flow	Recurrence Interval 50-Yr Flow	Recurrence Interval 100-Yr Flow
1-Day Low Value	16.3	10.9	7.8	6.8
7-Day Low Value	16.5	11.1	8.1	7.1
30-Day Low Value	18.0	12.2	9.0	8.0
7-Day High Value	1158.0	1698.1	2153.0	2332.6
30-Day High Value	783.0	1114.8	1352.8	1439.8

Source: Carrick, et al., 1988

TABLE 2-2

SUMMARY OF REGIONAL WATER QUALITY DATA

Discharge (during sampling)	13 to 1230 cfs
Temperature	0 to 8.5 degrees C
pH	6.2 to 8.1
Specific Conductance	46 to 220 μmhos
Hardness	18 to 102 mg/l as $CaCO_3$
Alkalinity	20 to 38 mg/l as $CaCO_3$
Total Suspended Sediment	0 to 2510 mg/l
Total Dissolved Solids	40 to 83 mg/l
Bicarbonate	24 to 103 mg/l
Sulfate	0.0 to 20 mg/l
Nitrate	0.05 to 40 mg/l
Chloride	0.5 to 21 mg/l
Fluoride	0.0 to 0.2 mg/l
Calcium	5.9 to 33 mg/l
Magnesium	1.3 to 4.6 mg/l
Sodium	3.7 to 12 mg/l
Potassium	0.5 to 1.7 mg/l
Iron	0 to 0.18 mg/l
Color	0 to 10

Source: Carrick et al., 1988

TABLE 3-1
FIELD ANALYTICAL RESULTS OF MONTHLY SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	pH	Specific Conductance uhmos	Temperature oC	Dissolved Oxygen mg/l	Turbidity NTU	Alkalinity mg/l
07/30/88	1	Moose Ck	7.20	70	9.5	11.7	1.60	--
08/31/88	1	Moose Ck	6.10	80	6.5	11.4	1.20	--
09/23/88	1	Moose Ck	7.29	112	2.5	13.2	0.70	--
10/22/88	1	Moose Ck	6.39	100	1.5	12.3	0.65	33.1
11/18/88	1	Moose Ck	7.17	163	3.0	11.2	0.58	30.2
12/20/88	1	Moose Ck	7.25	128	1.0	12.8	0.36	81.0
01/27/89	1	Moose Ck	7.36	164	1.0	13.2	0.20	50.0
02/24/89	1	Moose Ck	6.71	169	0.0	13.7	1.10	23.0
03/22/89	1	Moose Ck	7.33	173	0.5	14.3	0.50	30.0
04/15/89	1	Moose Ck	7.60	187	2.0	13.4	8.30	43.2
05/16/89	1	Moose Ck	6.81	134	2.0	13.6	2.60	34.0
06/19/89	1	Moose Ck	7.25	59	8.0	12.4	2.30	18.5
07/20/89	1	Moose Ck	7.10	53	7.5	11.2	3.50	19.2
07/30/88	2	Premier CK	7.80	120	11.0	10.2	1.20	--
08/31/88	2	Premier CK	6.30	114	7.0	11.5	1.00	--
09/23/88	2	Premier CK	7.30	93	6.5	10.6	7.20	--
10/21/88	2	Premier CK	6.30	86	1.5	13.1	2.60	43.5
11/18/88	2	Premier CK	7.29	114	2.0	11.4	0.84	49.2
12/19/88	2	Premier CK	7.49	133	1.0	12.6	0.70	53.0
01/29/89	2	Premier CK	7.20	150	3.0	14.2	1.00	86.0
02/24/89	2	Premier CK	6.16	135	0.0	14.0	2.60	39.0
03/21/89	2	Premier CK	6.11	140	0.5	14.7	0.50	47.0
04/14/89	2	Premier CK	7.65	107	1.0	14.7	16.00	36.0
05/16/89	2	Premier CK	7.81	86	7.0	13.0	7.50	34.7
06/19/89	2	Premier CK	7.82	101	9.0	13.6	3.50	43.1
07/20/89	2	Premier CK	7.59	95	7.0	11.8	2.60	48.1
07/30/88	3	Buffalo Ck	6.60	52	14.0	7.9	17.00	--
08/31/88	3	Buffalo Ck	5.90	45	10.0	9.8	20.00	--
09/23/88	3	Buffalo Ck	--	--	--	--	--	--
10/21/88	3	Buffalo Ck	6.06	40	3.0	11.8	3.00	19.0
11/19/88	3	Buffalo Ck	7.01	51	1.0	11.2	0.30	11.2
12/19/88	3	Buffalo Ck	7.12	57	1.0	11.4	0.25	21.0
01/27/89	3	Buffalo Ck	7.09	66	3.5	14.0	0.25	30.0
02/24/89	3	Buffalo Ck	5.60	59	0.0	10.2	0.90	11.0
03/21/89	3	Buffalo Ck	5.94	49	3.0	11.3	--	60.0
04/15/89	3	Buffalo Ck	6.26	53	0.0	9.3	0.80	17.6
05/15/89	3	Buffalo Ck	7.17	45	5.0	13.4	1.50	16.0
06/19/89	3	Buffalo Ck	6.97	45	15.0	8.2	1.60	17.8
07/20/89	3	Buffalo Ck	6.50	45	12.0	6.3	2.00	21.4
07/30/88	4	Buffalo Ck	6.50	59	9.5	12.0	0.58	--
08/31/88	4	Buffalo Ck	6.30	64	8.5	10.2	0.47	--
09/23/88	4	Buffalo Ck	6.88	48	6.5	10.4	2.70	--
10/21/88	4	Buffalo Ck	6.02	241	2.0	12.2	0.58	19.0
11/19/88	4	Buffalo Ck	7.20	59	1.0	11.6	0.50	22.6
12/19/88	4	Buffalo Ck	7.19	85	1.0	13.5	0.65	32.0
01/29/89	4	Buffalo Ck	--	--	--	--	--	--
02/24/89	4	Buffalo Ck	--	--	--	--	--	--
03/20/89	4	Buffalo Ck	6.29	62	1.0	7.2	0.50	22.4
04/14/89	4	Buffalo Ck	6.54	69	2.0	12.2	4.00	20.3
05/16/89	4	Buffalo Ck	7.08	47	5.0	13.6	2.40	15.7

NOTE: "--" means parameter not measured.

TABLE 3-1
FIELD ANALYTICAL RESULTS OF MONTHLY SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	pH	Specific Conductance uhmos	Temperature oC	Dissolved Oxygen mg/l	Turbidity NTU	Alkalinity mg/l
06/19/89	4	Buffalo Ck	7.22	53	8.5	13.0	0.40	15.7
07/20/89	4	Buffalo Ck	6.85	61	6.5	11.1	1.40	15.7
07/30/88	5	Moose Ck	6.90	84	10.5	10.2	1.20	--
08/31/88	5	Moose Ck	6.50	91	9.0	8.5	0.75	--
09/23/88	5	Moose Ck	7.36	115	6.0	12.6	5.00	--
10/21/88	5	Moose Ck	6.31	109	0.0	13.8	0.65	37.5
11/19/88	5	Moose Ck	7.09	132	3.0	11.2	0.30	44.6
12/20/88	5	Moose Ck	7.14	148	0.0	13.2	0.24	51.0
01/29/89	5	Moose Ck	7.30	180	1.0	15 +	0.23	50.0
02/24/89	5	Moose Ck	6.26	171	2.0	12.4	0.50	40.0
03/22/89	5	Moose Ck	7.20	189	0.0	14.2	0.50	35.0
04/15/89	5	Moose Ck	7.80	168	1.0	14.0	4.50	45.0
05/16/89	5	Moose Ck	7.47	120	8.0	10.6	2.70	44.6
06/19/89	5	Moose Ck	7.25	68	6.0	13.2	3.80	22.3
07/20/89	5	Moose Ck	6.59	71	6.5	11.6	3.40	25.4
07/30/88	6	Moose Ck	--	--	--	--	--	--
08/31/88	6	Moose Ck	6.30	85	7.0	11.6	2.30	--
09/23/88	6	Moose Ck	7.02	110	8.5	10.2	2.40	--
10/22/88	6	Moose Ck	6.30	111	0.0	14.8	0.50	33.0
11/18/88	6	Moose Ck	7.22	138	3.5	11.4	0.78	40.2
12/20/88	6	Moose Ck	7.40	148	0.0	13.9	0.44	46.0
01/29/89	6	Moose Ck	--	--	--	--	--	--
02/24/89	6	Moose Ck	6.66	181	0.0	13.7	0.55	36.0
03/20/89	6	Moose Ck	7.10	155	0.5	14.0	0.90	34.0
04/14/89	6	Moose Ck	7.93	183	2.0	13.6	4.50	47.6
05/16/98	6	Moose Ck	7.55	124	8.0	11.2	4.50	40.1
06/19/89	6	Moose Ck	7.17	68	8.0	12.6	2.70	20.7
07/20/89	6	Moose Ck	7.37	60	7.0	12.2	2.40	23.1
07/30/88	7	Moose Ck	--	--	--	--	--	--
08/31/88	7	Moose Ck	6.40	90	7.5	11.8	1.00	--
09/23/88	7	Moose Ck	7.11	110	7.0	10.9	3.40	--
10/22/88	7	Moose Ck	6.20	108	0.0	14.3	0.58	39.0
11/18/88	7	Moose Ck	7.26	128	3.0	10.4	0.30	43.8
12/19/88	7	Moose Ck	7.40	146	0.0	13.2	0.30	113.0
01/29/89	7	Moose Ck	--	--	--	--	--	--
02/25/89	7	Moose Ck	6.75	165	1	14	--	29
03/20/89	7	Moose Ck	7.08	151	1.0	13.2	0.70	39.0
04/14/89	7	Moose Ck	7.80	167	1.0	14.6	7.50	44.5
05/16/89	7	Moose Ck	7.79	120	9.0	11.2	3.90	39.7
06/19/89	7	Moose Ck	7.37	65	9.5	13.1	2.50	21.5
07/20/89	7	Moose Ck	7.07	62	7.5	11.2	2.50	25.0

NOTE: "--" means parameter not measured.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Al mg/l	As mg/l	Ba mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Hg mg/l	Se mg/l	Zn mg/l	Total Cr mg/l	Dis-solved Cr mg/l	Total Fe mg/l	Dis-solved Fe mg/l	Total Mn mg/l	Dis-solved Mn mg/l
07/30/88	1	Moose Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.17	<0.05	<0.02	<0.02
08/31/88	1	Moose Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
09/23/88	1	Moose Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
10/21/88	1	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.09	<0.05	<0.02	<0.02
11/18/88	1	Moose Ck	0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.11	<0.05	<0.02	<0.02
12/20/88	1	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.08	<0.05	<0.02	<0.02
01/27/89	1	Moose Ck	0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.08	<0.05	<0.02	<0.02
02/24/89	1	Moose Ck	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
03/22/89	1	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
04/15/89	1	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.66	0.12	0.05	0.02
05/16/89	1	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	0.08	<0.001	<0.005	0.02	<0.02	<0.02	0.06	0.06	<0.02	<0.02
06/19/89	1	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.19	<0.05	<0.02	<0.02
07/30/88	2	Premier CK	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.41	<0.05	0.02	<0.02
08/31/88	2	Premier CK	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	0.03	<0.02	<0.02	0.09	<0.05	<0.02	<0.02
09/23/88	2	Premier CK	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.25	0.05	<0.02	<0.02
10/21/88	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.35	<0.05	<0.02	<0.02
11/19/88	2	Premier CK	0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.16	<0.05	<0.02	<0.02
12/19/88	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.11	<0.05	<0.02	<0.02
01/27/89	2	Premier CK DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.21	<0.05	<0.02	<0.02
01/29/89	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.24	<0.05	<0.02	<0.02
02/24/89	2	Premier CK	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.04	<0.02	<0.02	0.07	<0.05	<0.02	<0.02
03/21/89	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.07	<0.05	<0.02	<0.02
03/21/89	2	Premier CK DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.06	<0.05	<0.02	<0.02
04/14/89	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	1.42	0.05	0.04	<0.02
05/16/89	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.06	0.06	<0.02	<0.02
06/19/89	2	Premier CK	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.55	<0.05	<0.02	<0.02
07/30/88	3	Buffalo Ck	0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	2.43	0.16	0.80	<0.02
07/30/88	3	Buffalo Ck DUP	0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	2.40	<0.05	0.08	<0.02
08/31/88	3	Buffalo Ck DUP	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	1.33	0.12	0.03	0.03
08/31/88	3	Buffalo Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	1.33	0.12	0.03	0.03
09/23/88	3	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/21/88	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.13	0.06	<0.02	<0.02
11/19/88	3	Buffalo Ck	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.16	0.10	<0.02	<0.02
12/19/88	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.03	<0.02	<0.02	0.15	0.05	<0.02	<0.02
12/19/88	3	Buffalo Ck DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.04	<0.02	<0.02	0.16	0.05	<0.02	<0.02

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

Golder Associates

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Al mg/l	As mg/l	Ba mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Hg mg/l	Se mg/l	Zn mg/l	Total Cr mg/l	Dis-solved Cr mg/l	Total Fe mg/l	Dis-solved Fe mg/l	Total Mn mg/l	Dis-solved Mn mg/l
01/27/89	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.29	0.05	<0.02	<0.02
02/24/89	3	Buffalo Ck	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.03	<0.02	<0.02	0.10	<0.05	<0.02	<0.02
02/24/89	3	Buffalo Ck DUP	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.07	<0.02	<0.02	0.10	<0.05	<0.02	<0.02
03/21/89	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.09	<0.05	<0.02	<0.02
04/15/89	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	0.03	<0.001	<0.005	<0.01	<0.02	<0.02	0.07	<0.05	<0.02	<0.02
05/16/89	3	Buffalo Ck DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
05/16/89	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
06/19/89	3	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.21	<0.05	<0.02	<0.02
06/19/89	3	Buffalo Ck DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.17	<0.05	<0.02	<0.02
07/30/88	4	Buffalo Ck	0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.13	<0.05	<0.02	<0.02
08/31/88	4	Buffalo Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.48	0.24	<0.02	<0.02
09/23/88	4	Buffalo Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.15	0.06	<0.02	<0.02
10/21/88	4	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.12	<0.05	<0.02	<0.02
11/19/88	4	Buffalo Ck DUP	0.1	<0.005	<0.5	0.002	<0.01	<0.02	<0.001	<0.005	0.03	<0.02	<0.02	0.16	0.08	<0.02	<0.02
11/19/88	4	Buffalo Ck	0.1	<0.005	<0.5	0.002	<0.01	<0.02	<0.001	<0.005	0.04	<0.02	<0.02	0.15	0.08	<0.02	<0.02
12/19/88	4	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.18	0.12	<0.02	<0.02
01/27/89	4	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	4	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/20/89	4	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	0.02	0.09	<0.001	<0.005	<0.01	<0.02	<0.02	0.20	<0.05	<0.02	<0.02
04/14/89	4	Buffalo Ck DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.17	0.10	<0.02	<0.02
04/14/89	4	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.17	0.10	<0.02	<0.02
05/16/89	4	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
06/19/89	4	Buffalo Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.12	0.07	<0.02	<0.02
07/30/88	5	Moose Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.14	<0.05	<0.02	<0.02
08/31/88	5	Moose Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.07	0.05	<0.02	<0.02
09/23/88	5	Moose Ck	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.11	<0.05	<0.02	<0.02
09/23/88	5	Moose Ck DUP	<0.1	<0.005	--	<0.002	--	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.11	<0.05	<0.02	<0.02
10/21/88	5	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.05	<0.05	<0.02	<0.02
10/21/88	5	Moose Ck DUP	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.08	<0.05	<0.02	<0.02
11/19/88	5	Moose Ck	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.08	<0.05	<0.02	<0.02
12/20/88	5	Moose Ck	<0.1	<0.005	<0.5	<0.002	0.01	<0.02	<0.001	<0.005	0.02	<0.02	<0.02	0.08	<0.05	<0.02	<0.02
01/29/89	5	Moose Ck	0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.10	<0.05	<0.02	<0.02
02/24/89	5	Moose Ck	0.2	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.05	<0.05	<0.02	<0.02
03/22/89	5	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.05	<0.05	<0.02	<0.02
04/15/89	5	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	0.30	0.08	<0.02	<0.02

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

Golder Associates

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Al mg/l	As mg/l	Ba mg/l	Cd mg/l	Cu mg/l	Pb mg/l	Hg mg/l	Se mg/l	Zn mg/l	Total Cr mg/l	Dis-solved Cr mg/l	Total Fe mg/l	Dis-solved Fe mg/l	Total Mn mg/l	Dis-solved Mn mg/l
05/16/89	5	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	<0.01	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02
06/19/89	5	Moose Ck	<0.1	<0.005	<0.5	<0.002	<0.01	<0.02	<0.001	<0.005	0.01	<0.02	<0.02	0.29	<0.05	<0.02	<0.02
08/31/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
09/23/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/22/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/18/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12/20/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
01/29/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/22/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
04/14/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
05/16/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/19/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
07/30/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
08/31/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
09/23/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/22/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/18/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12/20/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
01/29/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/22/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
04/14/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
05/16/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/19/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N)	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Sus-pended Solids mg/l	Total Dis-solved solid mg/l	Settle-able Solids mg/l	Turbid-ity NTU	Boron mg/l	Fluoride mg/l
07/30/88	1	Moose Ck	0.03	<0.1	0.002	0.002	--	24	27	<1	0.13	8	28	<0.1	1.6	0.04	0.07
08/31/88	1	Moose Ck	0.05	<0.1	0.001	<0.001	--	27	31	<1	0.14	1	24	<0.1	--	0.05	0.05
09/23/88	1	Moose Ck	<0.01	0.1	0.008	0.003	0.011	31	36	<1	0.18	2	54	<0.1	--	0.07	0.10
10/22/88	1	Moose Ck	<0.01	0.1	0.012	0.002	0.022	36	42	<1	0.34	<1	56	<0.1	--	0.08	0.02
11/18/88	1	Moose Ck	0.05	0.1	0.003	<0.001	0.005	32	43	<1	0.21	2	86	<0.1	--	0.36	0.03
12/20/88	1	Moose Ck	0.15	0.2	0.001	<0.001	0.007	37	47	<1	0.34	<1	92	<0.1	--	0.08	0.02
01/27/89	1	Moose Ck	0.03	<0.1	<0.001	<0.001	<0.001	33	50	<1	0.27	<1	80	<0.1	--	0.34	0.09
02/24/89	1	Moose Ck	<0.01	<0.1	0.008	0.013	0.024	36	50	<1	0.38	<1	76	<0.1	--	0.28	0.05
03/22/89	1	Moose Ck	0.03	<0.1	0.005	0.002	0.006	35	52	<1	0.33	<1	80	<0.1	--	0.20	0.07
04/15/89	1	Moose Ck	<0.01	0.2	0.015	0.023	0.045	51	46	<1	0.96	6	82	<0.1	--	0.39	0.09
05/16/89	1	Moose Ck	<0.01	0.1	0.020	0.001	0.026	45	42	<1	0.60	2	96	<0.1	--	<0.01	0.06
06/19/89	1	Moose Ck	0.04	<0.1	0.007	0.004	0.019	21	25	<1	0.12	<1	34	<0.1	--	<0.01	0.06
07/30/88	2	Premier CK	0.02	0.2	<.002	0.007	--	50	47	<1	0.22	6	50	<0.1	1.2	0.03	0.08
08/31/88	2	Premier CK	0.05	0.2	0.001	0.002	--	54	50	<1	0.20	4	48	<0.1	--	0.02	0.06
09/23/88	2	Premier CK	<0.01	0.1	0.008	0.002	0.018	43	41	<1	0.22	9	52	<0.1	--	<0.01	0.10
10/21/88	2	Premier CK	<0.01	<0.1	0.012	0.014	0.042	46	45	<1	0.21	4	58	<0.1	--	0.02	0.04
11/18/88	2	Premier CK	0.08	0.1	0.006	0.004	0.013	52	48	<1	0.20	10	78	<0.1	--	0.28	0.04
12/19/88	2	Premier CK	0.35	0.4	0.005	0.003	0.011	52	51	<1	0.15	9	70	<0.1	--	0.01	0.03
01/27/89	2	Premier CK DUP	0.02	<0.1	<0.001	<0.001	<0.001	51	50	<1	0.24	<1	68	<0.1	--	0.32	0.08
01/29/89	2	Premier CK	0.02	<0.1	<0.001	<0.001	<0.001	51	50	<1	0.23	<1	66	<0.1	--	0.26	0.09
02/24/89	2	Premier CK	<0.01	0.1	0.002	<0.001	0.005	58	50	<1	0.27	4	70	<0.1	--	0.21	0.08
03/21/89	2	Premier CK	0.03	<0.1	0.006	0.013	0.020	57	53	<1	0.21	<1	58	<0.1	--	0.26	0.07
03/21/89	2	Premier CK DUP	0.02	<0.1	0.006	0.014	0.021	57	52	<1	0.21	2	64	<0.1	--	0.20	0.07
04/14/89	2	Premier CK	0.03	0.4	0.013	0.036	0.084	41	39	<1	0.23	10	50	0.2	--	0.40	0.08
05/15/89	2	Premier CK	0.03	0.7	0.018	0.003	0.036	40	38	<1	0.24	9	72	<0.1	--	<0.01	0.06
06/19/89	2	Premier CK	0.02	<0.1	0.006	0.006	0.024	47	43	<1	0.20	<1	48	<0.1	--	<0.01	0.06
07/30/88	3	Buffalo Ck	0.02	<0.1	0.003	0.077	--	21	16	<1	0.30	48	22	0.2	17.0	0.05	0.06
07/30/88	3	Buffalo Ck DUP	0.02	<0.1	0.002	0.083	--	22	16	<1	0.33	46	34	<0.1	17.0	0.05	0.06
08/31/88	3	Buffalo Ck DUP	0.05	0.2	0.003	0.030	--	21	18	<1	0.26	18	18	<0.1	--	0.01	0.05

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N)	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Sus-pended Solids mg/l	Total Dis-solved solid mg/l	Settle-able Solids mg/l	Turbid-ity NTU	Boron mg/l	Fluoride mg/l
08/31/88	3	Buffalo Ck	0.05	0.1	0.003	0.028	--	21	17	<1	0.26	22	18	<0.1	--	0.01	0.05
09/23/88	3	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/21/88	3	Buffalo Ck	<0.01	0.3	0.012	0.012	0.032	22	19	<1	0.25	2	24	<0.1	--	<0.01	0.03
11/19/88	3	Buffalo Ck	<0.01	0.1	0.003	0.013	0.021	23	20	<1	0.27	8	40	<0.1	--	0.28	0.03
12/19/88	3	Buffalo Ck	0.42	1.6	0.002	<0.001	0.009	24	19	<1	0.14	<1	38	<0.1	--	0.01	0.02
12/19/88	3	Buffalo Ck DUP	0.56	1.2	0.002	0.010	0.010	23	19	<1	0.14	<1	22	<0.1	--	0.02	0.02
01/27/89	3	Buffalo Ck	0.02	<0.1	<0.001	<0.001	<0.001	23	20	<1	0.25	<1	30	<0.1	--	0.26	0.08
02/24/89	3	Buffalo Ck	<0.01	0.3	0.002	<0.001	0.004	23	17	<1	0.29	<1	32	<0.1	--	0.22	0.04
02/24/89	3	Buffalo Ck DUP	<0.01	0.5	0.002	0.004	0.006	22	17	<1	0.24	11	32	<0.1	--	0.19	0.04
03/21/89	3	Buffalo Ck	0.02	<0.1	0.006	0.004	0.013	22	18	<1	0.31	2.5	32	<0.1	--	0.25	0.04
04/15/89	3	Buffalo Ck	<0.01	0.1	0.010	0.018	0.033	23	23	<1	0.25	1	20	<0.1	--	0.40	0.05
05/16/89	3	Buffalo Ck DUP	<0.01	0.1	0.015	0.003	0.026	20	15	<1	0.25	5	48	<0.1	--	<0.01	0.03
05/16/89	3	Buffalo Ck	<0.01	0.4	0.016	0.002	0.026	20	15	<1	0.28	6	42	<0.1	--	<0.01	0.03
06/19/89	3	Buffalo Ck	0.03	<0.1	0.005	0.001	0.025	22	20	<1	0.23	<1	14	<0.1	--	<0.01	0.05
06/19/89	3	Buffalo Ck DUP	0.09	<0.1	0.005	0.009	0.025	22	18	<1	0.23	<1	10	<0.1	--	<0.01	0.04
07/30/88	4	Buffalo Ck	0.08	0.1	<0.002	0.006	--	28	23	<1	0.27	5	30	<0.1	0.6	<0.01	0.06
08/31/88	4	Buffalo Ck	0.05	<0.1	0.002	0.010	--	31	26	<1	0.25	2	34	<0.1	--	0.02	0.06
09/23/88	4	Buffalo Ck	<0.01	0.3	0.010	0.008	0.019	21	19	<1	0.25	7	40	<0.1	--	<0.01	0.09
10/21/88	4	Buffalo Ck	<0.01	0.1	0.010	0.007	0.025	22	20	<1	0.25	<1	28	<0.1	--	<0.01	0.03
11/19/88	4	Buffalo Ck DUP	<0.01	<0.1	0.002	0.006	0.013	26	23	<1	0.25	6	48	<0.1	--	0.30	0.03
11/19/88	4	Buffalo Ck	<0.01	<0.1	0.002	0.007	0.016	27	24	<1	0.27	9	54	<0.1	--	0.30	0.03
12/19/88	4	Buffalo Ck	0.27	0.4	0.002	0.003	0.008	29	24	<1	0.16	<1	22	<0.1	--	<0.01	0.02
01/27/89	4	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	4	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/20/89	4	Buffalo Ck	0.04	0.1	0.006	0.017	0.027	30	24	<1	0.35	1	32	<0.1	--	0.12	0.05
04/14/89	4	Buffalo Ck DUP	<0.01	<0.1	0.020	0.028	0.056	24	21	<1	0.22	<1	34	<0.1	--	0.36	0.05
04/14/89	4	Buffalo Ck	<0.01	<0.1	0.020	0.028	0.054	25	21	<1	0.24	1	34	<0.1	--	0.32	0.05
05/16/89	4	Buffalo Ck	<0.01	0.6	0.027	0.004	0.032	19	16	<1	0.28	7	48	<0.1	--	<0.01	0.04
06/19/89	4	Buffalo Ck	0.04	<0.1	0.006	0.006	0.019	24	21	<1	0.24	<1	8	<0.1	--	<0.01	0.05

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N)	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Sus-pended Solids mg/l	Total Dis-solved solid mg/l	Settle-able Solids mg/l	Turbid-ity NTU	Boron mg/l	Fluoride mg/l
07/30/88	5	Moose Ck	0.01	0.1	<.002	0.002	--	31	32	<1	0.23	4	40	<0.1	1.2	0.04	0.05
08/31/88	5	Moose Ck	0.05	0.1	0.002	0.005	--	34	36	<1	0.22	3	42	<0.1	--	0.05	0.05
09/23/88	5	Moose Ck	<0.01	0.2	0.006	0.002	0.010	45	42	<1	0.47	3	82	<0.1	--	0.03	0.10
09/23/88	5	Moose Ck DUP	<0.01	0.1	0.006	0.003	0.012	45	41	<1	0.50	4	76	<0.1	--	0.04	0.09
10/21/88	5	Moose Ck	<0.01	<0.1	0.010	0.002	0.022	45	47	<1	0.37	<1	60	<0.1	--	0.06	0.03
10/21/88	5	Moose Ck DUP	<0.01	0.1	0.010	0.003	0.020	45	47	<1	0.37	1	62	<0.1	--	0.05	0.02
11/19/88	5	Moose Ck	0.36	0.5	<0.001	0.003	0.007	48	52	<1	0.32	4	96	<0.1	--	0.46	0.03
12/20/88	5	Moose Ck	0.15	0.7	0.003	0.008	0.008	47	53	<1	0.28	<1	68	<0.1	--	0.09	0.02
01/29/89	5	Moose Ck	0.05	<0.1	<0.001	<0.001	<0.001	48	55	<1	0.35	2	74	<0.1	--	0.35	0.08
02/24/89	5	Moose Ck	0.10	0.1	0.001	0.002	0.003	51	57	<1	0.36	1	90	<0.1	--	0.27	0.05
03/22/89	5	Moose Ck	0.02	<0.1	0.006	0.004	0.010	51	59	<1	0.34	1	90	<0.1	--	0.29	0.04
04/16/89	5	Moose Ck	<0.01	0.1	0.012	0.020	0.040	52	51	<1	0.59	2	74	<0.1	--	0.36	0.05
05/16/89	5	Moose Ck	<0.01	0.6	0.020	0.027	0.001	47	44	<1	0.51	1	88	<0.1	--	<0.01	0.04
06/19/89	5	Moose Ck	0.03	<0.1	0.006	0.005	0.020	26	27	<1	0.15	<1	40	<0.1	--	<0.01	0.04
07/30/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
08/31/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	1	38	<0.1	--	--	--
09/23/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	2	70	<0.1	--	--	--
10/22/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	1	58	<0.1	--	--	--
11/18/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	2	94	<0.1	--	--	--
12/20/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	<1	54	<0.1	--	--	--
01/29/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/25/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	2	84	<0.1	--	--	--
03/20/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	<1	90	<0.1	--	--	--
04/14/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	3	68	<0.1	--	--	--
05/12/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	8	86	<0.1	--	--	--
06/19/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	6	48	<0.1	--	--	--
07/30/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
08/31/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	2	42	<0.1	--	--	--
09/23/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	3	74	<0.1	--	--	--

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	Ammonia (As N) mg/l	Total Kjeldahl Nitrogen (as N)	Ortho Phos-phorus mg/l	Total Organic Phos-phorus mg/l	Total Phos-phorus mg/l	Total Alka-linity mg/l	Total Hard-ness mg/l	Total Acid-ity mg/l	Sodium Adsorb-tion Ratio	Total Sus-pended Solids mg/l	Total Dis-solved solid mg/l	Settle-able Solids mg/l	Turbid-ity NTU	Boron mg/l	Fluoride mg/l
10/22/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	2	66	<0.1	--	--	--
11/18/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	2	102	<0.1	--	--	--
12/20/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	<1	54	<0.1	--	--	--
01/29/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/25/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	4	52	<0.1	--	--	--
03/20/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	<1	70	<0.1	--	--	--
04/14/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	4	70	<0.1	--	--	--
05/12/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	7	90	<0.1	--	--	--
06/19/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	4	48	<0.1	--	--	--

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	HCO3 mg/l	CO3 mg/l	Cl mg/l	NO3 mg/l	NO2 mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Anions meq/l	Cations meq/l	Cation/ Anion Difference %	pH (lab)	Specific Conduct-ance(lab) uhmos
07/30/88	1	Moose Ck	29	0	1.4	0.12	<0.01	5.3	9.2	1.1	0.4	1.6	0.63	0.63	0.00	7.28	69
08/31/88	1	Moose Ck	32	0	1.8	0.18	<0.01	5.3	11.0	1.0	0.3	1.8	0.70	0.70	0.00	7.16	78
09/23/88	1	Moose Ck	38	0	2.1	0.21	<0.01	8.2	13.0	1.2	0.4	2.5	0.87	0.84	1.75	7.42	92
10/22/88	1	Moose Ck	44	0	3.2	0.26	<0.01	9.5	14.0	1.9	0.4	5.1	1.03	1.07	1.90	7.05	104
11/18/88	1	Moose Ck	39	0	3.2	0.31	<0.01	14.0	14.0	1.7	0.4	3.3	1.04	1.00	1.96	7.17	118
12/20/88	1	Moose Ck	45	0	5.0	0.94	<0.01	14.0	16.0	1.5	0.6	5.2	1.24	1.18	2.48	7.53	135
01/27/89	1	Moose Ck	40	0	6.0	0.65	<0.01	16.0	17.0	2.1	<0.2	4.4	1.21	1.20	0.41	7.31	120
02/24/89	1	Moose Ck	43	0	8.2	0.50	<0.01	14.0	8.1	7.3	0.7	6.1	1.28	1.29	0.39	7.33	130
03/22/89	1	Moose Ck	42	0	9.0	0.34	<0.01	17.0	18.0	1.5	0.3	5.6	1.32	1.29	1.15	7.51	129
04/15/89	1	Moose Ck	62	0	5.7	0.69	<0.01	18.0	15.0	2.3	1.4	15.0	1.61	1.60	0.31	7.81	155
05/16/89	1	Moose Ck	54	0	2.8	0.89	<0.01	12.0	15.0	1.1	0.7	9.0	1.28	1.25	1.19	7.68	110
06/19/89	1	Moose Ck	25	0	1.1	0.14	<0.01	6.0	4.1	3.6	0.1	1.3	0.57	0.56	0.88	6.72	57
07/30/88	2	Premier CK	61	0	1.0	0.37	<0.01	2.1	13.0	3.4	0.4	3.4	1.10	1.10	0.00	7.66	108
08/31/88	2	Premier CK	65	0	0.7	0.34	<0.01	0.8	15.0	2.8	0.3	3.3	1.13	1.15	0.88	7.57	114
09/23/88	2	Premier CK	52	0	0.4	0.53	<0.01	2.3	13.0	1.9	0.6	3.2	0.95	0.97	1.04	7.62	97
10/21/88	2	Premier CK	56	0	1.1	0.57	<0.01	0.8	14.0	2.6	0.3	3.2	1.01	1.04	1.46	7.10	92
11/18/88	2	Premier CK	63	0	0.4	0.49	<0.01	2.1	15.0	2.8	0.3	3.3	1.12	1.12	0.00	7.19	98
12/19/88	2	Premier CK	63	0	0.7	0.56	<0.01	0.8	15.0	3.0	0.3	2.6	1.11	1.13	0.89	7.68	103
01/27/89	2	Premier CK DUP	62	0	1.1	0.56	<0.01	1.4	16.0	2.6	<0.2	3.9	1.12	1.18	2.61	7.72	107
01/29/89	2	Premier CK	62	0	1.1	0.58	<0.01	1.2	17.0	2.1	<0.2	3.7	1.12	1.17	2.18	7.74	109
02/24/89	2	Premier CK	70	0	<1.0	0.60	<0.01	0.6	7.7	7.5	0.6	4.4	1.20	1.21	0.41	7.61	102
03/21/89	2	Premier CK	70	0	0.7	0.50	<0.01	1.2	15.7	3.2	0.7	3.5	1.23	1.22	0.41	7.68	105
03/21/89	2	Premier CK DUP	70	0	0.7	0.48	<0.01	2.1	15.1	3.6	0.4	3.4	1.24	1.21	1.22	7.67	108
04/14/89	2	Premier CK	49	0	0.7	0.91	<0.01	1.0	13.0	1.3	0.8	3.2	0.92	0.93	0.54	7.55	89
05/16/89	2	Premier CK	48	0	<1.0	0.93	<0.01	1.9	12.0	1.8	0.7	3.5	0.91	0.93	1.09	7.68	77
06/19/89	2	Premier CK	57	0	0.7	0.39	<0.01	1.2	6.9	6.4	0.2	2.9	1.02	1.00	0.99	7.16	106
07/30/88	3	Buffalo Ck	25	0	0.7	0.05	<0.01	0.8	1.1	3.3	0.4	2.8	0.45	0.45	0.00	7.07	51
07/30/88	3	Buffalo Ck DUP	26	0	1.1	0.05	<0.01	2.5	5.3	0.7	0.4	2.9	0.51	0.46	5.15	7.03	52
08/31/88	3	Buffalo Ck DUP	26	0	1.1	<0.01	<0.01	0.4	5.9	0.7	0.4	2.5	0.46	0.48	2.13	6.67	48
08/31/88	3	Buffalo Ck	26	0	1.4	<0.01	<0.01	0.6	5.2	1.1	0.4	2.5	0.47	0.47	0.00	6.64	49
09/23/88	3	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/21/88	3	Buffalo Ck	26	0	1.1	<0.01	<0.01	0.4	4.9	1.7	0.3	2.5	0.47	0.50	3.09	6.65	43
11/19/88	3	Buffalo Ck	28	0	0.7	0.03	<0.01	0.6	4.9	1.7	0.3	2.7	0.49	0.52	2.97	6.56	48
12/19/88	3	Buffalo Ck	29	0	1.1	0.04	<0.01	<0.1	1.6	3.8	0.2	1.4	0.51	0.46	5.15	7.17	50
12/19/88	3	Buffalo Ck DUP	28	0	0.7	0.05	<0.01	1.0	3.2	2.8	0.2	1.4	0.50	0.46	4.17	7.03	49

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	HCO3 mg/l	CO3 mg/l	Cl mg/l	NO3 mg/l	NO2 mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Anions meq/l	Cations meq/l	Cation/ Anion Difference %	pH (lab)	Specific Conduct-ance(lab) uhmos
01/27/89	3	Buffalo Ck	28	0	1.1	0.21	<0.01	0.6	5.7	1.5	<0.2	2.5	0.52	0.51	0.97	7.23	48
02/24/89	3	Buffalo Ck	27	0	0.7	0.12	<0.01	<1.0	3.1	2.3	0.3	2.7	0.49	0.47	2.08	6.67	53
02/24/89	3	Buffalo Ck DUP	27	0	0.7	0.09	<0.01	0.2	3.0	2.3	0.3	2.4	0.47	0.45	2.17	6.70	57
03/21/89	3	Buffalo Ck	27	0	1.4	0.06	<0.01	0.4	5.0	1.2	0.2	3.0	0.49	0.49	0.00	6.74	45
04/15/89	3	Buffalo Ck	27	0	2.1	0.10	<0.01	2.7	5.7	2.2	0.2	2.7	0.58	0.59	0.85	6.52	46
05/16/89	3	Buffalo Ck DUP	24	0	1.1	0.06	<0.01	1.0	5.4	0.5	0.4	2.4	0.44	0.42	2.33	7.07	40
05/16/89	3	Buffalo Ck	24	0	1.1	0.06	<0.01	1.4	4.6	1.0	0.4	2.5	0.45	0.43	2.27	7.09	41
06/19/89	3	Buffalo Ck	26	0	1.1	0.01	<0.01	2.1	2.4	3.3	0.2	2.4	0.50	0.50	0.00	6.62	46
06/19/89	3	Buffalo Ck DUP	26	0	0.7	<0.01	<0.01	1.2	2.3	3.0	0.2	2.3	0.48	0.48	0.00	6.67	44
07/30/88	4	Buffalo Ck	34	0	0.4	0.58	<0.01	1.0	7.2	1.2	0.5	3.1	0.62	0.60	1.64	7.33	64
08/31/88	4	Buffalo Ck	37	0	0.7	0.18	<0.01	0.4	7.4	1.8	0.4	3.0	0.65	0.66	0.76	7.02	67
09/23/88	4	Buffalo Ck	25	0	2.8	0.01	<0.01	0.8	5.3	1.3	0.6	2.6	0.51	0.50	0.99	7.15	56
10/21/88	4	Buffalo Ck	27	0	1.1	0.10	<0.01	<0.1	4.9	1.7	0.2	2.6	0.48	0.51	3.03	6.98	46
11/19/88	4	Buffalo Ck DUP	32	0	0.7	0.16	<0.01	1.2	6.0	2.1	0.2	2.9	0.59	0.61	1.67	6.65	48
11/19/88	4	Buffalo Ck	31	0	0.7	0.16	<0.01	1.2	6.1	1.8	0.2	2.8	0.57	0.59	1.72	6.69	50
12/19/88	4	Buffalo Ck	35	0	<1.0	0.21	<0.01	<0.1	7.3	1.5	<0.2	1.9	0.61	0.56	4.27	7.33	64
01/27/89	4	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	4	Buffalo Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/20/89	4	Buffalo Ck	36	0	0.7	0.29	<0.01	1.2	6.9	1.7	0.3	3.9	0.66	0.66	0.00	6.63	61
04/14/89	4	Buffalo Ck DUP	29	0	1.4	0.41	<0.01	0.0	7.1	0.7	1.5	2.4	0.55	0.56	0.90	6.89	59
04/14/89	4	Buffalo Ck	30	0	1.1	0.41	<0.01	0.4	7.5	0.5	1.5	2.5	0.56	0.57	0.88	6.89	58
05/16/89	4	Buffalo Ck	23	0	0.7	0.10	<0.01	0.8	4.6	1.1	0.4	2.5	0.43	0.44	1.15	7.21	43
06/19/89	4	Buffalo Ck	29	0	1.1	0.05	<0.01	1.9	3.0	3.3	0.1	2.6	0.54	0.53	0.93	6.65	53
07/30/88	5	Moose Ck	37	0	1.4	0.13	<0.01	6.0	11.0	1.3	0.5	3.1	0.78	0.79	0.64	7.43	86
08/31/88	5	Moose Ck	41	0	1.8	0.12	<0.01	7.0	12.0	1.5	0.8	3.0	0.89	0.87	1.14	7.09	93
09/23/88	5	Moose Ck	54	0	1.8	0.25	<0.01	9.5	14.0	1.8	0.5	7.0	1.16	1.14	0.87	7.59	116
09/23/88	5	Moose Ck DUP	54	0	2.5	0.24	<0.01	9.5	14.0	1.8	0.5	7.3	1.18	1.16	0.85	7.66	118
10/21/88	5	Moose Ck	55	0	2.5	0.31	<0.01	9.1	14.0	2.6	0.4	5.8	1.18	1.19	0.42	7.16	108
10/21/88	5	Moose Ck DUP	54	0	2.8	0.31	<0.01	8.6	14.0	2.7	0.4	5.8	1.17	1.19	0.85	7.14	109
11/19/88	5	Moose Ck	58	0	2.8	0.39	<0.01	12.0	16.0	2.9	0.4	5.3	1.30	1.29	0.39	7.02	107
12/20/88	5	Moose Ck	57	0	3.9	0.43	<0.01	11.0	17.0	2.7	0.5	4.5	1.30	1.26	1.56	7.62	118
01/29/89	5	Moose Ck	59	0	5.0	0.47	<0.01	13.0	18.0	2.8	0.8	6.0	1.41	1.39	0.71	7.58	121
02/24/89	5	Moose Ck	62	0	5.7	0.49	<0.01	12.0	8.7	8.8	0.6	6.2	1.47	1.44	1.03	7.60	150
03/22/89	5	Moose Ck	62	0	6.7	0.38	<0.01	13.0	19.0	2.9	0.5	6.0	1.51	1.45	2.03	7.72	135
04/15/89	5	Moose Ck	63	0	4.3	0.68	<0.01	13.0	15.0	3.2	0.9	9.7	1.47	1.47	0.00	7.67	144

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-2
ANALYTICAL RESULTS OF MONTHLY
SURFACE WATER SAMPLING

DATE	Sta. #	STREAM	HCO3 mg/l	CO3 mg/l	Cl mg/l	NO3 mg/l	NO2 mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Anions meq/l	Cations meq/l	Cation/ Anion Difference %	pH (lab)	Specific Conduct-ance(lab) uhmos
05/16/89	5	Moose Ck	57	0	2.8	0.78	<0.01	9.5	15.0	1.7	0.6	7.8	1.28	1.25	1.19	7.61	107
06/19/89	5	Moose Ck	31	0	0.7	0.15	<0.01	5.3	4.3	4.0	0.3	1.8	0.65	0.63	1.56	6.76	63
07/30/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
08/31/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
09/23/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/22/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/18/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12/20/88	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
01/29/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/22/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
04/14/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
05/16/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/19/89	6	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
07/30/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
08/31/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
09/23/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/22/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/18/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12/19/88	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
01/29/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
02/24/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
03/22/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
04/14/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
05/16/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/19/89	7	Moose Ck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

NOTE: "DUP" means Duplicate sample.
"--" means parameter not analyzed.

TABLE 3-3
SEDIMENT LOAD AND DISCHARGE VALUES

DATE	Sta. #	Est. Q (cfs)	TURBIDITY (NTU)	TSS (mg/l)	SS (mg/l)
31-Aug-88	1	142.8	1.20	1	<0.1
23-Sep-88	1	109.7	0.70	2	<0.1
21-Oct-88	1	44.5	0.65	<1	<0.1
18-Nov-88	1	18.7	0.58	2	<0.1
20-Dec-88	1	12.5	0.36	<1	<0.1
27-Jan-89	1	* 11.1	0.20	<1	<0.1
24-Feb-89	1	* 10.0	1.10	<1	<0.1
22-Mar-89	1	9.0	0.50	<1	<0.1
15-Apr-89	1	34.0	8.30	6	<0.1
16-May-89	1	27.0	2.60	2	<0.1
19-Jun-89	1	379.4	2.30	<1	<0.1
17-Jul-89	1	221.8	3.50	NA	NA
31-Aug-88	4	2.7	0.47	2	<0.1
23-Sep-88	4	7.3	2.70	7	<0.1
21-Oct-88	4	2.9	0.58	<1	<0.1
20-Nov-88	4	NM	0.50	9	<0.1
19-Dec-88	4	NM	0.65	<1	<0.1
27-Jan-89	4	NM	NM	NM	NM
24-Feb-89	4	NM	NM	NM	NM
22-Mar-89	4	NM	0.50	1	<0.1
15-Apr-89	4	NM	4.00	1	<0.1
16-May-89	4	7.1	2.40	7	<0.1
19-Jun-89	4	3.8	0.40	<1	<0.1
17-Jul-89	4	2.6	1.40	NA	NA
31-Aug-88	5	172.7	0.75	3	<0.1
23-Sep-88	5	178.3	5.00	3	<0.1
21-Oct-88	5	83.3	0.65	1	<0.1
19-Nov-88	5	* 36.0	0.30	4	<0.1
20-Dec-88	5	* 28.1	0.24	<1	<0.1
27-Jan-89	5	* 26.3	0.23	2	<0.1
24-Feb-89	5	* 24.9	0.50	1	<0.1
22-Mar-89	5	16.0	0.50	1	<0.1
15-Apr-89	5	44.0	4.50	2	<0.1
16-May-89	5	80.0	2.70	1	<0.1
19-Jun-89	5	355.9	3.80	<1	<0.1
17-Jul-89	5	185.8	3.40	NA	NA

TSS = TOTAL SUSPENDED SOLIDS
SS = SETTLEABLE SOLIDS
NM = STATION NOT MEASURED DUE TO ICING
* = FLOW ESTIMATED DUE TO ICING
NA = DATA NOT YET AVAILABLE

TABLE 3-4

STAGE-DISCHARGE RELATIONSHIPS
STATIONS 1 AND 5: MOOSE CREEK

Station 1: Moose Creek

Date	Measured Stage (Y)	Measured Discharge (Q)
05-09-89	1.21	32.9
09-16-88	1.39	64.2
09-30-88	1.41	64.0
09-23-88	1.52	86.6
08-20-88	1.58	152.0
08-30-88	1.64	157.0
07-24-89	2.15	471.9

Log/Log Linear Regression Curve Fit of Data Calibrated Q vs Y

$Q = aY^b$

Where: $a = 13.64$
$b = 4.74$
$r^2 = 0.997$

Station 5: Moose Creek
Fall/Winter 1988

Date	Measured Stage (Y)	Measured Discharge (Q)
09-16-88	2.29	89.5
09-30-88	2.45	109.9
08-20-88	2.53	151.0
07-10-88	2.56	133.1
08-30-88	2.66	180.0
09-23-88	2.66	185.8

Log/Log Linear Regression Curve Fit of Data Calibrated Q vs Y

$Q = aY^b$

Where: $a = 1.524$
$b = 4.864$
$r^2 = 0.932$

Station 5: Moose Creek
Spring 1989

Date	Measured Stage (Y)	Measured Discharge (Q)
04-15-89	2.30	44.0
05-09-89	2.71	70.0
07-02-89	3.43	158.9
07-24-89	4.45	550.7 (SB)

Log/Log Linear Regression Curve Fit of Data Calibrated Q vs Y

$Q = aY^b$

Where: $a = 1.635$
$b = 3.829$
$r^2 = 0.988$

TABLE 3-5

COMPARISON OF SITE BRIDGE AND STATION 5
STAGE-DISCHARGE RELATIONSHIPS

STATION 5			SITE BRIDGE		
Date	Stage (Y)	Discharge (Q)	Date	Stage (Y)	Discharge (Q)
04-15-89	2.30	44.0	04-24-89	1.48	47.3
05-09-89	2.71	70.0	05-04-89	1.65	81.1
07-02-89	3.43	158.9	07-02-89	2.00	183.6
			07-24-89	2.80	550.7

Log/Log Linear Regression

$$Q = aY^b$$

Where: $a = 1.635$
$b = 3.829$
$r^2 = 0.988$

Log/Log Linear Regression

$$Q = aY^b$$

Where: $a = 11.663$
$b = 3.804$
$r^2 = 0.992$

TABLE 4-1

SUMMARY OF WATERSHED CHARACTERISTICS

Characteristic	Moose Creek	Matanuska River	Little Susitna River
Drainage Area (sq. mi.)	49.6	2070	61.9
Avg. Elev. (ft. MSL)	3500 est.	4000	3700
Basin Relief (feet)	6450 est.	10000+	6000 est.
Stream Length (miles)	18	77	14.9
Average Slope (ft. / mile)	200	79.7	187
% Forested	NA	14	16
% Glaciated	NA	12	5

NOTE: NA indicates data not available from cited references.

SOURCE: USGS, 1980

TABLE 4-2

SUMMARY OF CHEMICAL ANALYSIS
OF SURFACE WATER IN AND NEAR PROPOSED PERMIT AREA

	UNITS	MINIMUM CONCENTRATION MEASURED	MAXIMUM CONCENTRATION MEASURED	MEAN CONCENTRATION
pH (lab)	Stand. units	6.56	7.74	7.23
pH (field)	Stand. units	5.60	7.93	6.72
Specific Conductance (Lab)	µmhos	43	150	87
Specific Conductance (field)	µmhos	40	241	105
Temperature	°C	0.0	15.0	4.3
Dissolved Oxygen	mg/l	6.30	14.80	12.06
Turbidity (lab)	NTU	0.6	17.0	6.4
Turbidity (field)	NTU	0.20	20.00	2.39
Alkalinity (lab)	mg/l	19	58	35
Alkalinity (field)	mg/l	11.0	113.0	37.5
Aluminum	mg/l	<0.1	0.2	0.1
Arsenic	mg/l	<0.005	<0.005	N/A
Barium	mg/l	<0.5	<0.5	N/A
Cadmium	mg/l	<0.002	0.002	0.002
Copper	mg/l	<0.01	0.02	0.02
Lead	mg/l	<0.02	0.09	0.06
Mercury	mg/l	<0.001	<0.001	N/A
Selenium	mg/l	<0.005	<0.005	N/A
Zinc	mg/l	<0.01	0.07	0.02
Total Chromium	mg/l	<0.02	<0.02	N/A
Dissolved Chromium	mg/l	<0.02	<0.02	N/A
Total Iron	mg/l	<0.05	2.43	0.30
Dissolved Iron	mg/l	<0.05	0.24	0.09
Total Manganese	mg/l	<0.02	0.80	0.15
Dissolved Manganese	mg/l	<0.02	0.03	0.03
Ammonia as N	mg/l	<0.01	0.56	0.09
Total Kjeldahl Nitrogen As N	mg/l	<0.1	1.60	0.30
Ortho Phosphorus	mg/l	<0.001	0.027	0.007
Total Organic Phosphorus	mg/l	<0.001	0.083	0.011
Total Phosphorus	mg/l	<0.001	0.084	0.021
Total Hardness	mg/l	15	59	34
Total Acidity	mg/l	<1	<1	N/A
Sodium Adsorbtion Ratio	N/A	0.12	0.96	0.28
Total Suspended Solids	mg/l	<1	48	6.0
Total Dissolved solid	mg/l	8	102	54
Settleable Solids	mg/l	<0.1	0.2	0.2
Boron	mg/l	<0.01	0.46	0.18
Fluoride	mg/l	0.02	0.10	0.05
Bicarbonate HCO3	mg/l	23	70	42
Carbonate CO3	mg/l	0	0	0
Chloride	mg/l	<1.0	9.0	2.0
Nitrate NO3	mg/l	<0.01	0.94	0.33
Nitrite NO2	mg/l	<0.01	<0.01	N/A
Sulfate SO4	mg/l	<0.1	18.0	5.0
Calcium	mg/l	1.1	19.0	9.8
Magnesium	mg/l	0.5	8.8	2.4
Potasium	mg/l	<0.2	1.5	0.5
Sodium	mg/l	1.3	15	3.8
Anions	meq/l	0.43	1.61	0.87
Cations	meq/l	0.42	1.60	0.86
Cation/Anion Difference	%	0.00	5.15	1.31

Note: Mean concentrations based on values above detection limit.
NA = Not applicable

TABLE 4-3

COMPARISON OF FEDERAL DRINKING WATER QUALITY STANDARDS

AND SURFACE WATER QUALITY IN THE MOOSE CREEK WATERSHED

Parameter	Maximum Allowable Concentration[1] (mg/l)	Maximum Measured Concentration In Surface Water (mg/l)
Primary Standards		
Nitrate as N	10.000	0.94
Ba	1.000	<0.5
As	0.050	<0.005
Cr	0.050	<0.02
Pb*	0.050	0.090
Ag	0.050	NM
Cd	0.010	0.002
Se	0.010	<0.005
Hg	0.002	<0.001
Fluoride	4.000	0.10
Secondary Standards		
Cu*	1.00	0.02
Fluoride	2.00	0.10
Fe	0.30	0.24
Mn	0.05	0.03
Zn	5.00	0.07
TDS	500	102
Chloride	250	9.0
Sulfate	250	18.0
Color	15 units	<1 unit
Turbidity	5 NTU	17.00 NTU
Odor-Thres.	3 units	NM
Corrosivity	"Rel. Low"	NM

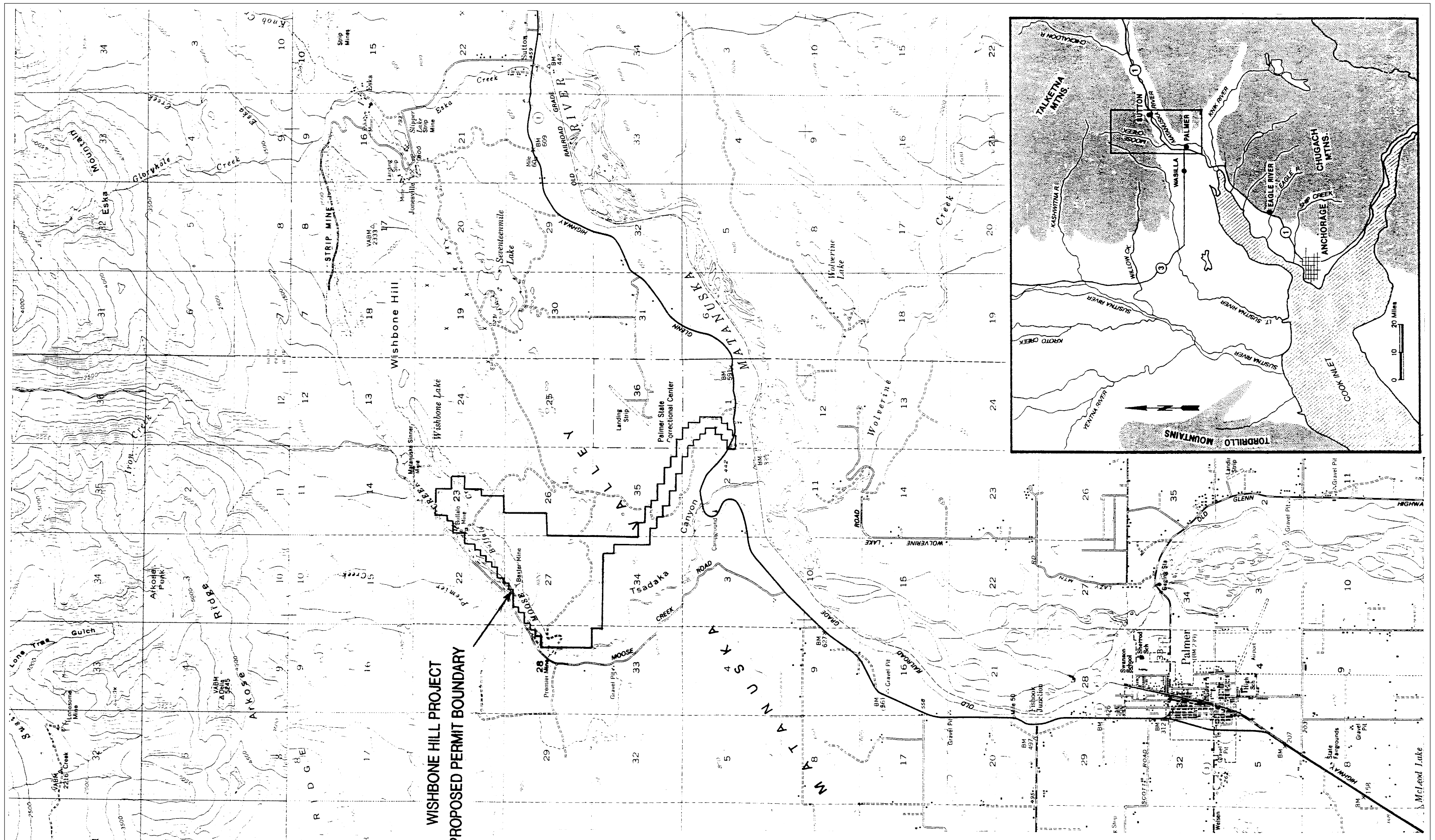
Notes: <indicates measured values below detectable limit.

*indicates standard is currently under review.

NM indicates parameter not measured.

[1]Source: Alaska Water Quality Standards 18AAC.70

FIGURES



SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

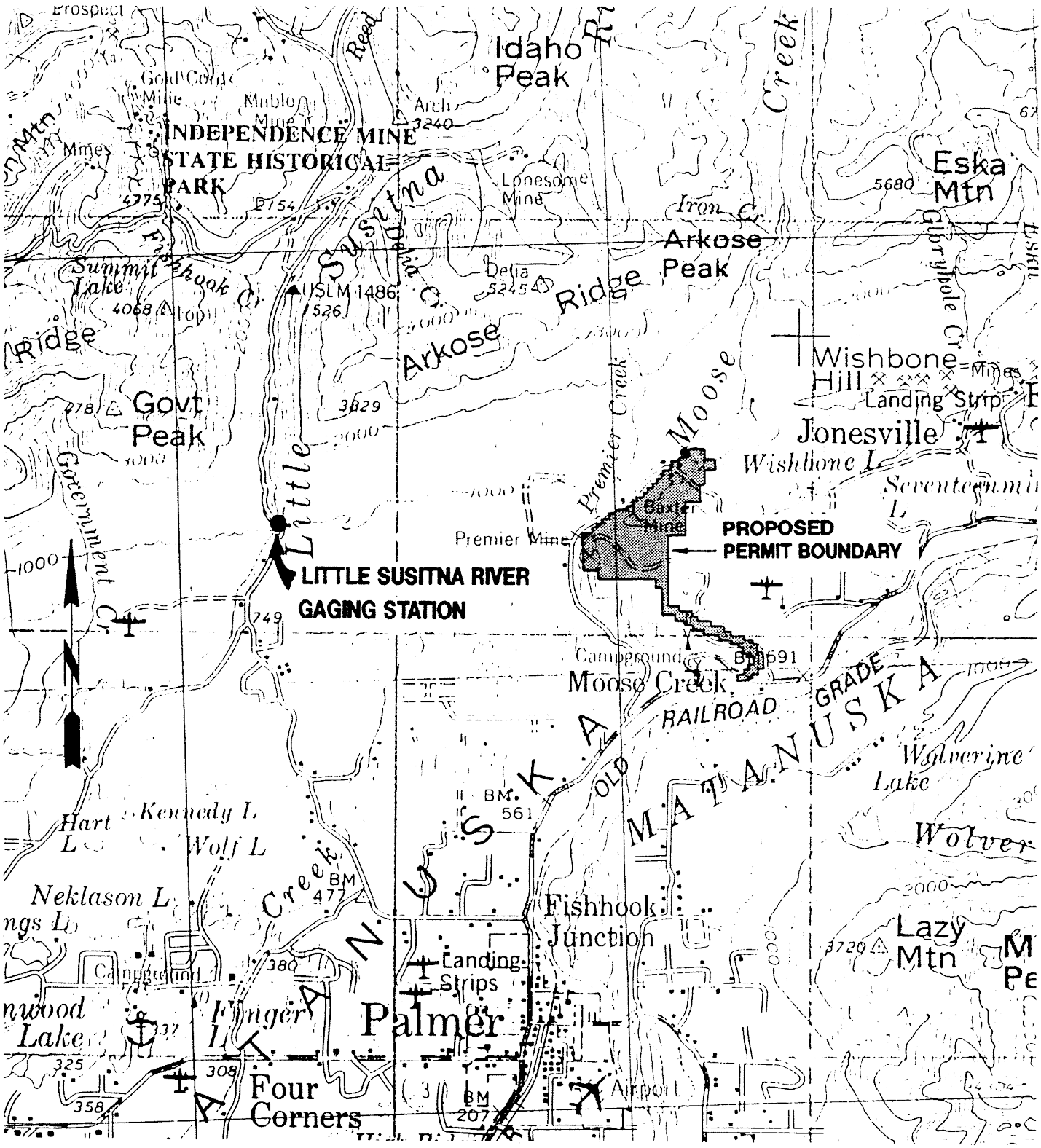
SITE LOCATION

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

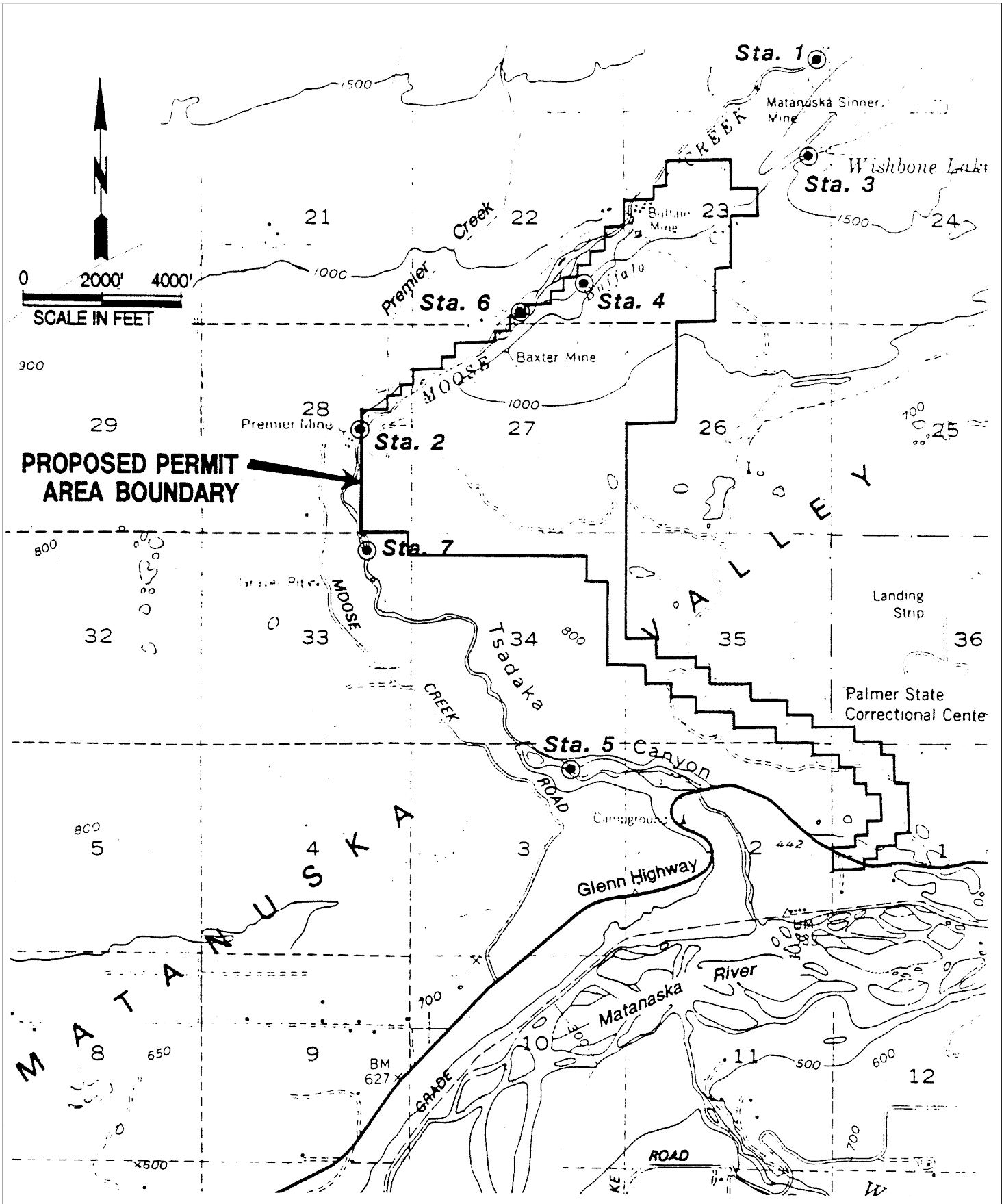
FIGURE No. 1-1

SCALE: 1" = 1 MILE

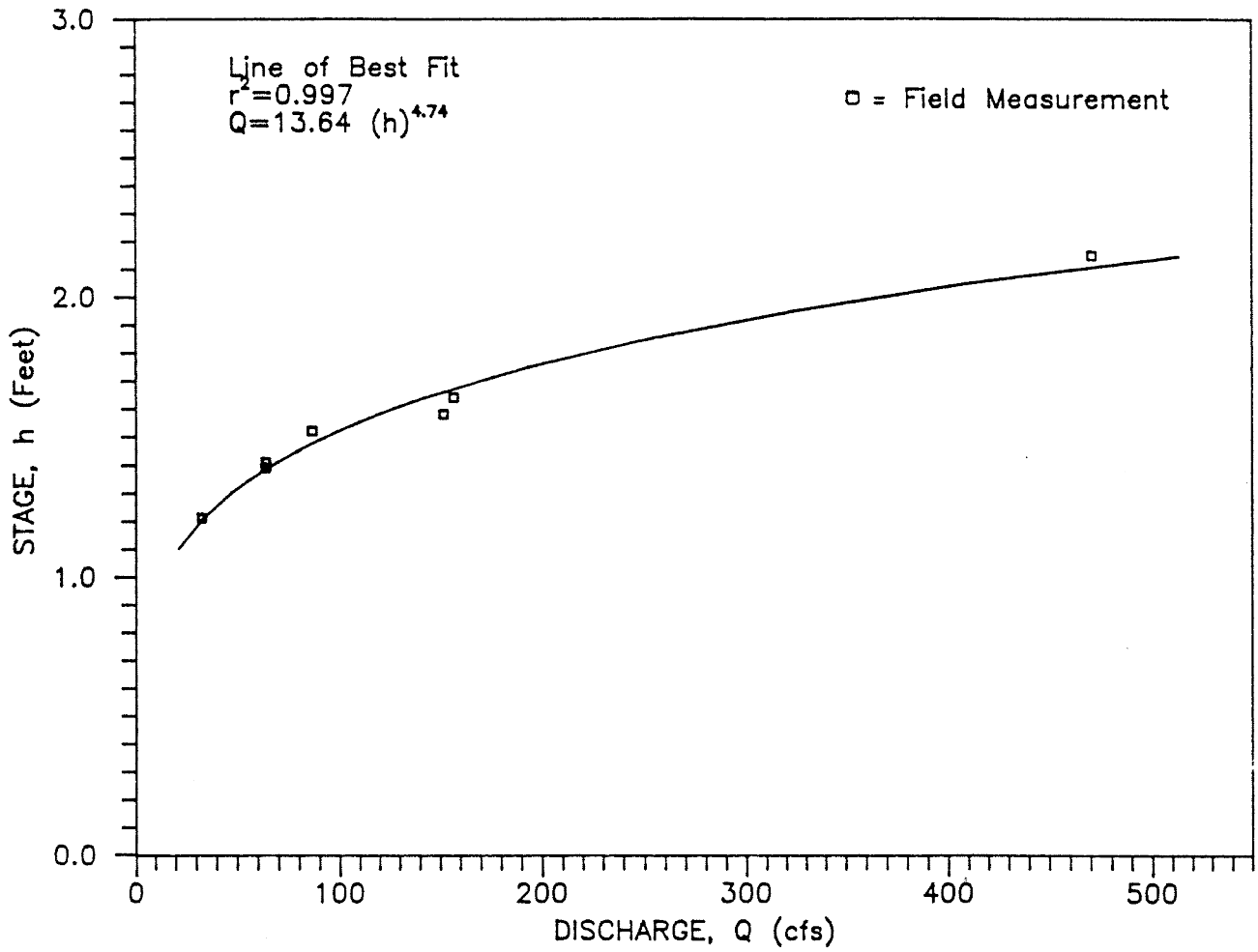
REV. 1



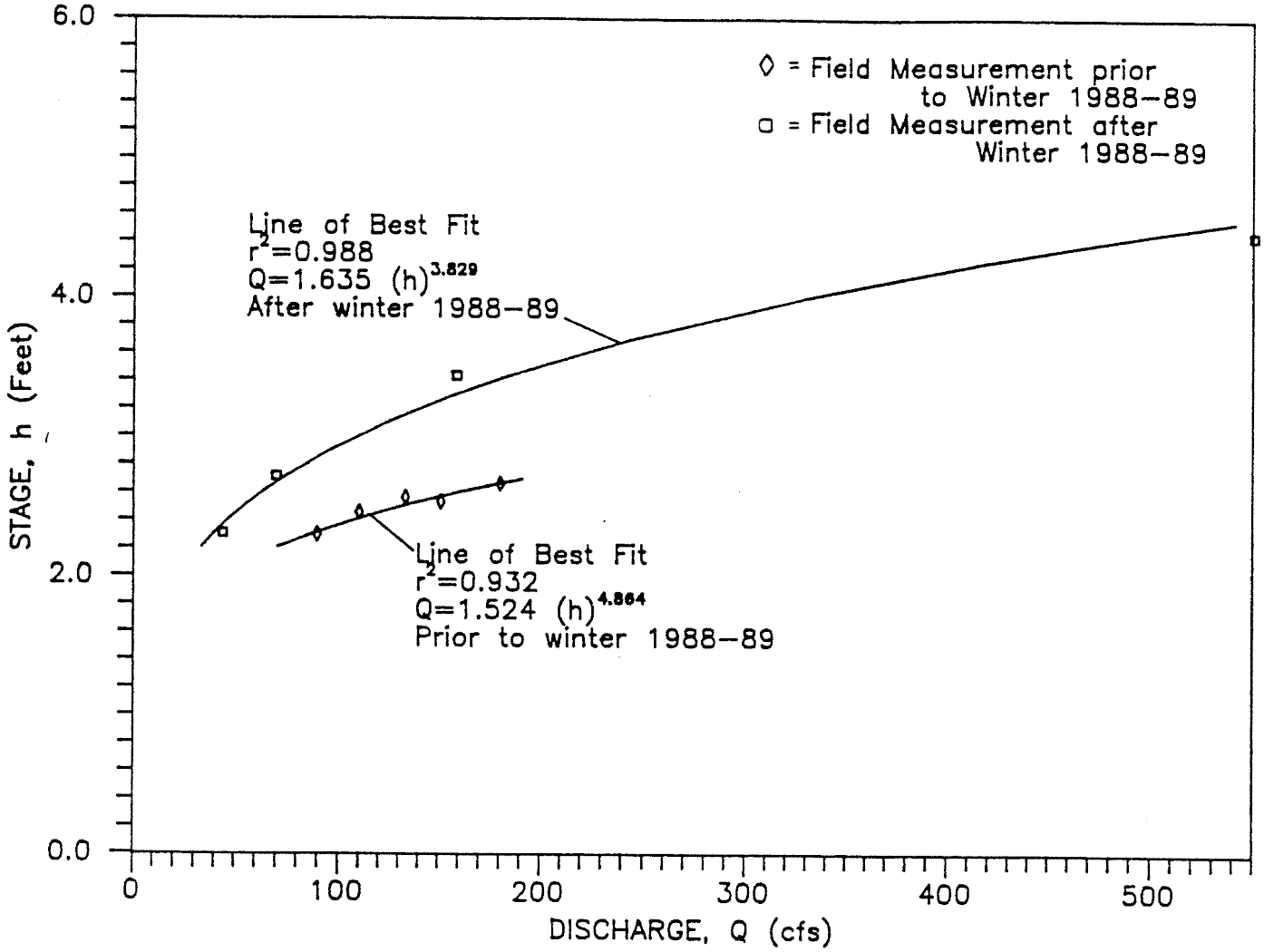
DESIGN BY:	LOCATION OF LITTLE SUSITNA RIVER GAGING STATION	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 2-1	REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN	



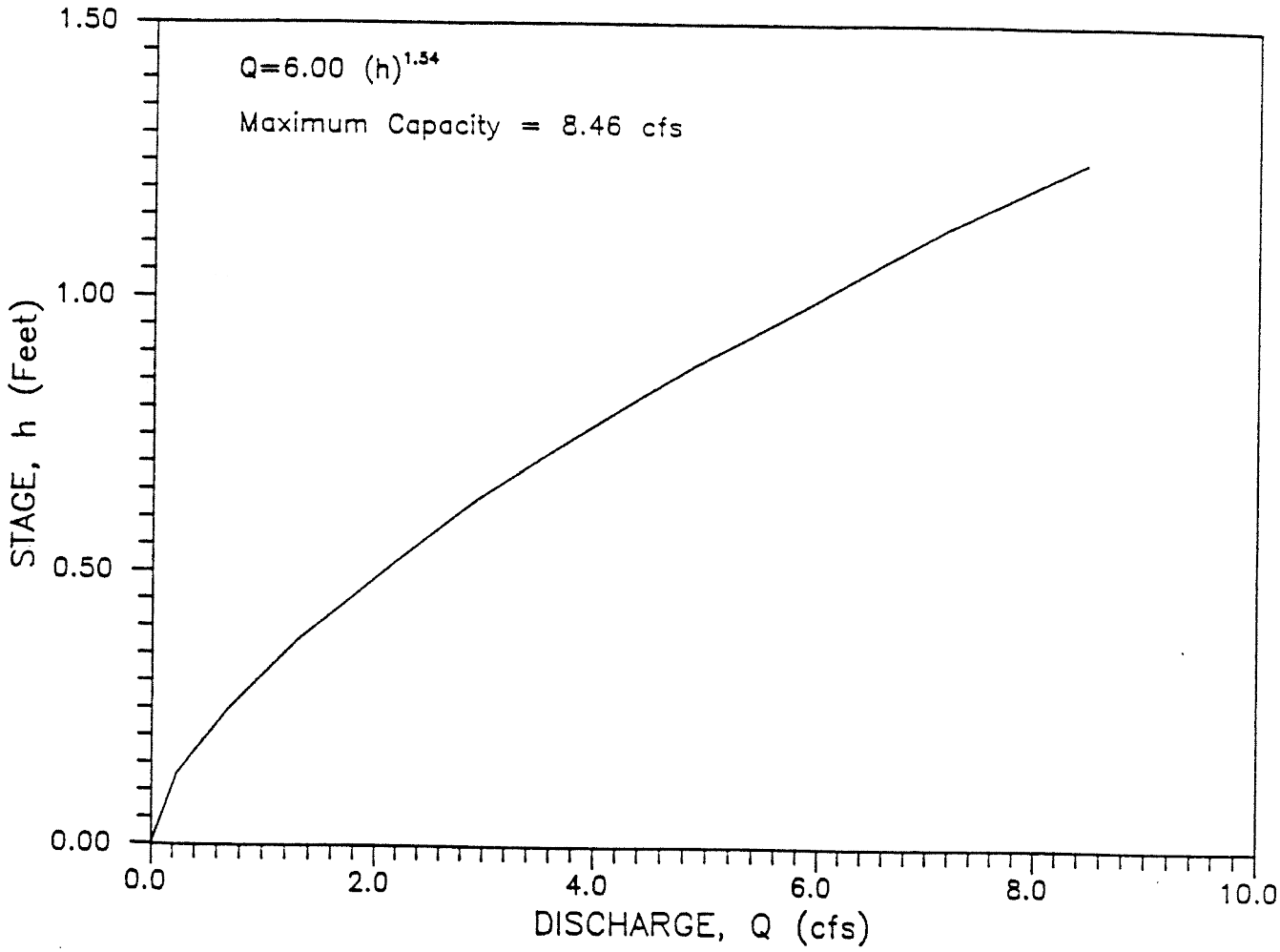
DESIGN BY:	LOCATION OF SURFACE WATER MONITORING STATIONS	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-1	REV. 0
DATE DRAWN: 8/89		SCALE: AS SHOWN	



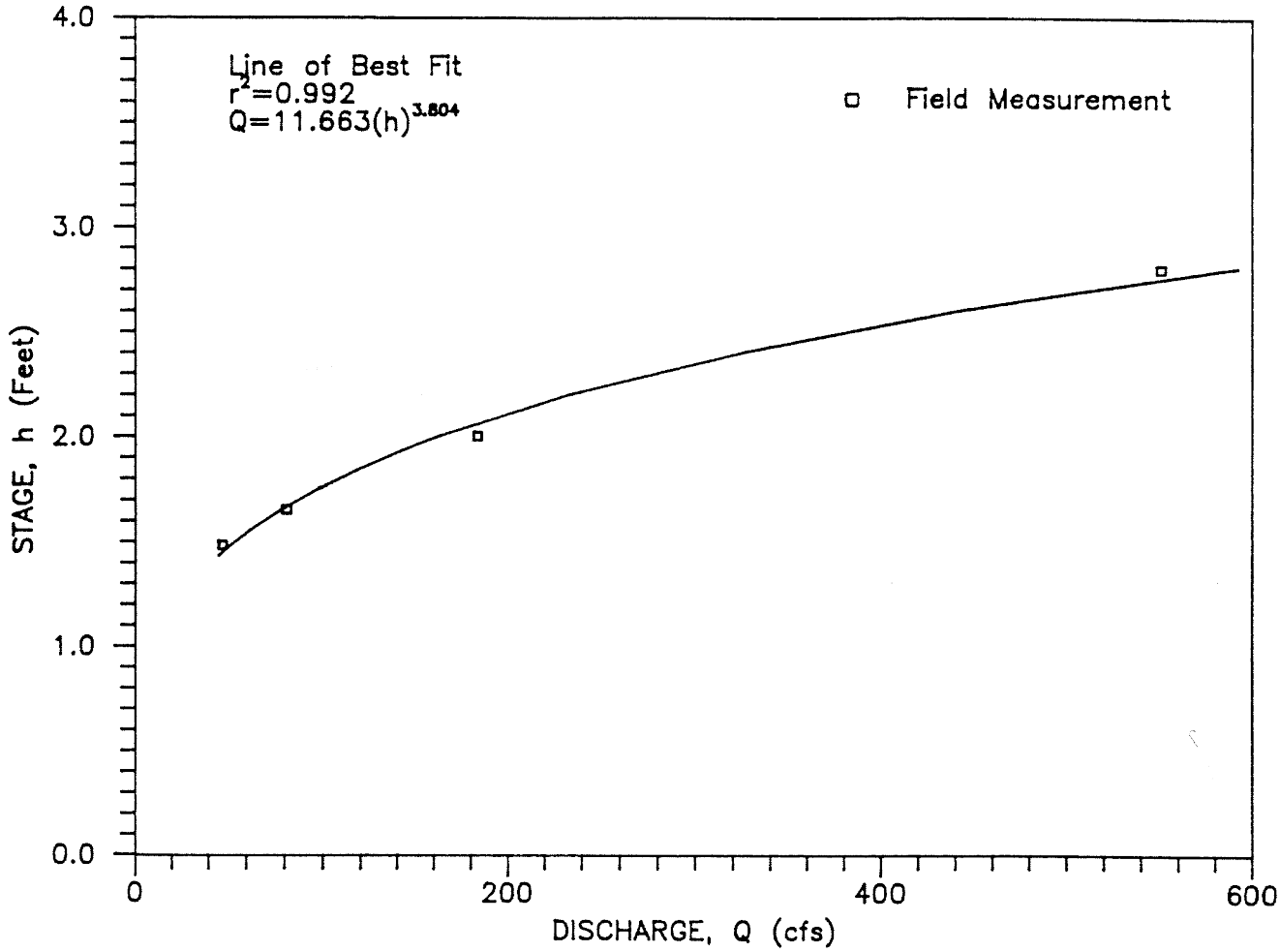
DESIGN BY:	MOOSE CREEK STATION #1 (UPSTREAM) STAGE–DISCHARGE RELATIONSHIP	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-2	REV. 0
DATE DRAWN: 8/89		SCALE:	



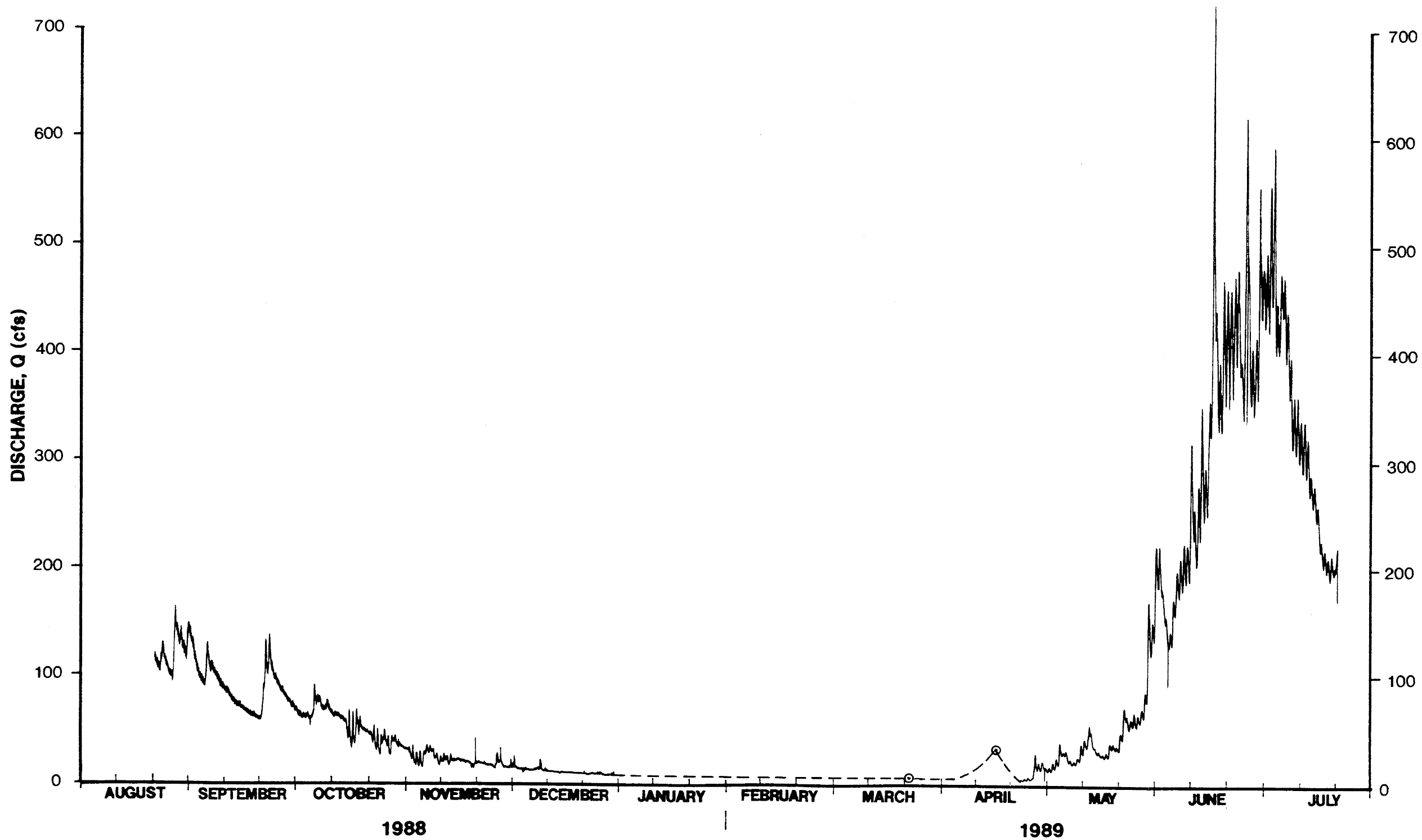
DESIGN BY:	MOOSE CREEK STATION #5 (DOWNSTREAM) STAGE–DISCHARGE RELATIONSHIP	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-3	REV. 0
DATE DRAWN: 8/89		SCALE:	



DESIGN BY:	BUFFALO CREEK STATION #4 (FLUME) STAGE–DISCHARGE RELATIONSHIP	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-4	REV. 0
DATE DRAWN: 5/89		SCALE:	



DESIGN BY:	MOOSE CREEK SITE BRIDGE STATION STAGE–DISCHARGE RELATIONSHIP	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-5 — REV. 0
DATE DRAWN: 8/89		SCALE:



EXPLANATION

- - - - - ESTIMATED FLOWS, CONTINUOUS RECORDER NOT FUNCTIONING IN WATER, ICE BUILDUP OCCURED IN STREAM

⊙ FLOWS MEASURED BY STREAM GAGING

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

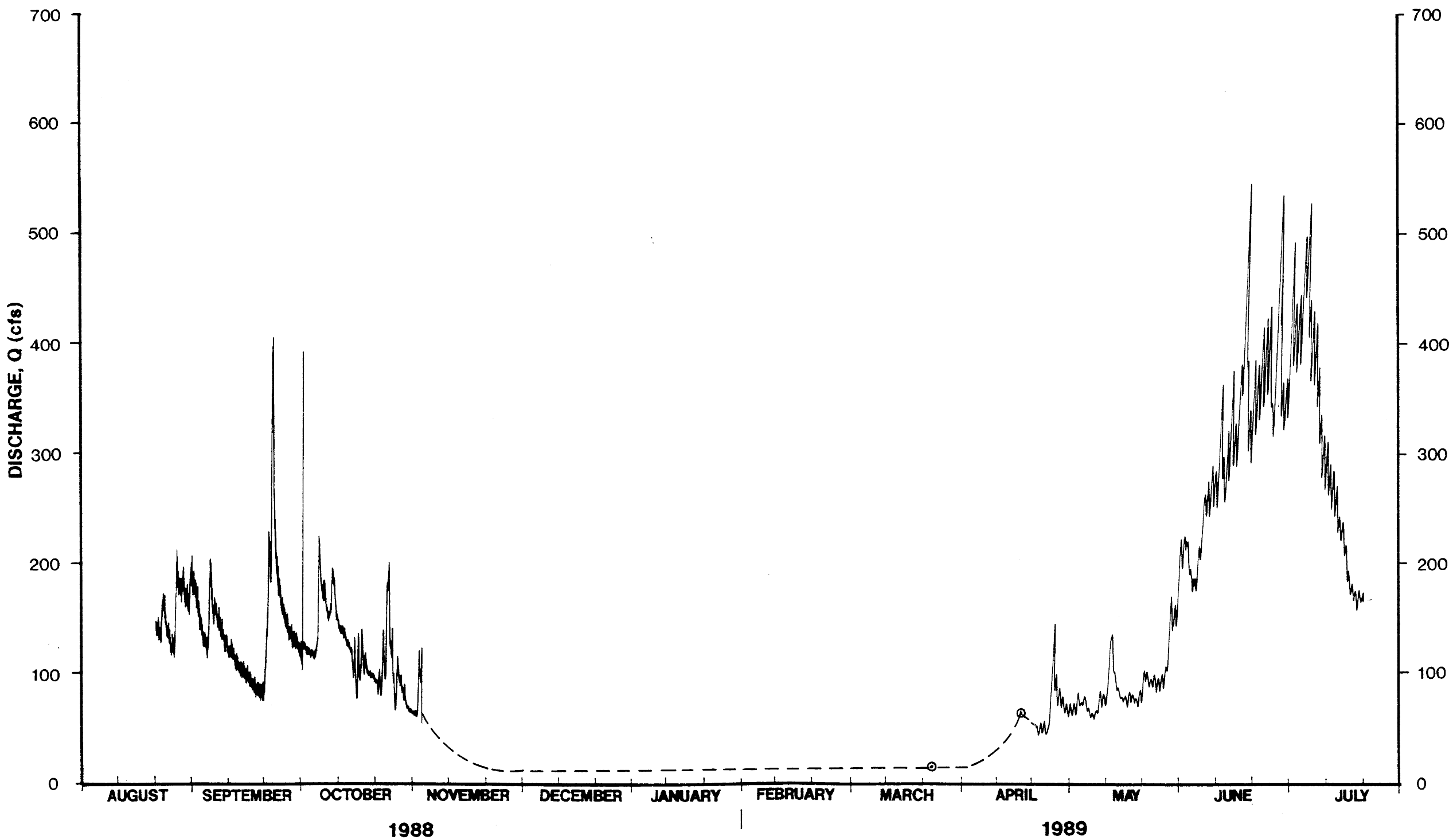
DISCHARGE HYDROGRAPH
MOOSE CREEK STATION No. 1

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 3-6

SCALE: N/A

REV. 1



EXPLANATION

- - - - ESTIMATED FLOW, CONTINUOUS RECORDER NOT FUNCTIONING IN WATER,ICE BUILDUP OCCURED IN STREAM

⊙ FLOW MEASURED BY STREAM GAGING

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

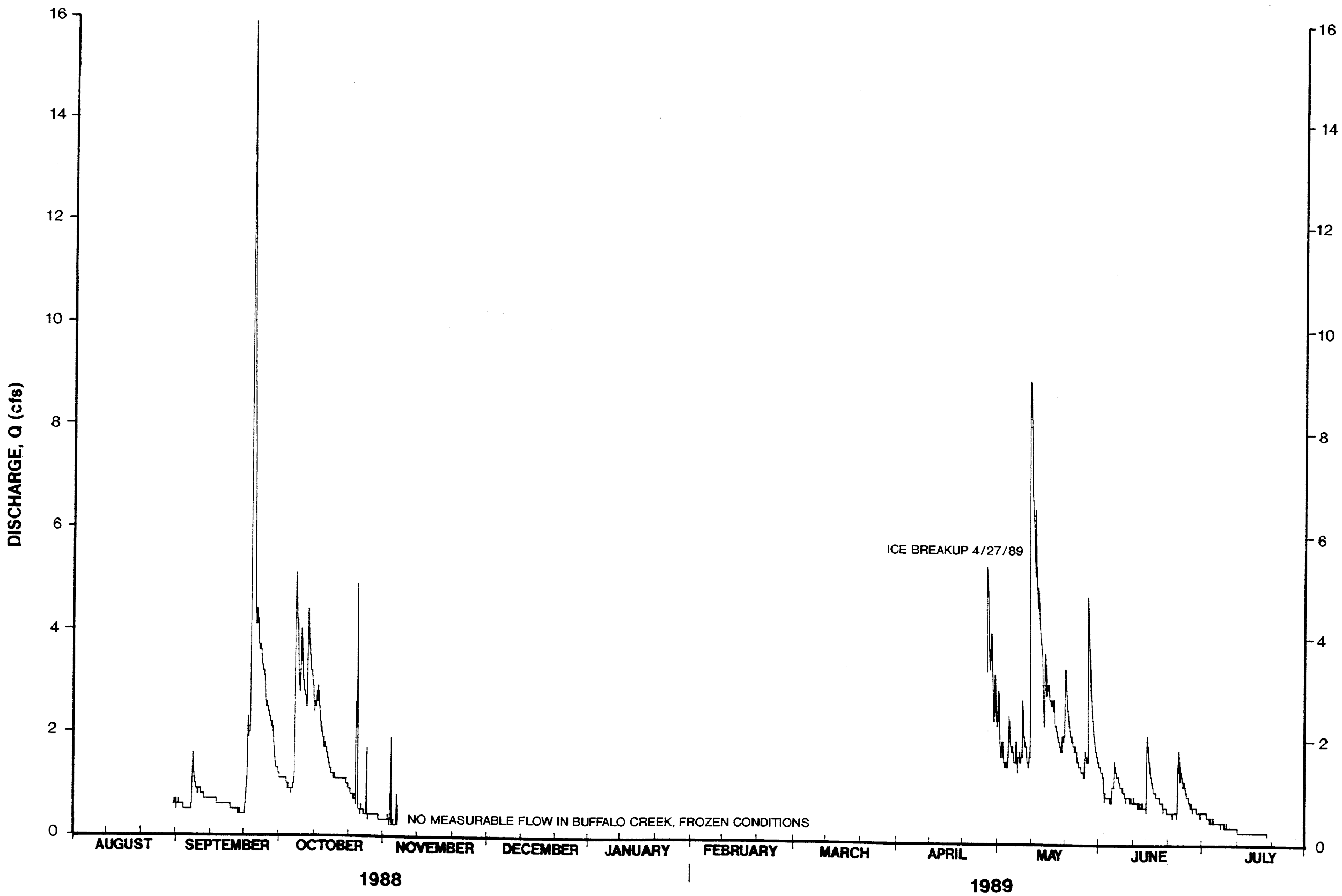
DISCHARGE HYDROGRAPH
MOOSE CREEK STATION No. 5

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 3-7

SCALE: N/A

REV. 1



SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

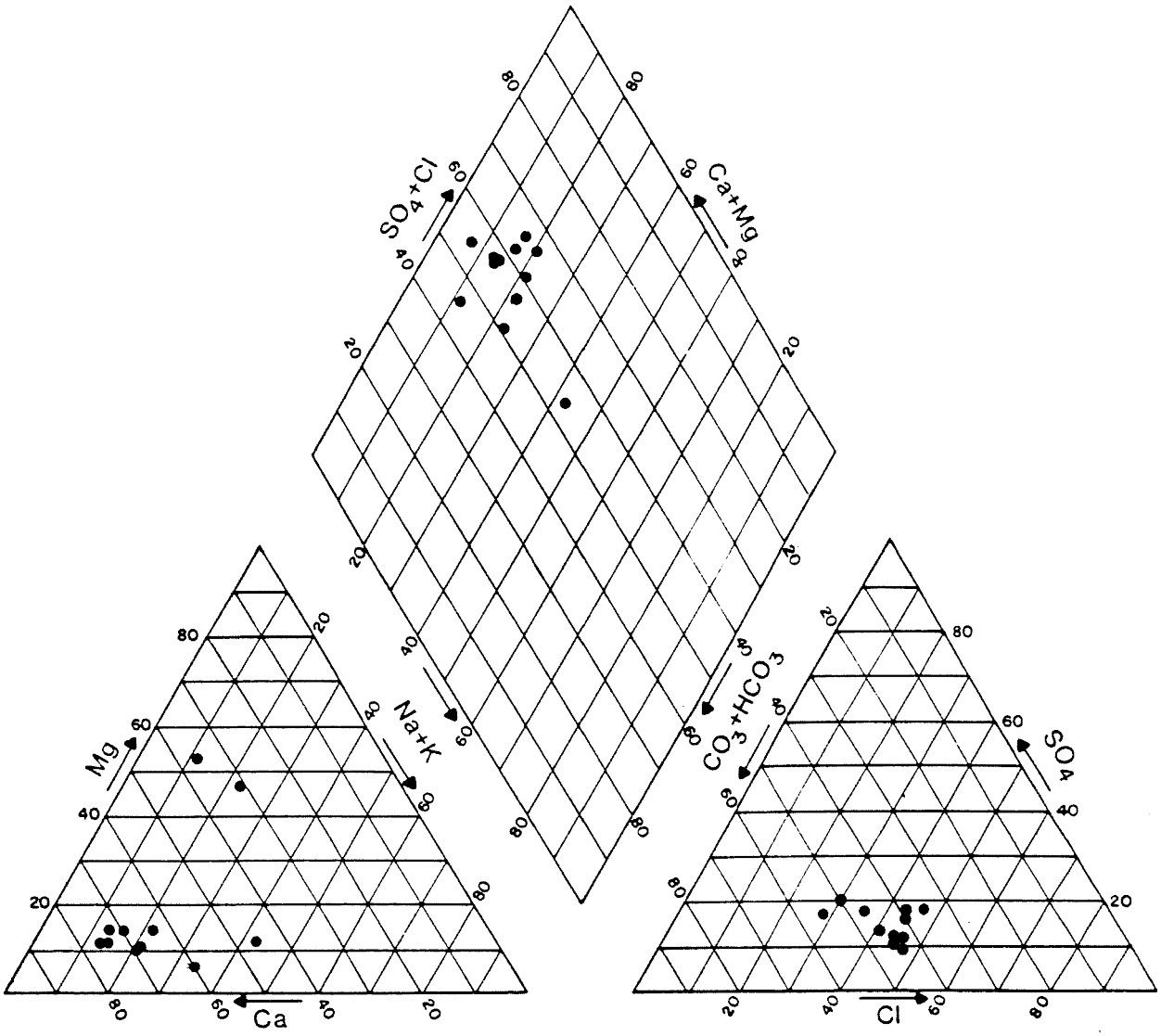
DISCHARGE HYDROGRAPH
BUFFALO CREEK No. 4

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

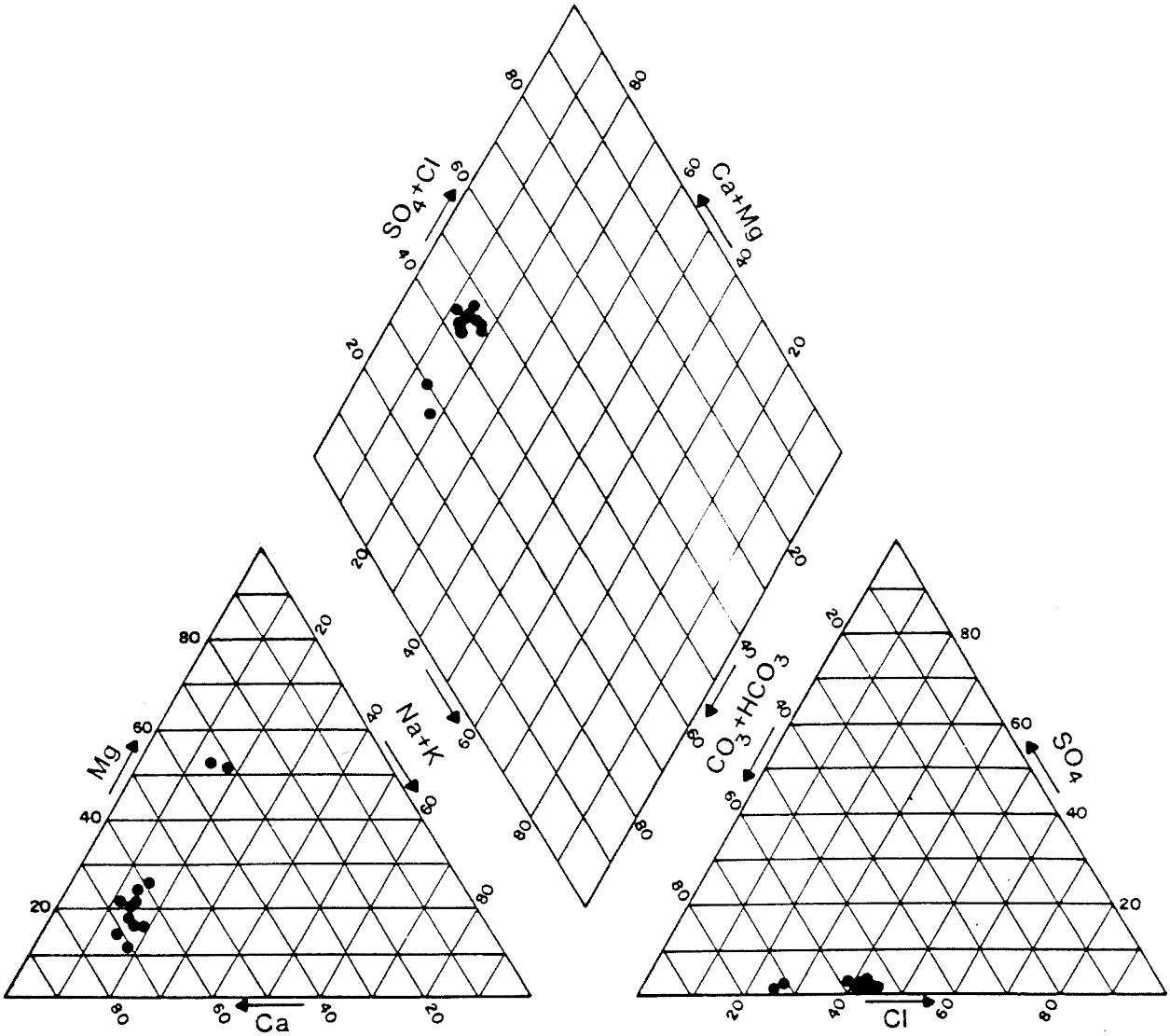
FIGURE No. 3-8

SCALE: N/A

REV. 1

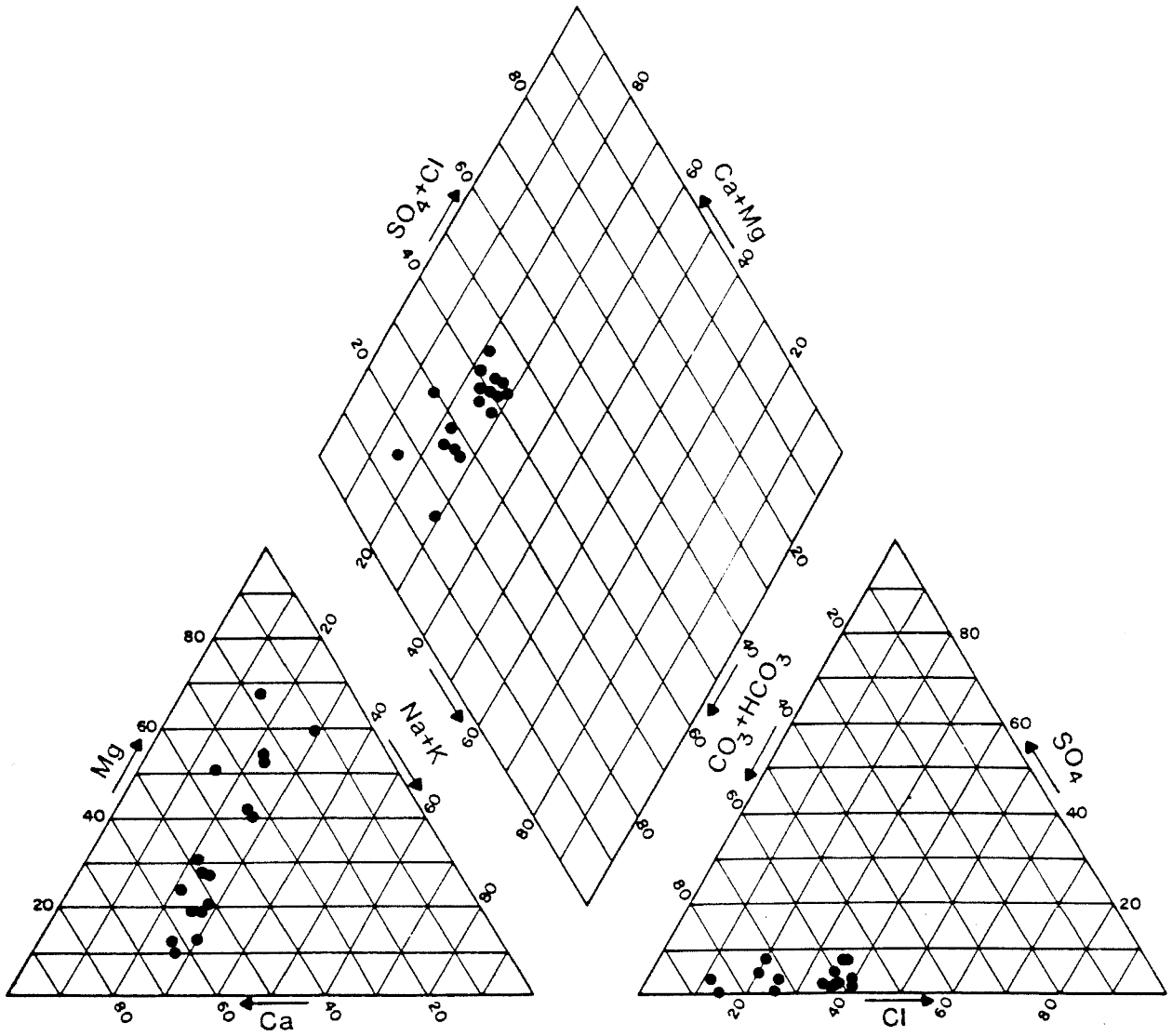


DESIGN BY:	TRILINEAR DIAGRAM OF SURFACE WATER ANALYSES FOR STATION #1 MOOSE CREEK, JULY 1988 – JUNE 1989	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-9	REV. 0
DATE DRAWN: 8/89		SCALE:	



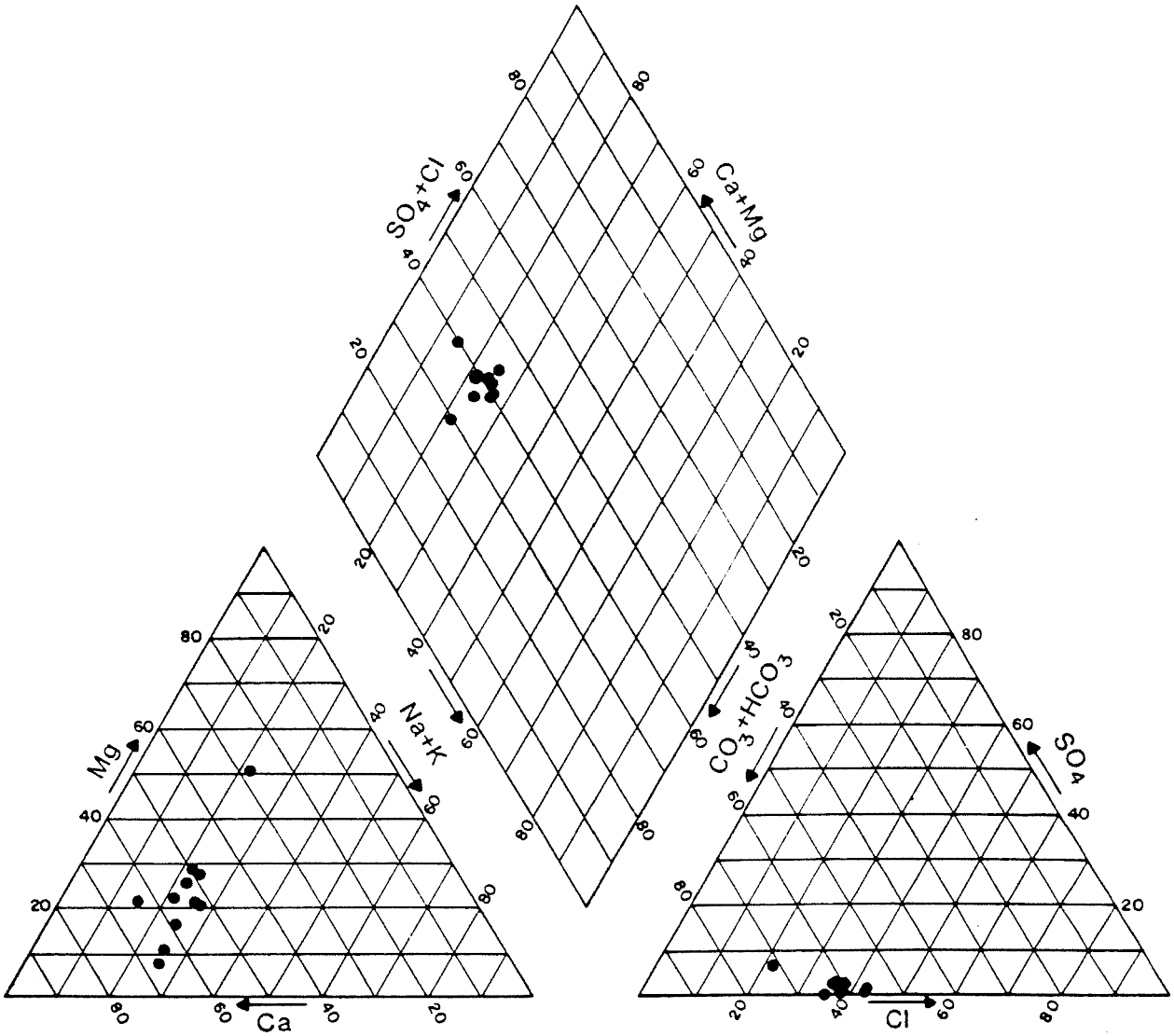
PERCENTAGE REACTING VALUES

DESIGN BY:	TRILINEAR DIAGRAM OF SURFACE WATER ANALYSES FOR STATION #1 MOOSE CREEK, JULY 1988 – JUNE 1989	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-10	REV. 0
DATE DRAWN: 8/89		SCALE:	



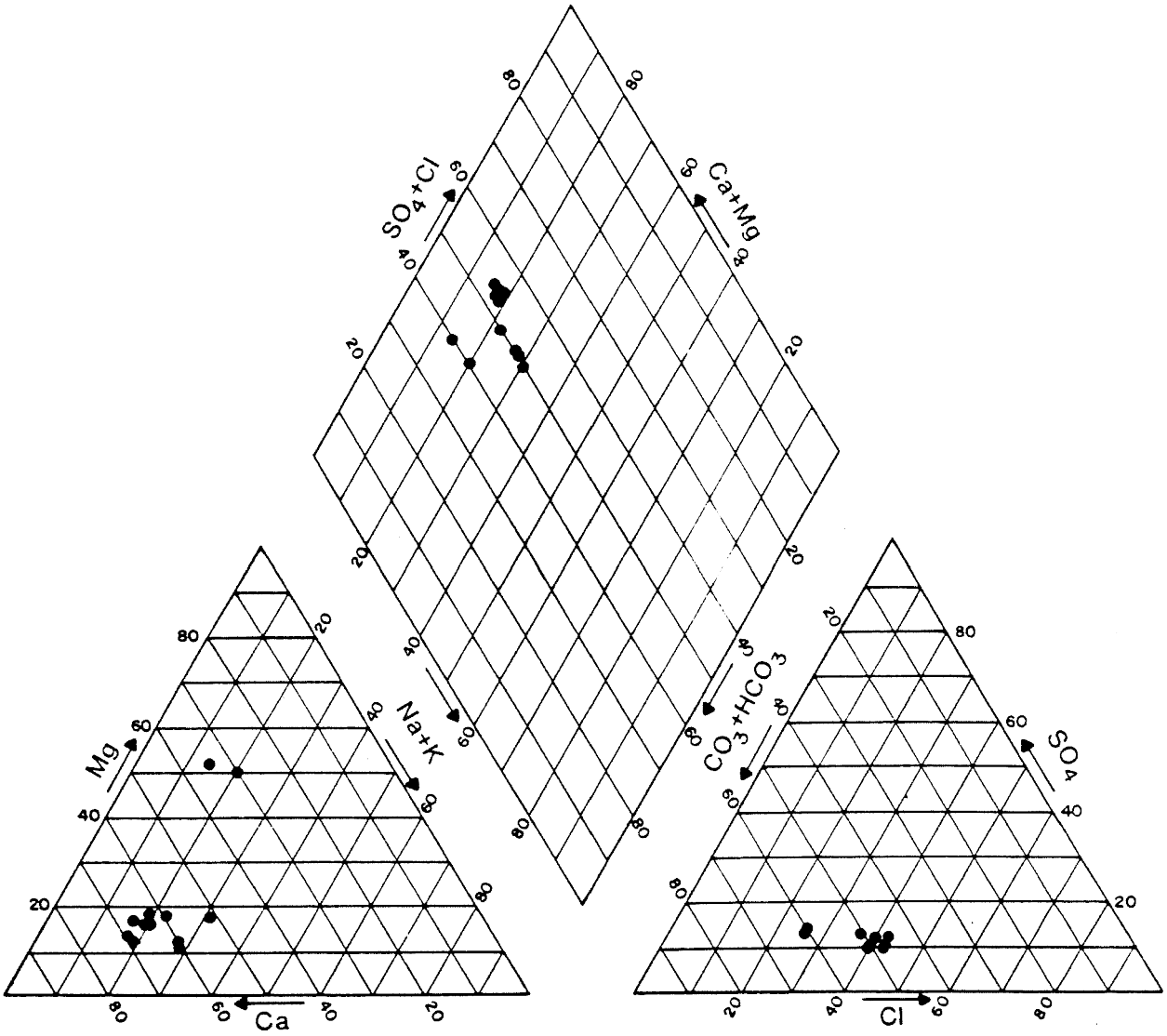
PERCENTAGE REACTING VALUES

DESIGN BY:	TRILINEAR DIAGRAM OF SURFACE WATER ANALYSES FOR STATION #3 BUFFALO CREEK, JULY 1988 – JUNE 1989	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-11	REV. 0
DATE DRAWN: 8/89		SCALE:	

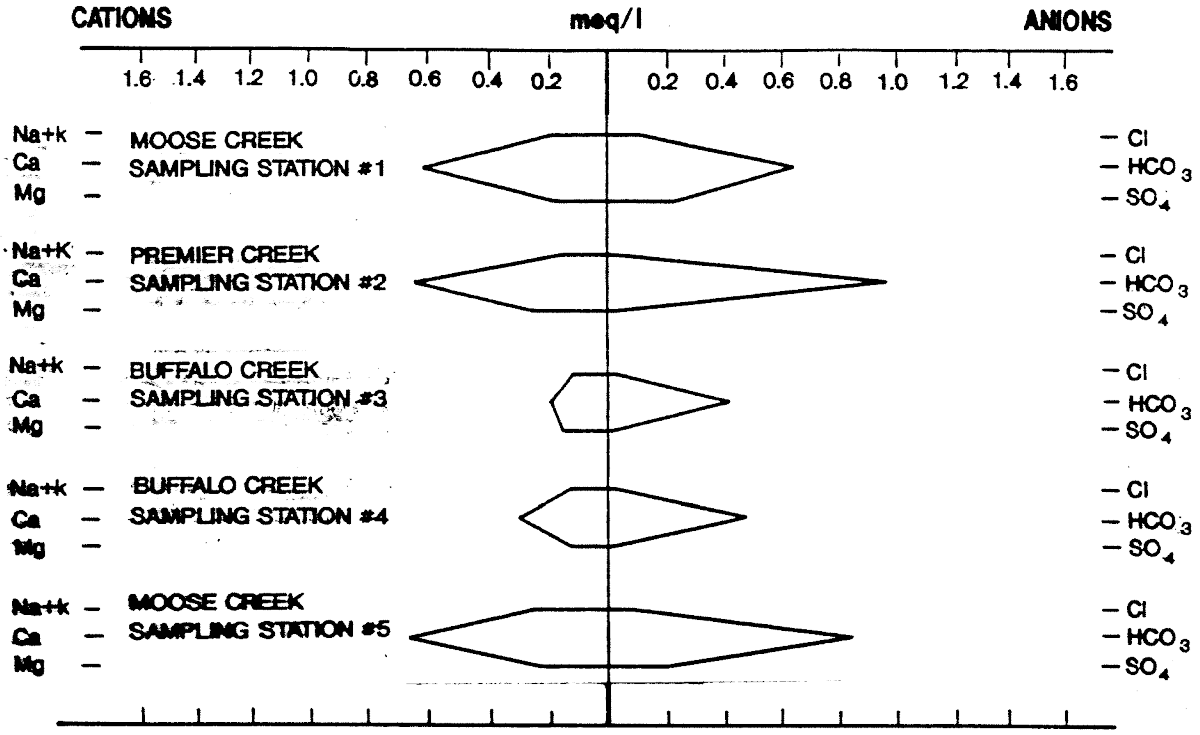


PERCENTAGE REACTING VALUES

DESIGN BY:	TRILINEAR DIAGRAM OF SURFACE WATER ANALYSES FOR STATION #4 BUFFALO CREEK, JULY 1988 – JUNE 1989	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-12	REV. 0
DATE DRAWN: 8/89		SCALE:	

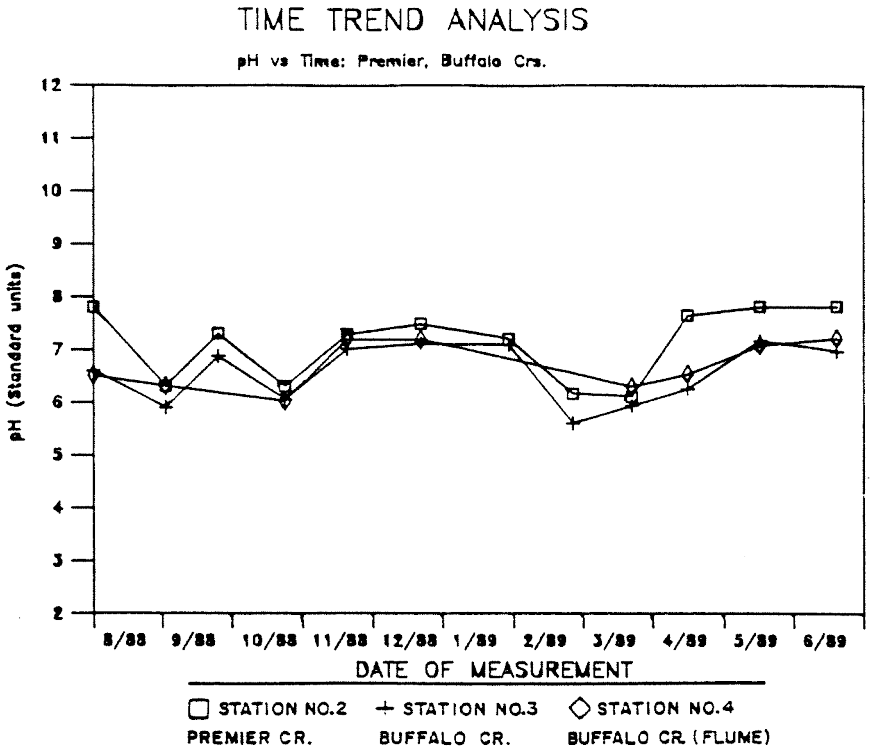


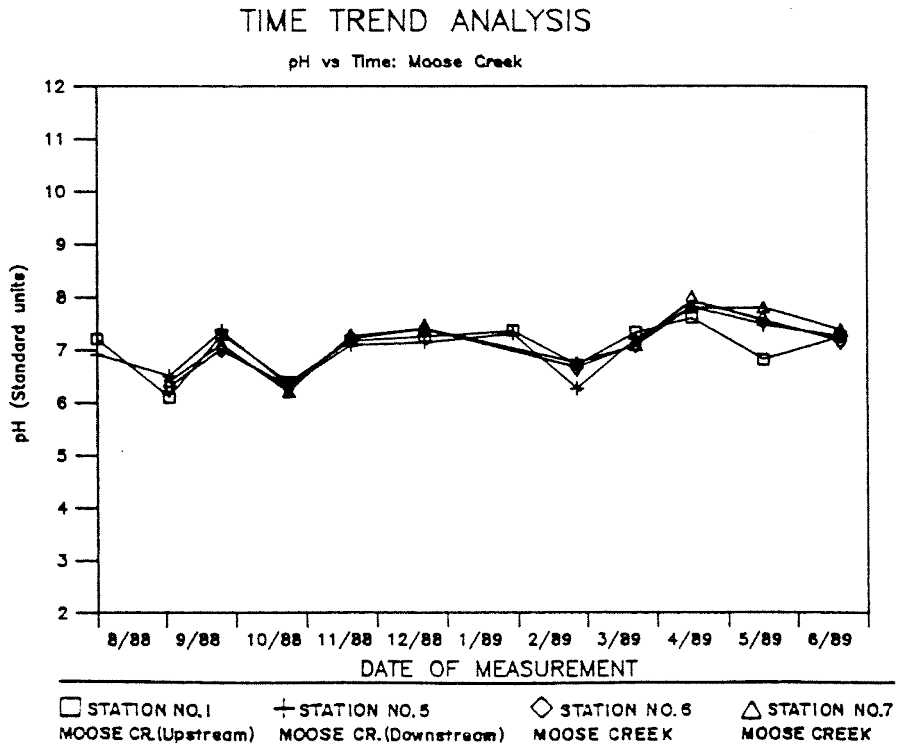
DESIGN BY:	TRILINEAR DIAGRAM OF SURFACE WATER ANALYSES FOR STATION #5 MOOSE CREEK, JULY 1988 – JUNE 1989	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-13	REV. 0
DATE DRAWN: 8/89		SCALE:	



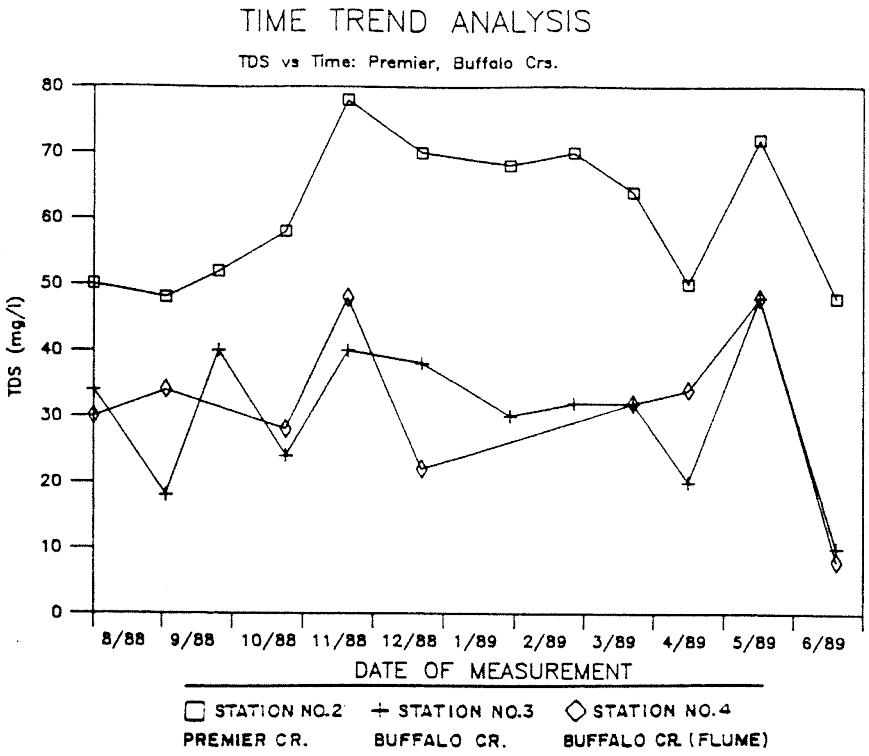
NOTE: Diagrams Were Constructed Using Average Values For Individual Constituents Based On Monthly Sampling And Analysis Conducted From 7/88 To 6/89

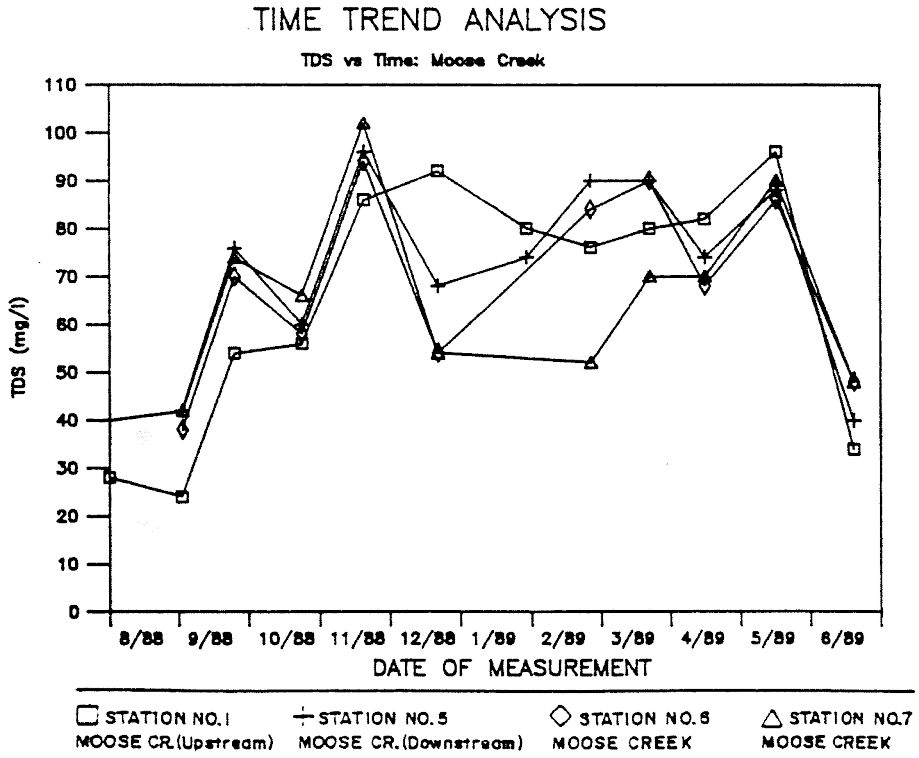
DESIGN BY:	STIFF DIAGRAMS OF WATER COMPOSITION FOR SURFACE WATER SAMPLING STATIONS	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-14	REV. 0
DATE DRAWN: 8/89		SCALE:	





DESIGN BY:	TIME TREND ANALYSES FOR SURFACE WATER pH vs. TIME	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-15	REV. 0
DATE DRAWN: 8/89		SCALE:	

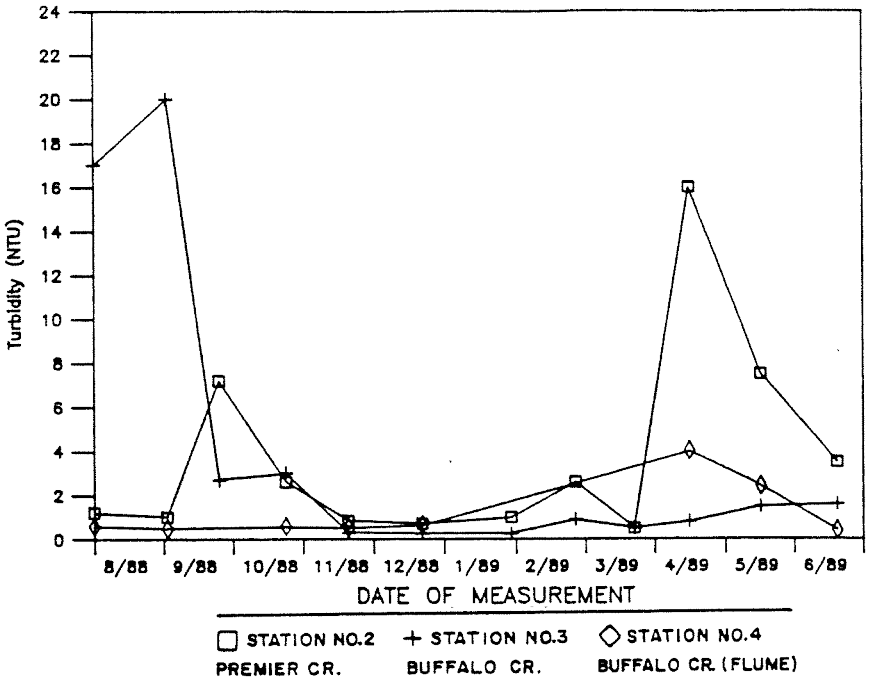




DESIGN BY:	TIME TREND ANALYSES FOR SURFACE WATER TDS vs. TIME	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-16	REV. 0
DATE DRAWN: 8/89		SCALE:	

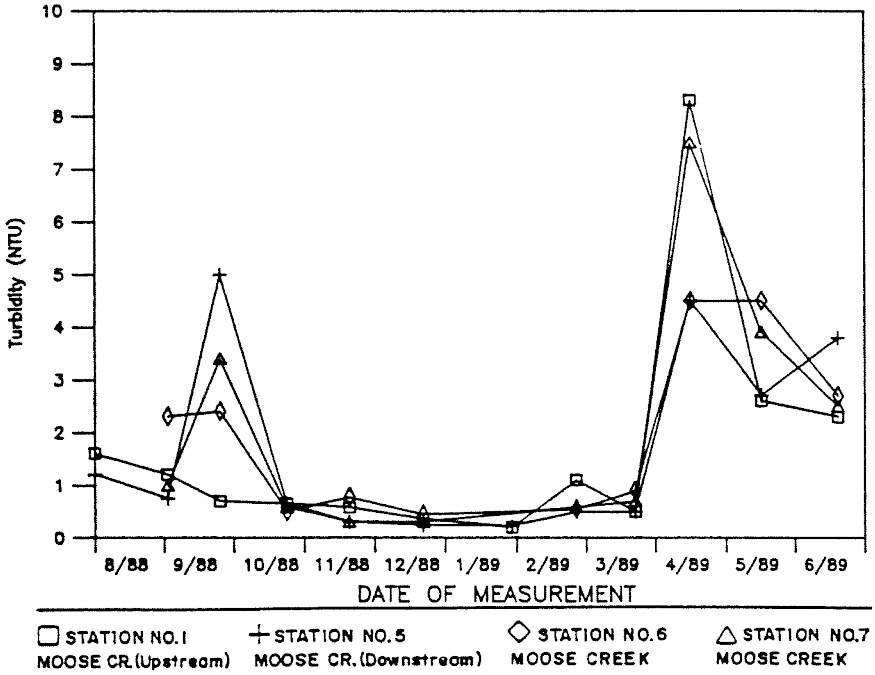
TIME TREND ANALYSIS

Turbidity vs Time: Premier, Buffalo Crs.

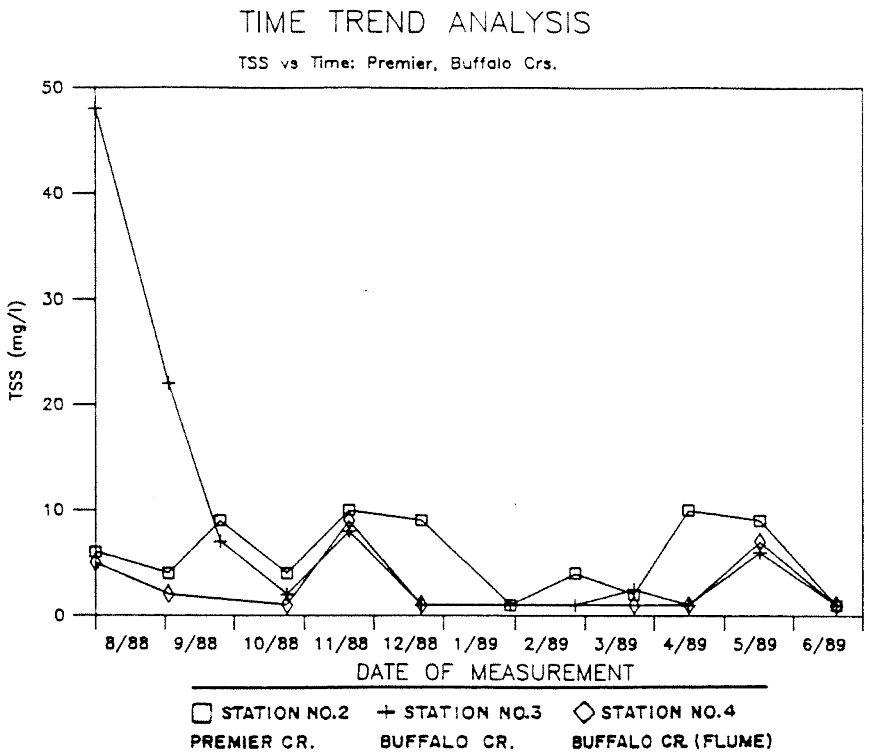


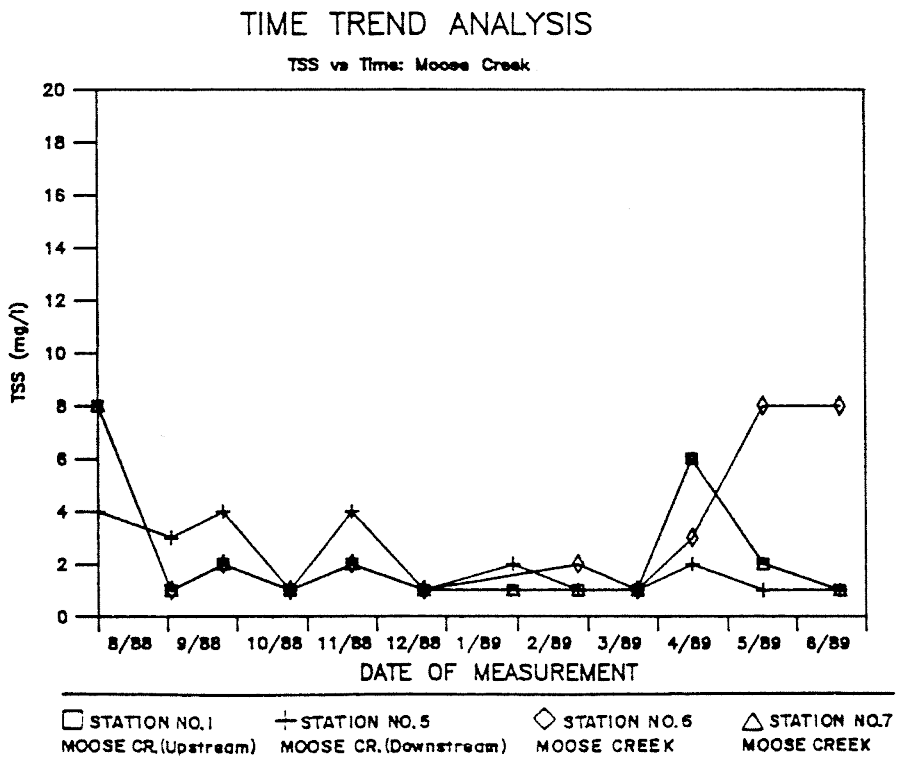
TIME TREND ANALYSIS

Turbidity vs Time: Moose Creek

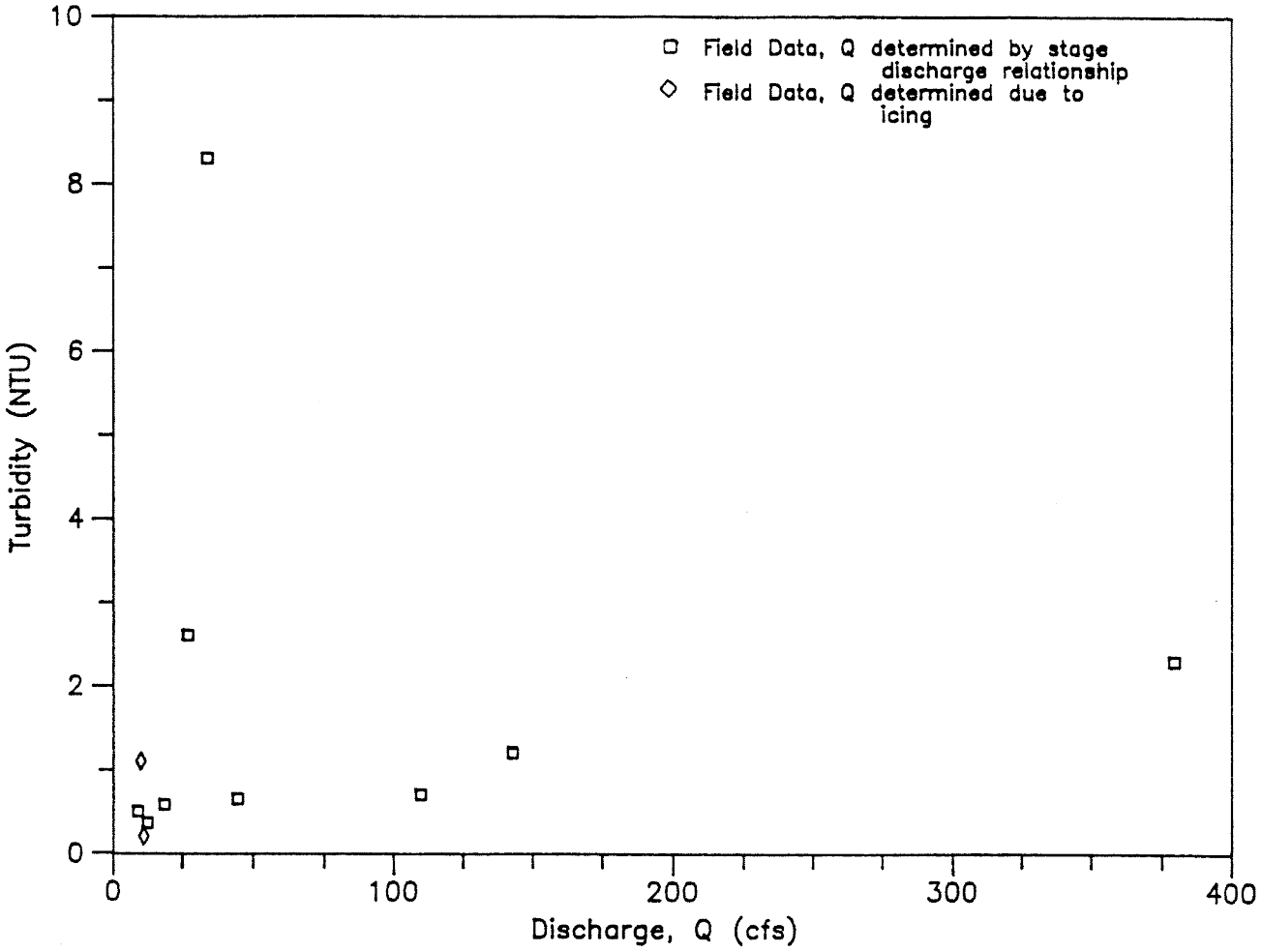


DESIGN BY:	TIME TREND ANALYSES FOR SURFACE WATER TURBIDITY vs. TIME	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-17 — REV. 0
DATE DRAWN: 8/89		SCALE:

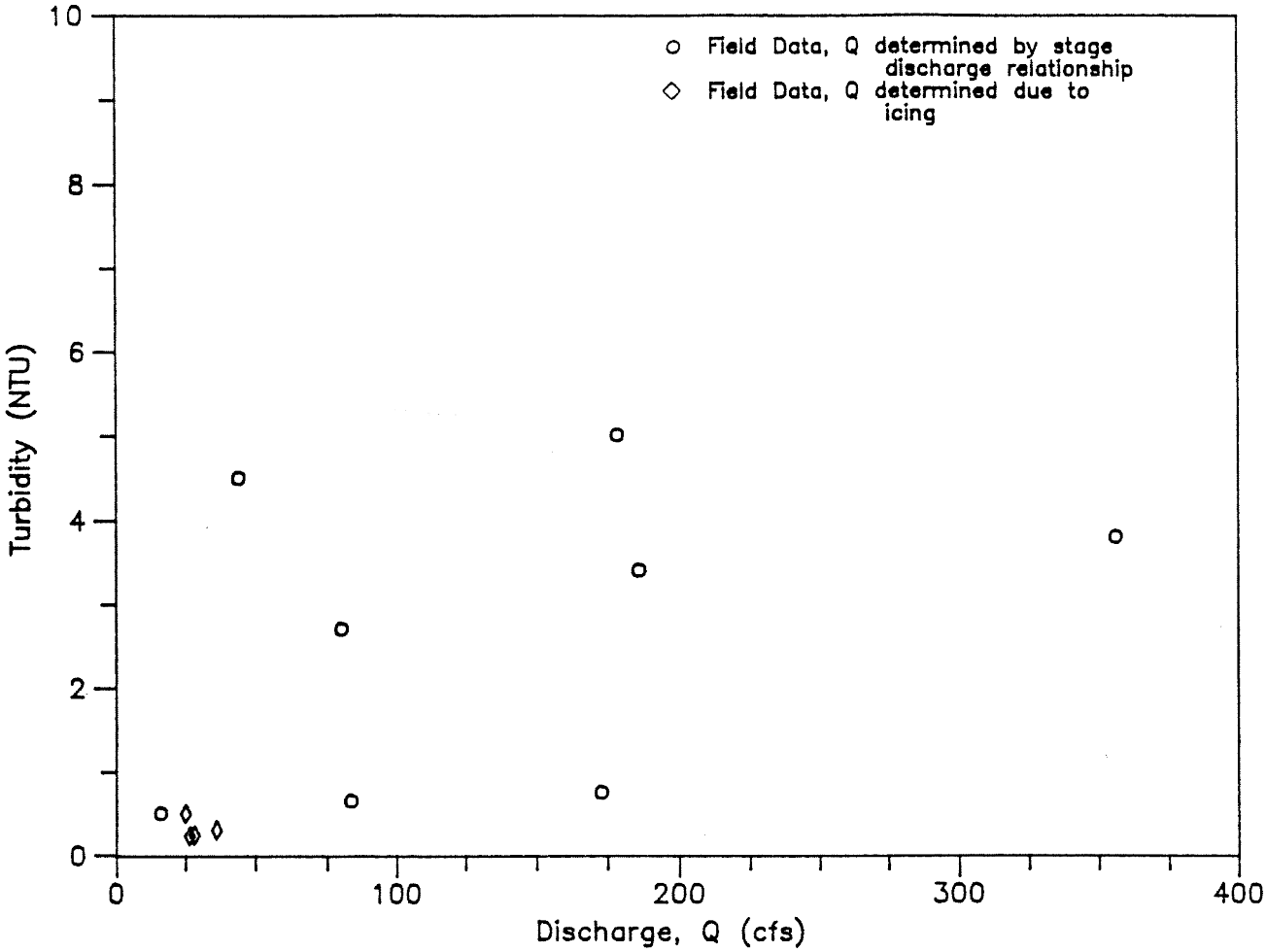




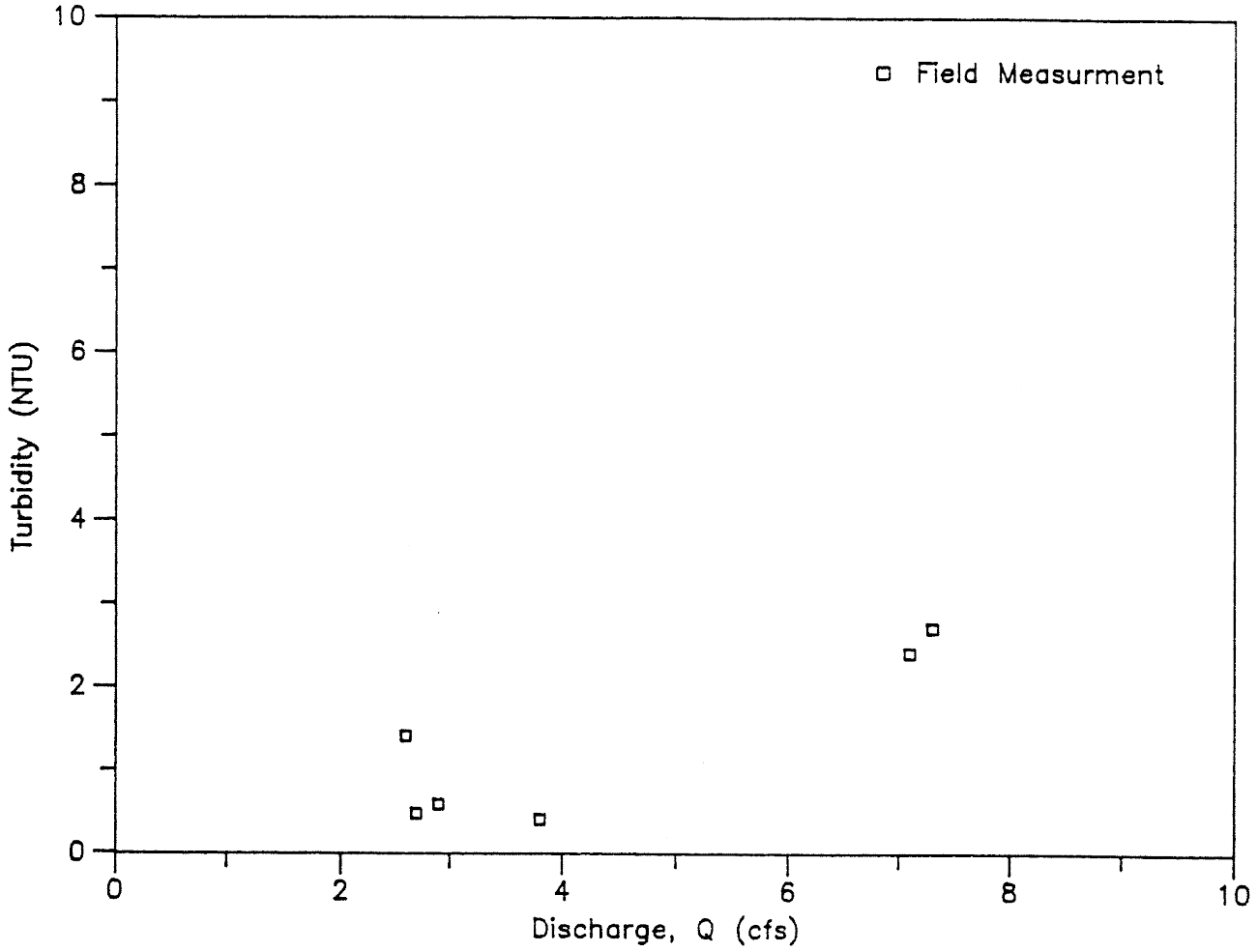
DESIGN BY:	TIME TREND ANALYSES FOR SURFACE WATER TOTAL SUSPENDED SOLIDS vs. TIME	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-18	REV. 0
DATE DRAWN: 8/89		SCALE:	



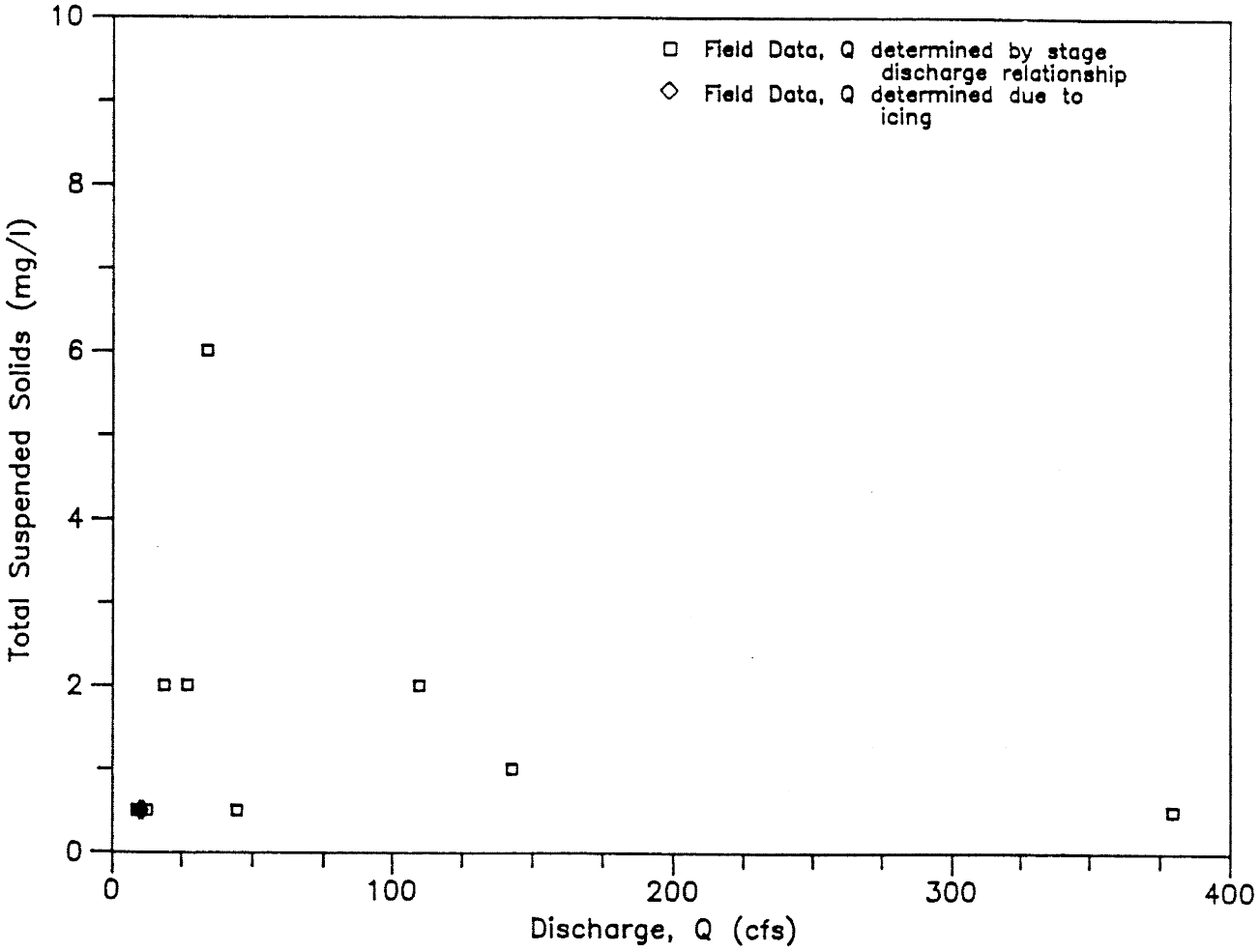
DESIGN BY:	MOOSE CREEK STATION #1 (UPSTREAM) TURBIDITY vs. DISCHARGE	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-19	REV. 0
DATE DRAWN: 8/89		SCALE:	



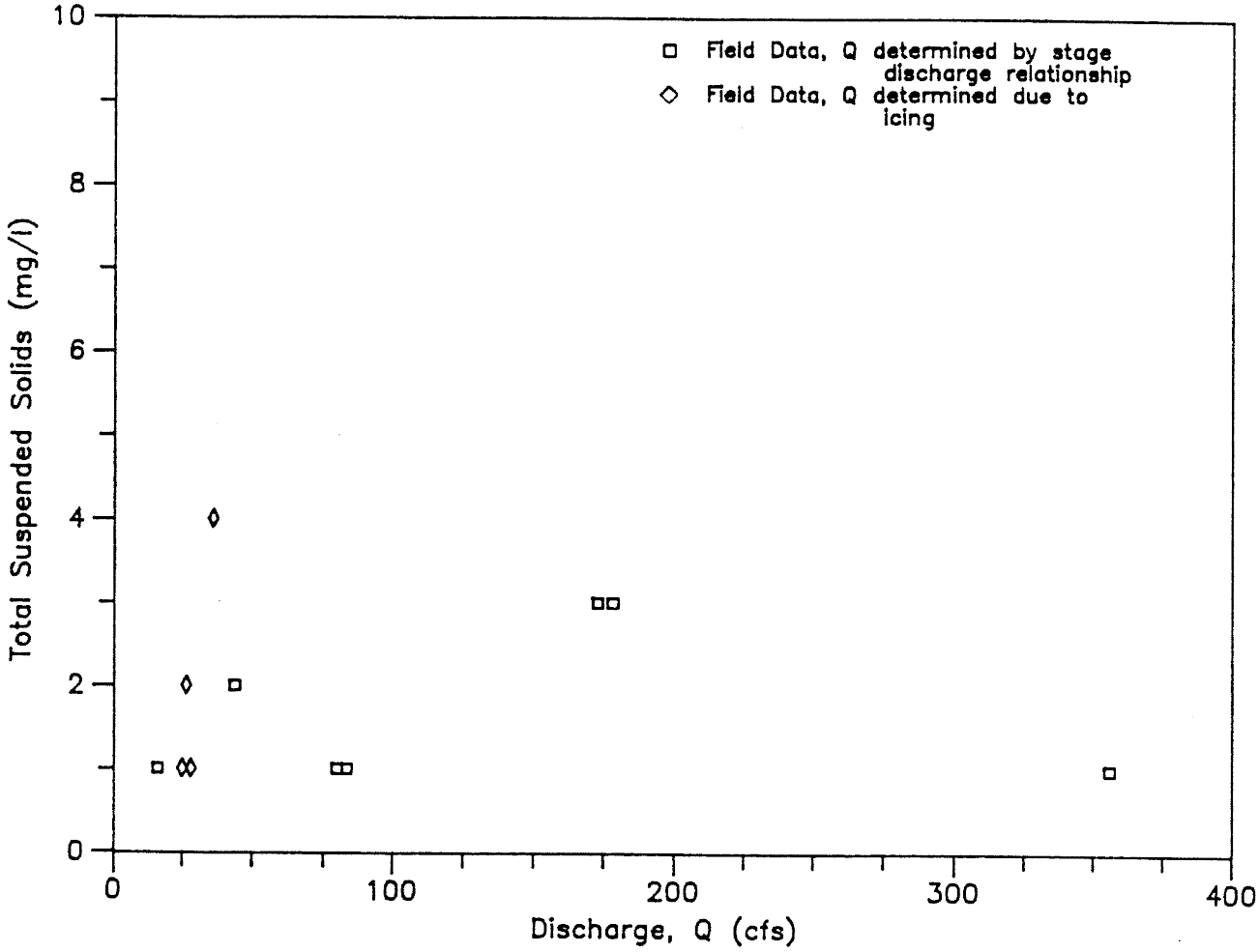
DESIGN BY:	MOOSE CREEK STATION #5 (DOWNSTREAM) TURBIDITY vs. DISCHARGE	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-20	REV. 0
DATE DRAWN: 8/89		SCALE:	



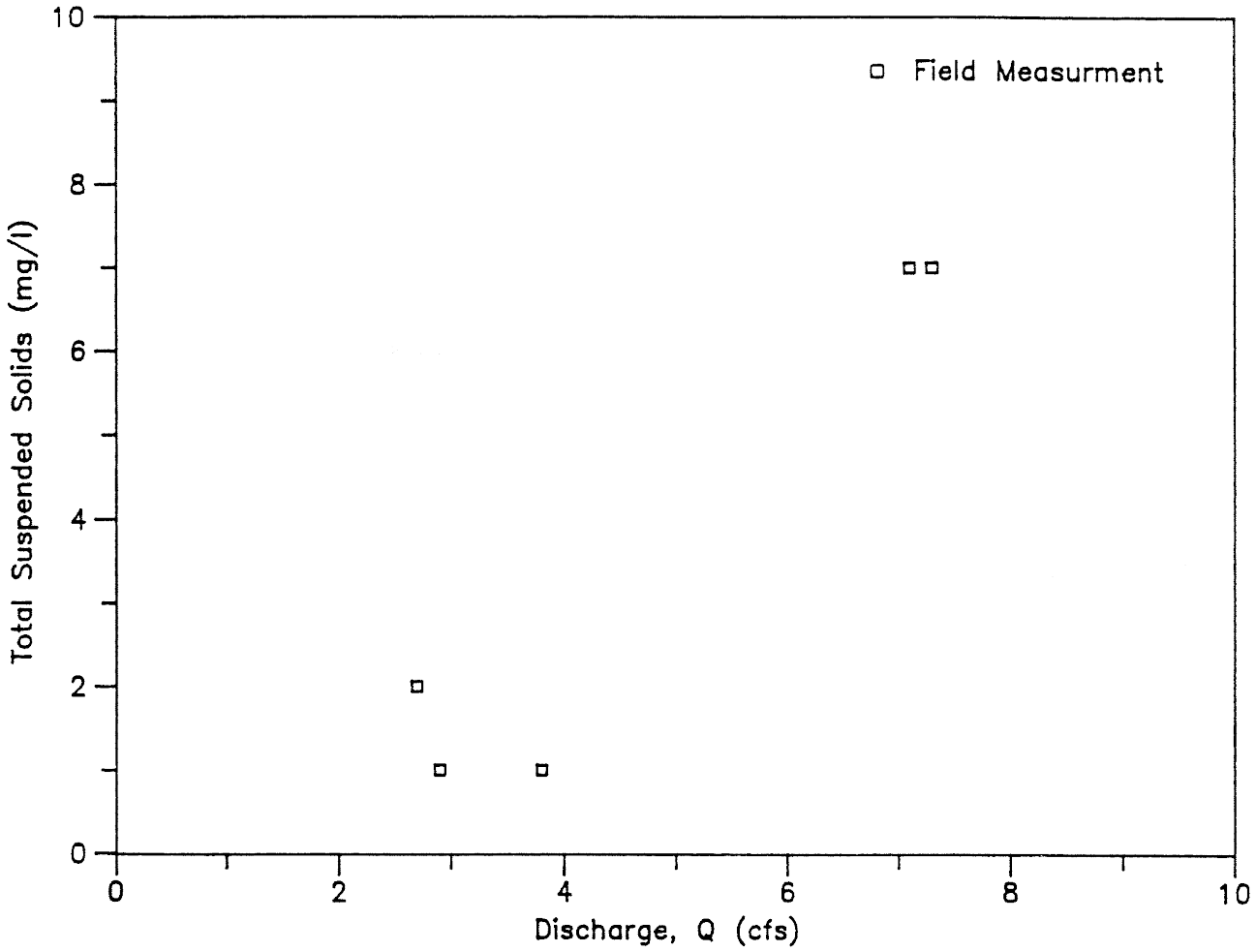
DESIGN BY:	BUFFALO CREEK STATION #4 (FLUME) TURBIDITY vs. DISCHARGE	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-21	REV. 0
DATE DRAWN: 8/89		SCALE:	



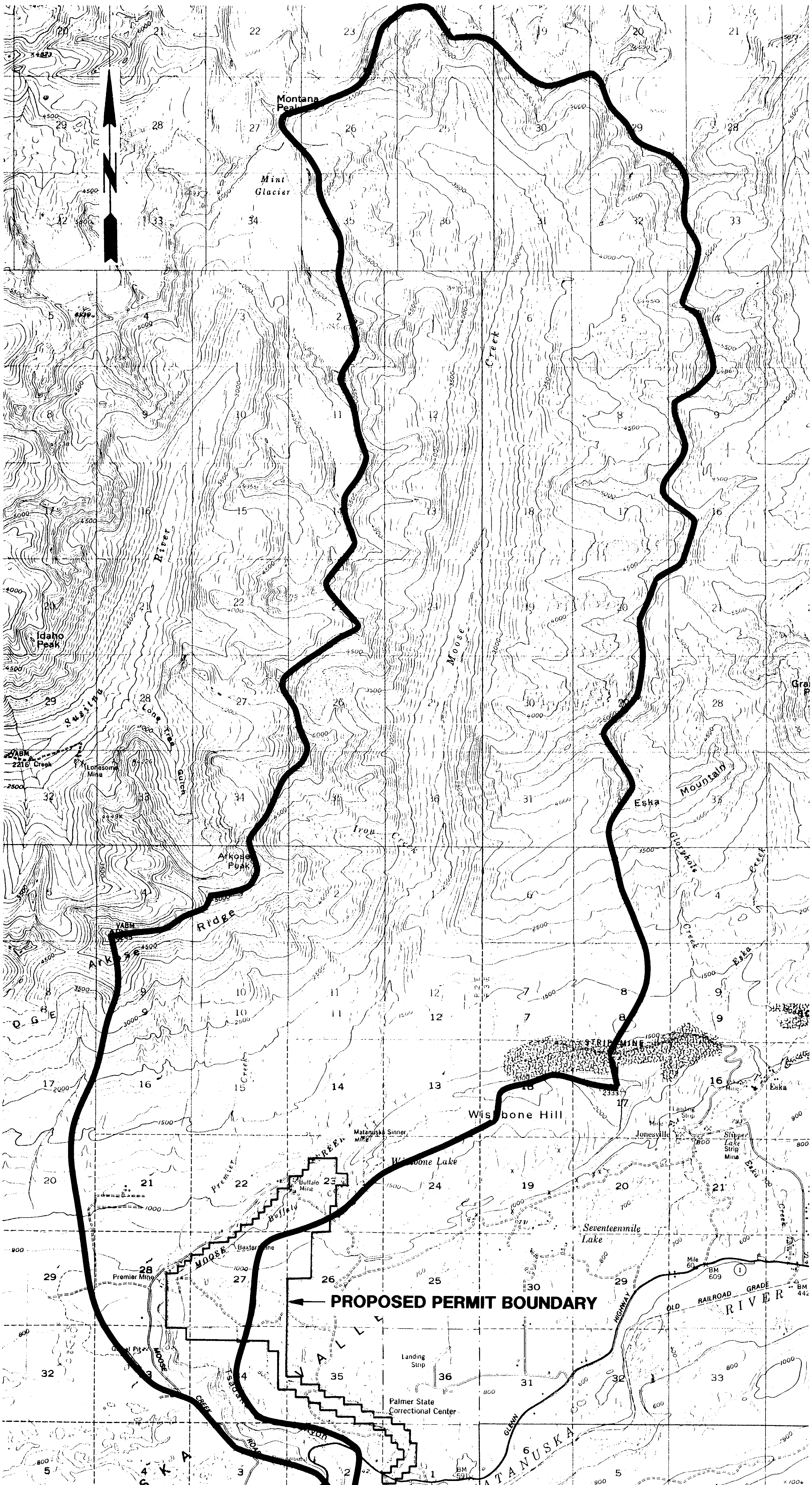
DESIGN BY:	MOOSE CREEK STATION #1 (UPSTREAM) TOTAL SUSPENDED SOLIDS vs. DISCHARGE	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-22	REV. 0
DATE DRAWN: 8/89		SCALE:	



DESIGN BY:	MOOSE CREEK STATION #5 (DOWNSTREAM) TOTAL SUSPENDED SOLIDS vs. DISCHARGE	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-23	REV. 0
DATE DRAWN: 8/89		SCALE:	



DESIGN BY:	BUFFALO CREEK STATION #4 (FLUME) TOTAL SUSPENDED SOLIDS vs. DISCHARGE	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 3-24 — REV. 0
DATE DRAWN: 8/89		SCALE:



SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 8/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

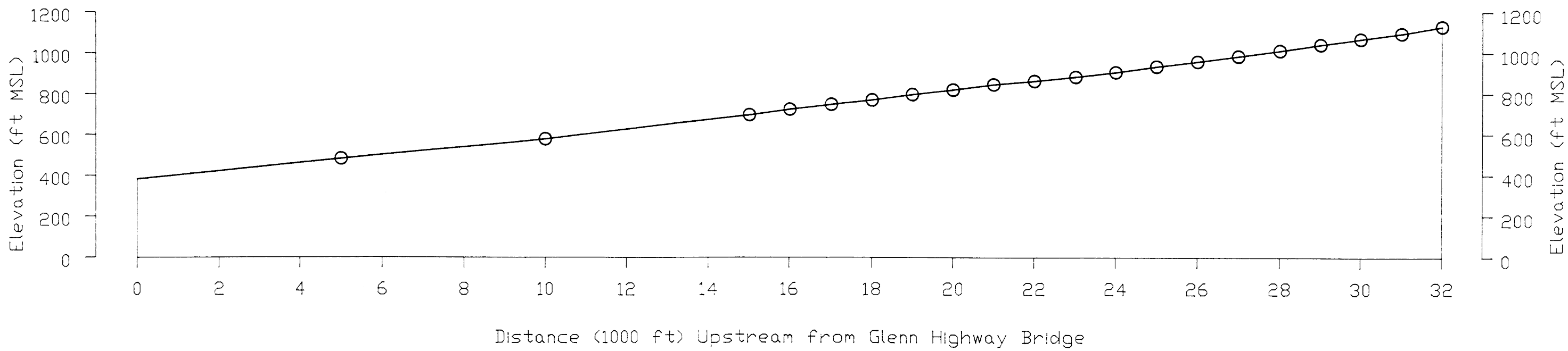
MOOSE CREEK DRAINAGE BASIN

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-1

REV. 1

SCALE: 1" = 1 MILE



O CHANNEL ELEVATION FROM TOPOGRAPHIC MAP

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

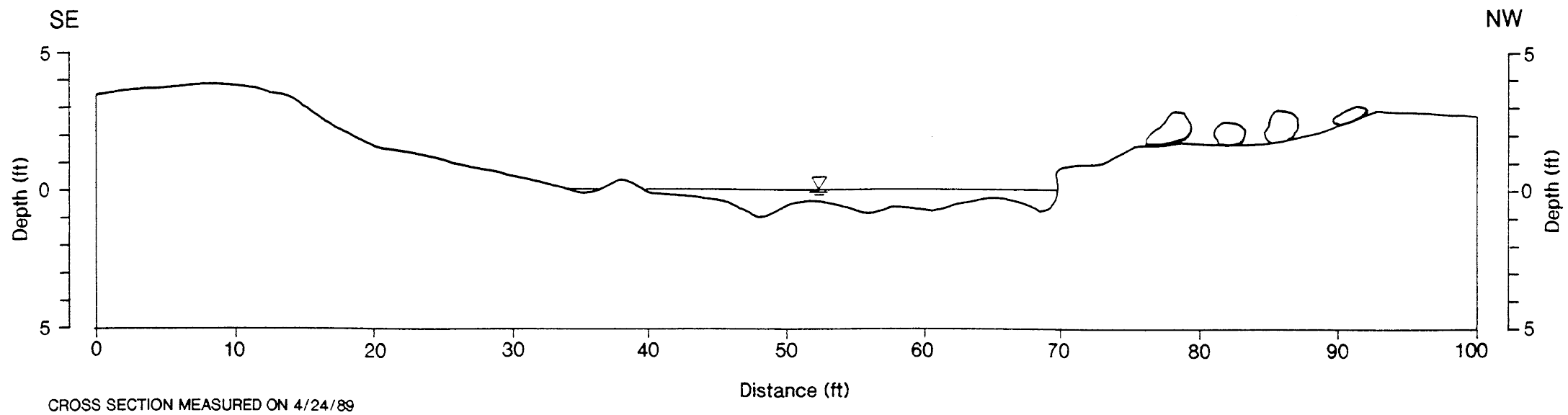
MOOSE CREEK CHANNEL PROFILE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-2

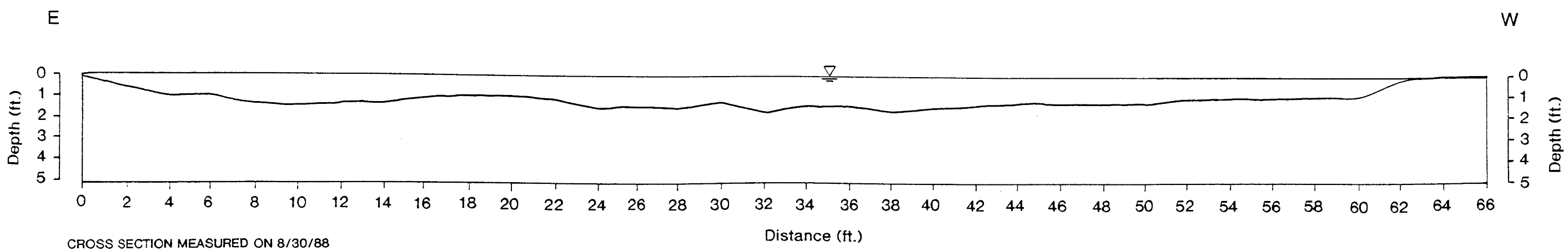
SCALE: AS SHOWN

REV. 1



CROSS SECTION MEASURED ON 4/24/89

STATION 1 CROSS-SECTION



CROSS SECTION MEASURED ON 8/30/88

STATION 5 CROSS-SECTION

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN: 5/89

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

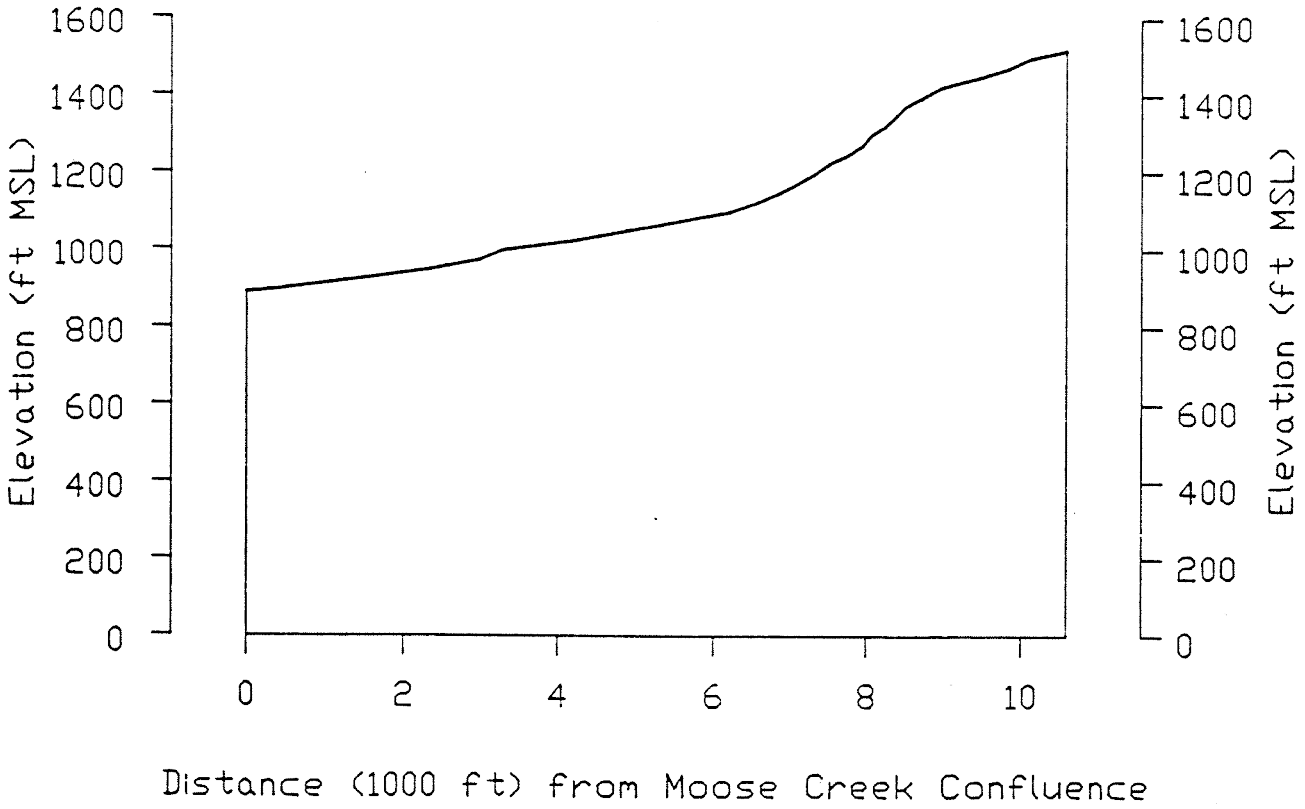
MOOSE CREEK CROSS-SECTIONS AT SAMPLING STATIONS No. 1 AND No. 5

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. 4-3

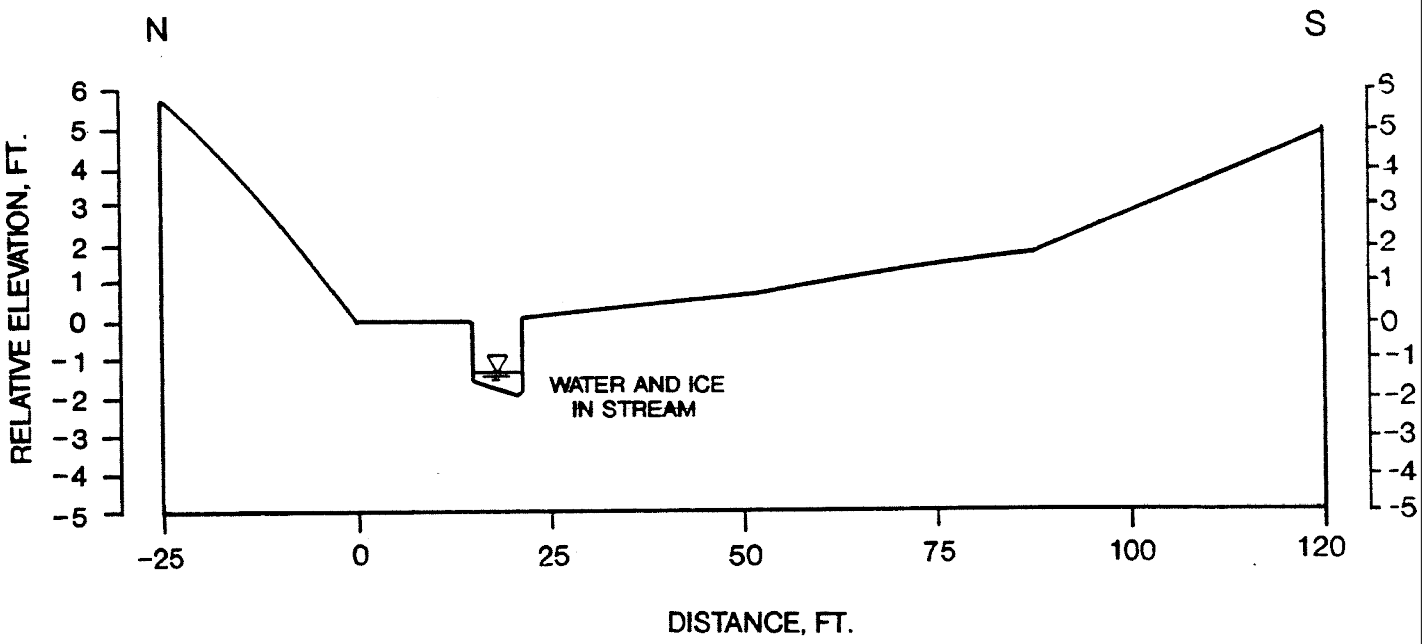
SCALE: N/A

REV. 1



BUFFALO CREEK CHANNEL PROFILE

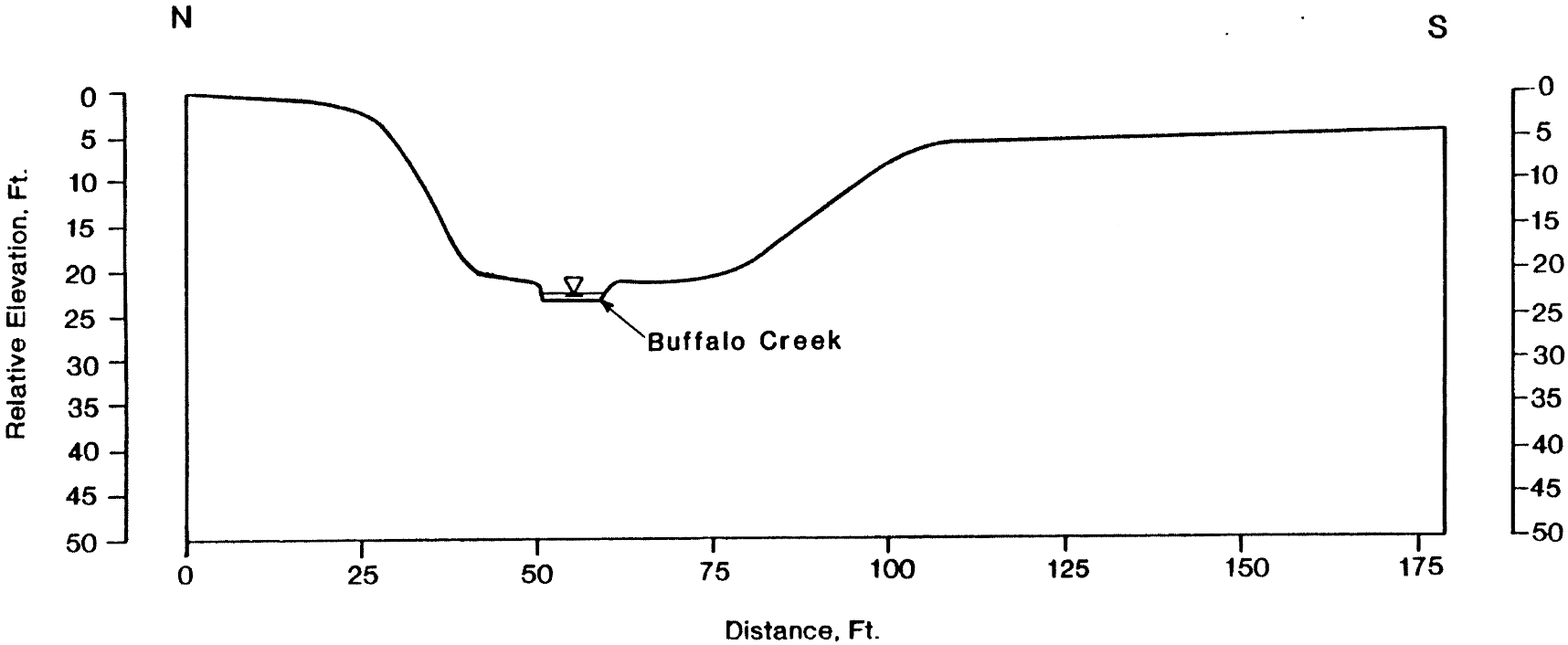
DESIGN BY:	BUFFALO CREEK CHANNEL PROFILE	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC.	FIGURE No. 4-4 — REV. 0
DATE DRAWN: 5/89	P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	SCALE:



CROSS SECTION MEASURED ON 4/23/89

Note: Location # 1 Shown On Plate 3-1

DESIGN BY:	BUFFALO CREEK CROSS SECTION AT LOCATION #1	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC.	FIGURE No. 4-5	REV. 0
DATE DRAWN: 5/89	P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	SCALE: AS SHOWN	



CROSS SECTION MEASURED ON 4/23/89

Note: Location # 2 Shown On Plate 3-1

BUFFALO CREEK CROSS SECTION AT LOCATION #2

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226

WISHBONE HILL MINE

PERMIT No. 01-89-796

FIGURE No. 4-6

REV. 0

SCALE: AS SHOWN

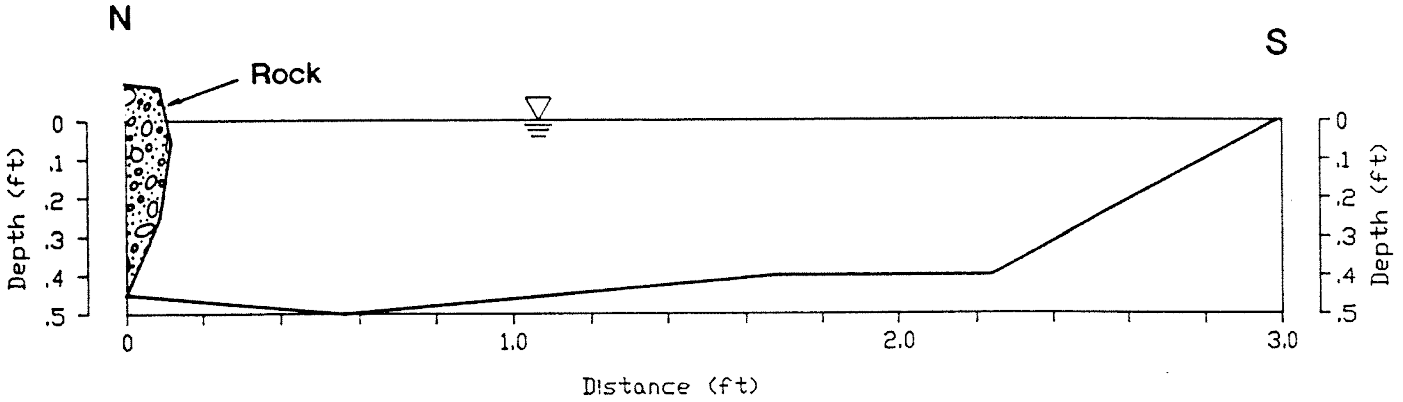
DATE DRAWN: 5/89

DWG FILE:

CHECK BY:

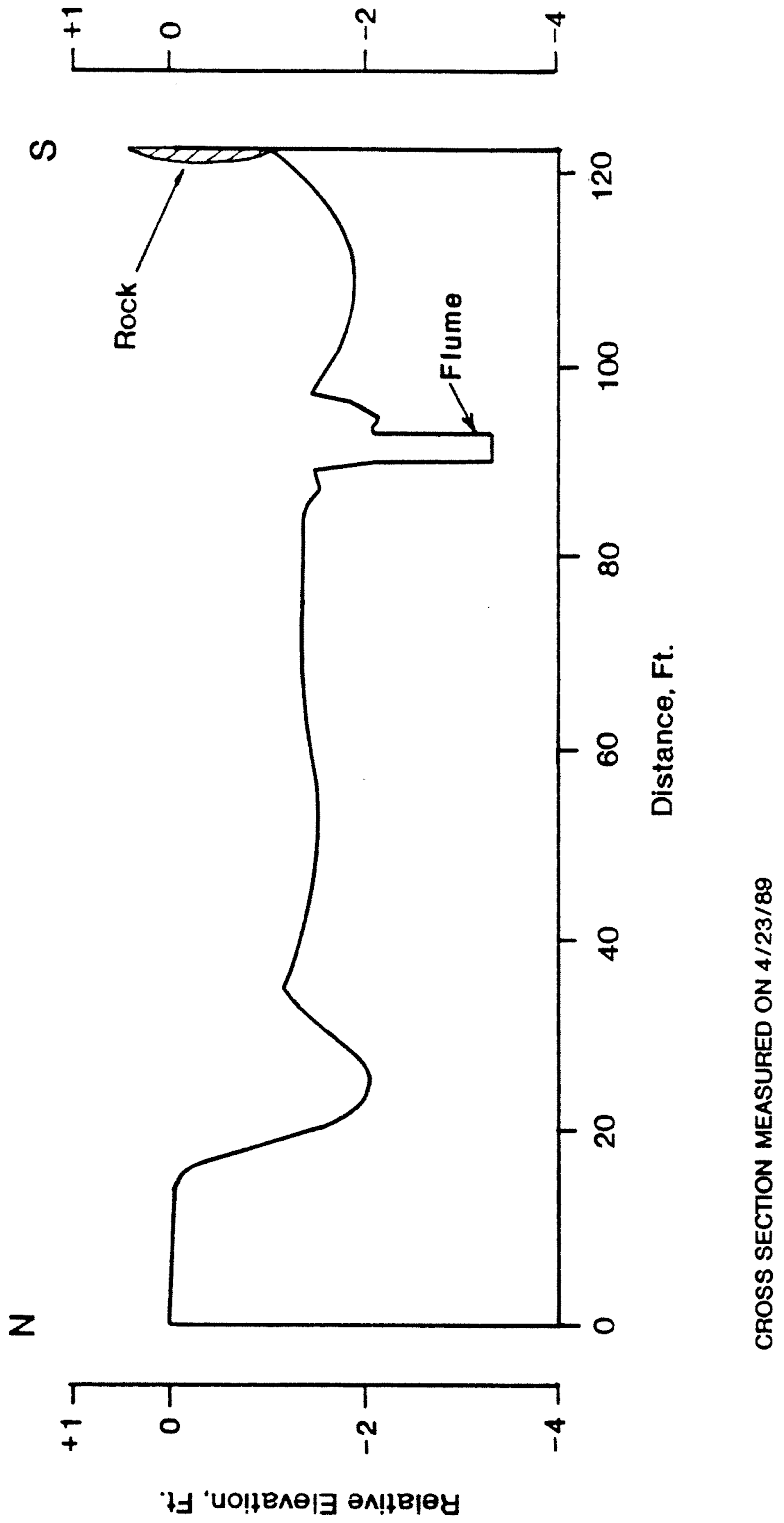
DRAWN BY:

DESIGN BY:



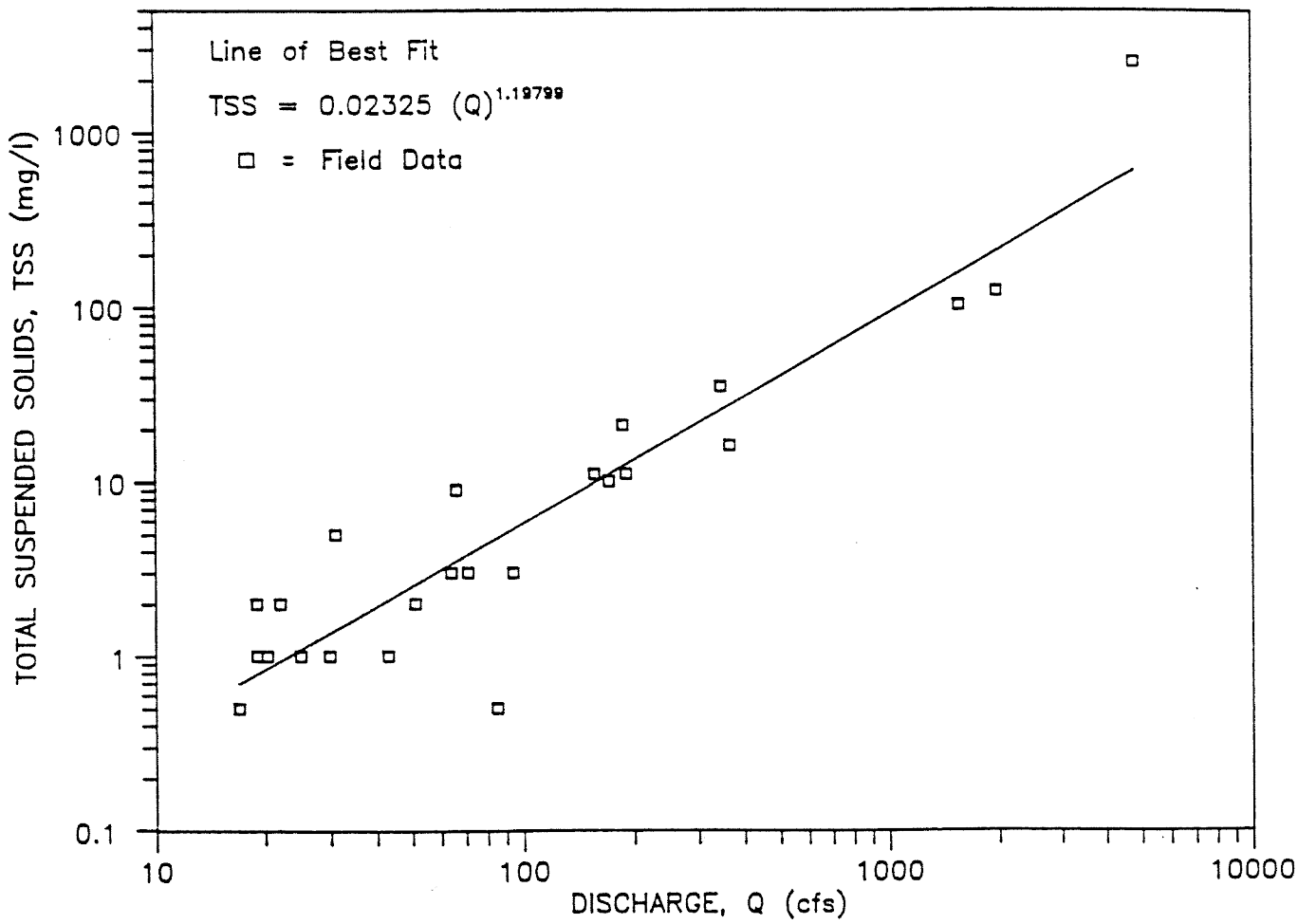
CROSS SECTION MEASURED ON 10/21/88

DESIGN BY:	BUFFALO CREEK CROSS SECTION AT SAMPLING STATION #3	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 4-7	REV. 0
DATE DRAWN: 5/89		SCALE: AS SHOWN	



CROSS SECTION MEASURED ON 4/23/89

DESIGN BY:	BUFFALO CREEK CROSS SECTION AT SAMPLING STATION #4	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 4-8	REV. 0
DATE DRAWN: 5/89		SCALE: AS SHOWN	



SOURCE:CARRICK,.et al 1988

DESIGN BY:	LITTLE SUSITNA RIVER, NEAR PALMER TOTAL SUSPENDED SOLIDS vs. DISCHARGE	WISHBONE HILL MINE	PERMIT No. 01-89-796
DRAWN BY:			
CHECK BY:			
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 4-9	REV. 0
DATE DRAWN: 5/89		SCALE: AS SHOWN	

PLATES

R 2 E

STA. 1
STA. 3
STA. IV
LLOCATION 1
LOCATION 2
H88-12
STA. 4
STA. B
STA. 6
BUFFALO CK
H88-22
S-4
S-3
S-1
S-5
S-2
TRIB "D"
STA. I
TRIB "C"
PREMIER CK STA.
STA. 2
STA. II
H88-10
H88-21
STA. 7
STA. III
STA. A
BRAID B.
STA. 5
T 19 N
T 18 N

CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

Jerry W. Rose

LEGEND

- STREAM GAGE, WATER QUALITY AND SEDIMENT SAMPLING STATION (1,4,5)
- WATER QUALITY AND SEDIMENT SAMPLING STATION (2,3)
- SEDIMENT SAMPLING STATION (6,7)
- STOCKPILE SOIL SAMPLES (S-1 THRU S-5) NOTE: LIMITS OF COMPOSITE SAMPLES INDICATED BY
- SOIL SAMPLES FROM SHALLOW AND DEEP WELLS (AS-BUILT WELL LOCATION) (H88-10,12,21,22)
- SEEPAGE ANALYSIS GAGING STATIONS

NOVEMBER 1988		APRIL 1989	
INFLOW	OUTFLOW	INFLOW	OUTFLOW
STA. B	STA. A.	STA. IV	STA. III (TOTAL)
BUFFALO CK.	BRAID. B	BUFFALO CK.	STA. I (INTERMEDIATE)
TRIB "C"		PREMIER CK.	STA. II (INTERMEDIATE)
TRIB "D"		TRIB "C"	
PREMIER CK		TRIB "D"	

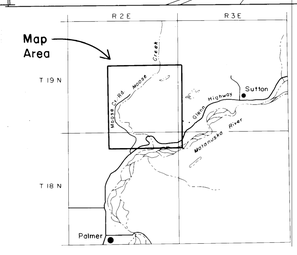
- DRAINAGE AREA BOUNDARY
- APPROXIMATE DIRECTION OF SURFACE WATER FLOW
- 100 YEAR FLOOD PLAIN
- STREAM CROSS SECTION ON BUFFALO CREEK

The core map area was photogrammetricaly mapped from photography of 5/8/84, 5/8/83, 6/22/85 by Air Photo Tech, Inc. of Anchorage, Alaska.

The core map area meets National Map Accuracy Standards at 1"=200' and smaller scales. Topographic and Planimetric features outside of the core area were taken from a photo enlarged 1"=1mile USGS Anchorage C-6 quad map of 1987.

Horizontal datum is Alaska State Plane, zone 4.

Vertical datum is based on USC & GS monumentation.



North

500 250 0 500 1000 1500

SCALE IN FEET
1" = 500'
CONTOUR INTERVAL
5 FEET

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2/2/93	JEH	MINOR REVISION

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN:

WISHBONE HILL MINE

PERMIT NUMBER 01-89-796

SURFACE WATER DRAINAGES, FLOOD PLAIN, AND MONITORING STATIONS

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. V-1
SHEET No. 1 OF 1
REV. 1

APPENDIX A

QUALITY ASSURANCE SAMPLING PLAN

SAMPLING QUALITY ASSURANCE PLAN
FOR
PRE-MINING GROUNDWATER AND SURFACE WATER INVESTIGATIONS

WISHBONE HILLS PROJECT
PALMER, ALASKA

Revision -0-

Prepared for
McKinley Mining Consultants, Inc.

883-2145

Golder Associates Inc.
Anchorage, Alaska

Reviewed and approved by:

A. Krause 11/4/88

A. Krause, GAI Project Manager

J. Rowe 11/1/88

J. Rowe, GAI Hydrogeology Task Leader

G. Laird

G. Laird, GAI Hydrology Task Leader

G. Mills 11/1/88

G. Mills, GAI Corporate QA Officer

TABLE OF CONTENTS

	Page No.
1. INTRODUCTION	1
2. PROJECT LOCATION AND DESCRIPTION	1
3. PROJECT ORGANIZATION AND RESPONSIBILITIES	1
4. SAMPLING LOCATION AND FREQUENCY	1
4.1 Location	1
4.2 Sampling Frequency	2
5. SAMPLING PROCEDURES	2
6. SAMPLE HANDLING AND CHAIN OF CUSTODY PROCEDURES	2
6.1 Sample Container Preparation and Transport	2
6.2 Sample Chain of Custody	3
7. PARAMETERS FOR ANALYSIS AND ANALYTICAL PROCEDURES	3
8. PROCEDURE ALTERATION CHECKLISTS	5
9. REVIEW OF ANALYTICAL REPORTS	5
10. RECORDS	5

1. INTRODUCTION

It is Golder Associates Inc. (GAI) corporate policy to establish appropriate Quality Assurance (QA) program controls for all hydrological and hydrogeological sampling investigations. In keeping with this policy, certain QA program elements and procedures have been selected for use on this project and are defined by this Sampling QA Plan (SQAP). The purpose of the SQAP is to provide a procedural framework that will ensure that the sampling activities completed as part of this project are fully documented, defensible, and in compliance with established sampling practices.

2. PROJECT LOCATION AND DESCRIPTION

The hydrological and hydrogeological sampling activities discussed in this plan are part of the scope of site characterization activities to be conducted by Golder Associates Inc. as part of the pre-mining investigations for the Wishbone Hill Mine project, near Palmer, Alaska. Site topography and location are shown on the sampling location maps included as Figures 4-1 and 4-2.

3. PROJECT ORGANIZATION AND RESPONSIBILITIES

Primary responsibility for the implementation of the requirements of this SQAP lies with the Project Manager and the Task Leaders for each area of investigation. The QA Manager is responsible for the preparation and update of this SQAP, and has the independence, authority, and access to technical staff to ensure the proper implementation of the requirements discussed in this plan. Project assignments are as follows:

- A. Krause, Project Manager
- J. Rowe, Hydrogeology Task Leader
- G. Laird, Hydrology Task Leader
- G. Mills, QA Manager

4. SAMPLING LOCATION AND FREQUENCY

4.1 Location

Surface water sampling shall be performed at 7 locations, as shown in detail on Figure 4-1 and as described below:

- on Moose Creek, at the northeastern limits of the Wishbone Hill Western Lease permit boundary,
- on Moose Creek, upstream from its confluence with Buffalo Creek,
- on Moose Creek, on the western side of the Wishbone Hill Western Lease permit boundary,

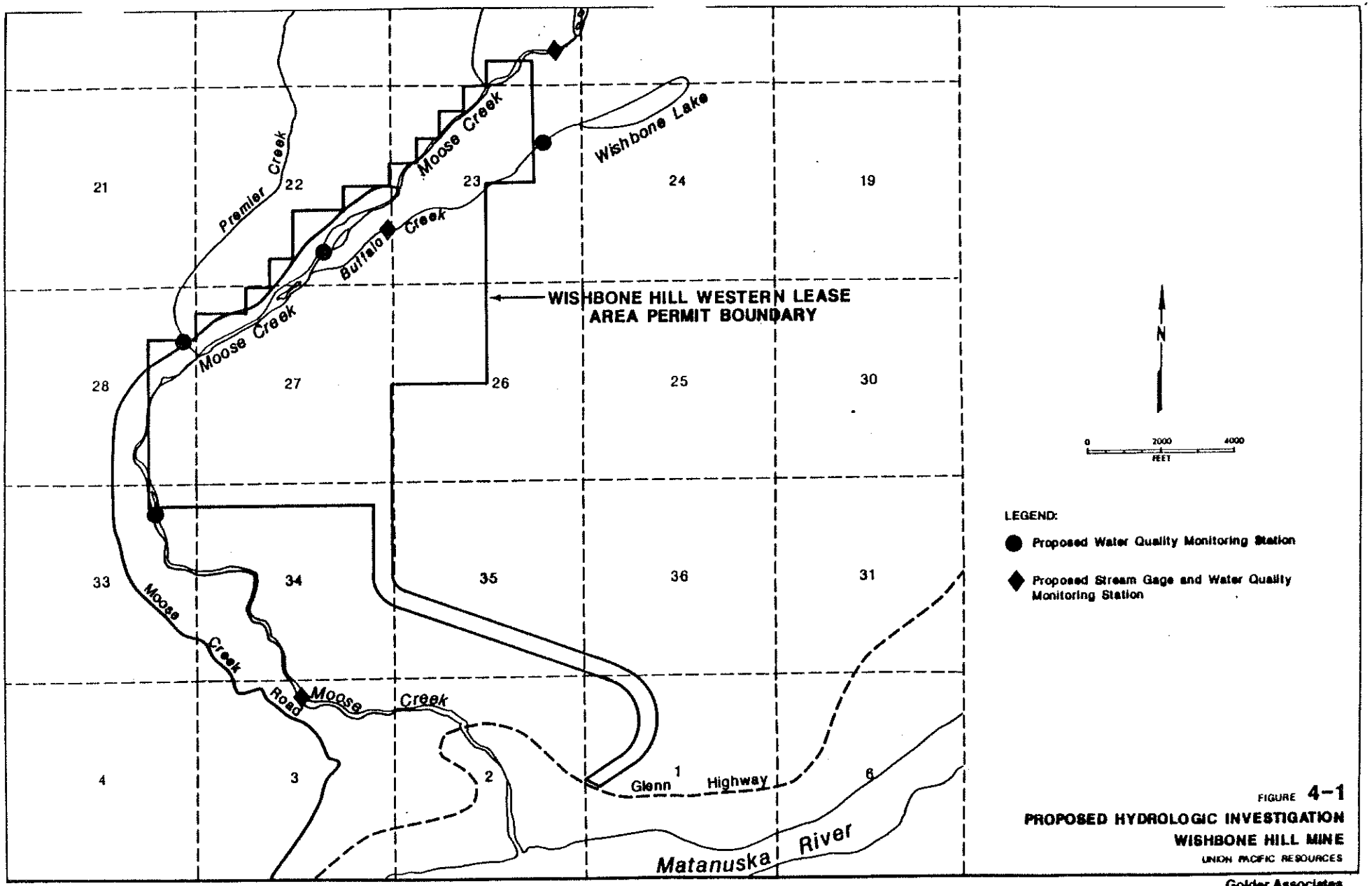


FIGURE 4-1
PROPOSED HYDROLOGIC INVESTIGATION
WISHBONE HILL MINE
UNION PACIFIC RESOURCES

Golder Associates

PROJECT NO 883-2145-000 DWG NO 10909 DATE 10/31/88 DRAWN LD APPROVED JR

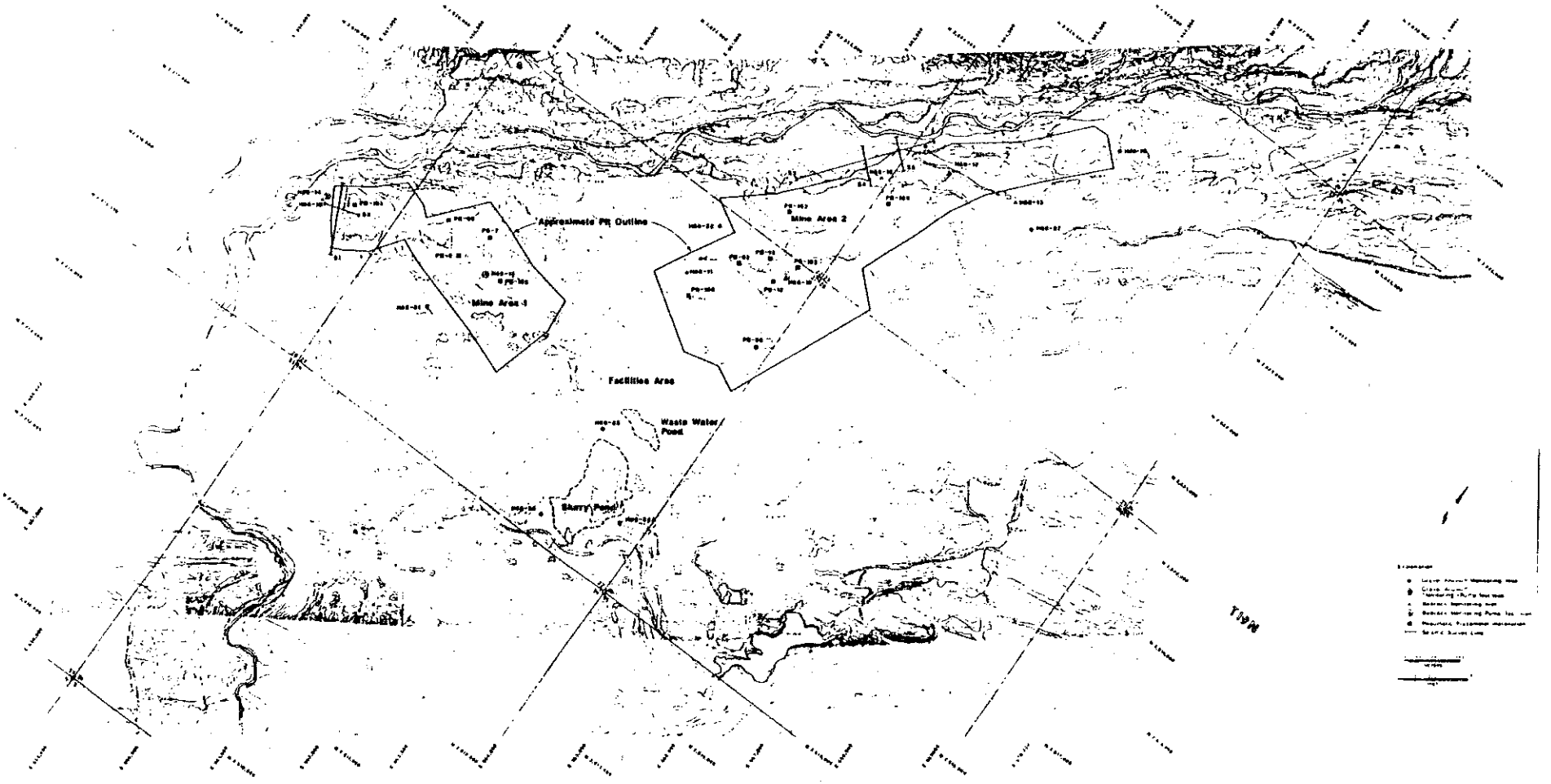


FIGURE 4-2

SITE PLAN AND WELL LOCATIONS

MCKINLEY MINING CONSULTANTS, INC.

WISHBONE HILL MINE

PROJECT NO 883-2145 DWG NO 9161 DATE 10/31/88 DRAWN CW APPROVED JR

Golder Associates

- on Moose Creek, to the south of the southern limits of the Wishbone Hill Western Lease permit boundary,
- on Buffalo Creek, upstream from its confluence with Moose Creek,
- on Premier Creek, near its confluence with Moose Creek, and
- on Buffalo Creek, at the northeastern limits of the Wishbone Hill Western Lease permit boundary.

Groundwater sampling shall be performed using 16 separate monitoring well installations, as shown in detail on Figure 4-2. Water levels shall be measured and recorded in each well prior to sampling. Piezometric levels shall be measured in each piezometer installation shown in Figure 4-2.

4.2 Sampling Frequency

Water quality samples shall be taken from each surface water sampling location on a monthly basis for an entire year and subjected to the full range of field and laboratory analyses described in Section 7. Additional samples shall be taken, at the direction of the Task Leader, during two separate storm events; during each event, periodic samples shall be taken from selected locations and subjected to all required field measurements and analyses. At the direction of the Task Leader, ten samples shall be selected from the total group of storm event samples, and routed to the laboratory for analysis of settleable solids and total suspended solids.

On a quarterly basis, one pair of groundwater water quality samples shall be taken from the groundwater monitoring locations described in Section 4.1 and subjected to the full range of field and laboratory analyses described in Section 7. Water/piezometric levels shall be measured quarterly in each monitoring well/piezometer location described in Section 4.1. More frequent measurements may be taken at the discretion of the Task Leader or Project Manager.

5. SAMPLING PROCEDURES

All sampling activities on this project shall be conducted in compliance with Appendix A, "Surface Water Sampling Procedure", or Appendix B, "Groundwater Sampling Procedure." Water levels shall be measured as required by Appendix C, and piezometric levels shall be measured as required by Appendix D.

6. SAMPLE HANDLING AND CHAIN OF CUSTODY PROCEDURES

6.1 Sample Container Preparation and Transport

All sample containers shall be prepared and labeled by the analytical laboratory; containers shall be made of high-density linear polyethylene or borosilicate glass, with airtight caps. The containers shall be given a

distilled/deionized water rinse prior to use. Samples shall be transported in suitable coolers with adequate "blue ice" cold packs to maintain the interior temperature below 4 degrees Centigrade.

6.2 Sample Chain of Custody

Labels shall be filled out on all sample containers sent to the analytical laboratory. Containers shall be secured with a tamper-proof seal (Figure 6-1), and shall be accompanied by a sample chain of custody record (Figure 6-2). Each seal shall be assigned a unique number which shall be entered on the chain of custody record, sample integrity data sheet, and the Field Report form (see Appendices A and B). When samples are ready for shipment, the Task Leader or designated Field Hydrologist shall release the sample to the carrier, who shall sign the custody form. The pink copy of the form shall retained by the Task Leader or Field Hydrologist, and the remainder of the form shall be shipped or mailed with the sample. Upon receipt, the laboratory's sample custodian shall verify the identification and integrity of the sample, sign the form, and return the original copy of the form to the GAI Task Leader.

7. PARAMETERS FOR ANALYSIS AND ANALYTICAL PROCEDURES

The following analyses shall be performed on all samples delivered to the laboratory; where specified, analytical procedures shall comply with the appropriate EPA standard method from EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes. Where procedures are indicated as the laboratory's option, copies shall be appended to the analytical results when presented to the GAI project manager for review. The laboratory shall perform at least one duplicate analysis each sampling round as a quality control check on the applicable analytical procedures.

Test or Compound of Interest	Method
Total acidity	Laboratory option
Total alkalinity	Titrimetric (EPA 310.1)
Total hardness	Titrimetric (EPA 130.2)
Settleable solids	Laboratory option
Total dissolved solids	Gravimetric (EPA 160.1 or SM 208c)
Total suspended solids	Laboratory option
Color	Laboratory option
Carbonate	Laboratory option
Bicarbonate	Laboratory option
Sulfate	Gravimetric (EPA 375.3)
Chloride	Titrimetric (EPA 325.3)
Nitrate	Laboratory option

Test or Compound of Interest	Method
Sodium	AA (EPA 273.1)
Potassium	AA (EPA 258.1)
Calcium	AA or Titrimetric (EPA 215.1/.2)
Magnesium	AA (EPA 242.1) or CAL (SM 313c)
Arsenic	AA (EPA 206.2 or .3)
Iron (total)	AA (EPA 236.1 or .2)
Manganese (total)	AA (EPA 243.1 or .2)
Cadmium	AA (EPA 213.1 or .2)
Selenium	AA (EPA 270.2 or .3)
Zinc	AA (EPA 289.1 or .2)
Mercury	CV TECH (EPA 245.1)
Lead	AA (EPA 239.1 of .2)
Chromium (total)	AA (EPA 218.1 or .2)
Aluminum	AA (EPA 202.1 or .2)
Copper	AA (EPA 220.1 or .2)
Barium	AA (EPA 208.2)
Boron	Color, CARM (SM 405b) or CURC (EPA 212.3)
Fluoride	Potentiometric (EPA 340.2)
Nitrite	Colorimetric, (EPA 352.1 or 353.2)
Ammonium ion	Potentiometric (EPA 350.3
Total nitrogen (Kjedahl)	Titrimetric (EPA 351.3) or potentiometric (EPA 351.4)
Phosphate (organic)	Laboratory option
Phosphorus (total)	S. Digest (EPA 365.4)

The following tests or examinations will be performed as part of the field sampling activities and are described in detail in Appendices A and B.

- Total dissolved oxygen
- pH
- Conductivity
- Temperature
- Turbidity (surface water only)
- Alkalinity

FIGURE 6-1

Golder Associates
Seal Number
0398

Sent By: _____

Date: _____

EXAMPLE OF TAMPER-PROOF SEAL

CHAIN OF CUSTODY

CLIENT INFORMATION	Contact Person:	Requested Analysis	Page 1 of 1
Company:		Perservative Added	
Address:	**WWTP APDES #:**		
City, State Zip:	**PWS ID #:**		
Phone:	Send Results to ADEC:		☐ Normal Turnaround
Fax:	☐ Yes ☐ No		
Email:	Purchase Order/Charge Code:		☐ RUSH ____ day(s)
Project Name:			
Sampled By:			

Sample Identification	Sample Date	Sample Time	Matrix	PE Lab ID#	Sub Lab ID#	Number of Containers								Sample Comments

Possible Hazard Identification:

☐ *Non-Hazardous* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Unknown*

Sample Condition:

Temperature on arrival: _____ °C *COC Seal:* ☐ *Intact* ☐ *Broken* ☐ *Absent*

Sub Lab Temperature on arrival: _____ °C *COC Seal:* ☐ *Intact* ☐ *Broken* ☐ *Absent*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date & Time:	Received by:	Company:	Date & Time:
Relinquished by:	Company:	Date & Time:	Received by:	Company:	Date & Time:
Relinquished by:	Company:	Date & Time:	Received by:	Company:	Date & Time:

FIGURE 6-2. SAMPLE CHAIN OF CUSTODY RECORD FORM

8. PROCEDURE ALTERATION CHECKLISTS

Changes in the sampling procedures discussed in Section 5 and Appendices A and B may be required in response to field situations, and may be implemented under the authority of the Task Leader provided that they are documented on a Procedure Alteration Checklist (Figure 8-1) and verbally reported to the Project Manager within 24 hours. The Procedure Alteration Checklist shall be submitted to the Appropriate Project Manager and QA Manager for review within 2 working days. All approved Procedure Alteration Checklists will be submitted to the client with the final report. Disapproval of the checklist shall automatically require re-performance of the sampling activity concerned.

9. REVIEW OF ANALYTICAL REPORTS

The results of laboratory analyses (including the duplicate analyses performed as internal quality control checks) shall be submitted to the GAI Project Manager for review and approval prior to transmittal to the client. Acceptance shall be documented by the GAI Project Manager's dated signature on the transmittal memo or submittal letter sent to the client.

10. RECORDS

Copies of all Field Report forms, completed Chain of Custody forms, laboratory analyses and supporting procedures, sample integrity data sheets, and transmittal letters or memoranda shall be retained in project records.

FIGURE 8-1

Procedural Alteration Checklist

Sample Program Identification: _____

Material to be Sampled: _____

Measurement Parameter: _____

Standard Procedure for Analysis: _____

_____

Reference: _____

Variation from Standard Procedure: _____

_____

Reason for Variation: _____

_____

_____

_____

Special Equipment, Material, or Personnel Required: _____

_____

_____

Alteration Requested By: _____ Date: _____

Title: _____

Reviewed by: _____ Title: GAI Project Manager Date: _____

Comments: _____

_____

_____

_____

Reviewed by: _____ Title: GAI QA Officer Date: _____

Comments: _____

_____

_____

_____

SURFACE WATER SAMPLING PROCEDURE

1. METHOD DESCRIPTION

This method uses hand-operated dippers, samplers, or containers to obtain samples from gauging stations or the stream surface. Instructions are also provided for obtaining stream velocity measurements, which may be appropriately conducted in conjunction with sampling.

2. EQUIPMENT REQUIREMENTS

All water sampling devices shall be designed so that only suitable noncontaminating materials (such as glass, teflon, or appropriate grades of stainless steel) come into contact with the water sample. Sampling, velocity measurement, and support equipment may include the following items:

- stainless steel dipper, or decontaminated 1 gallon container, for collecting samples
- calibrated pH/conductivity meter with field calibration solutions
- folding rule
- calibrated dissolved oxygen meter and temperature probe, with field calibration solutions
- sufficient quantities of pure deionized distilled rinse water for in-process decontamination of samplers (roughly 4 gallons)
- small quantity of nitric acid, for preservation of samples for trace metals analysis
- small quantity of sulfuric acid, for preservation of samples
- calibrated turbidimeter, with precleaned test vials
- field alkalinity test kit
- pre-labeled sample containers in sufficient quantities
- Sample Integrity Data Sheets, sample seals, chain of custody forms, and Field Log forms
- cooler or coolers with sufficient capacity for transporting all required samples and "blue ice" refrigerant packages

- 24 size "C" batteries, for "Datapod" and Data Storage Modules (DSMs)
- paper towels
- filtration unit and 45 micron filters
- velocity measurement forms, as required
- survey rod
- digital readout velocity meter
- hip waders

3. PROCEDURE

3.1 Preliminary Activities

Review the location of the sampling or velocity measurement activity on a site map with an appropriate level of detail. Review the scope of the field activity with the Task Leader, prepare all required field equipment (using the bulleted items in Section 2 as a checklist), verify battery charge adequacy where appropriate, and perform all required equipment calibrations. Verify adequacy of containers, coolers, and condition of "blue ice" ice packs.

3.2 Sampling

1. Place all required field measurement calibration solutions in the stream for temperature adjustment; activate the pH/conductivity meter, dissolved oxygen/temperature meter, and turbidimeter. Prepare the filtration unit and alkalinity kit. Calibrate each device as required by the manufacturer's instructions. The dissolved oxygen/temperature meter must remain activated for the entire shift.

2. Samples shall be taken using the type of device most appropriate for the location. Withdraw the sample and transfer it to an appropriate container. Split the primary sample between three sample containers. Filter a portion of the primary sample into a 250 ml container and label the sample as "filtered." Prepare a separate aliquot container for the pH, conductivity, temperature, turbidity, and dissolved oxygen content measurements described in item 4 below.

3. After filling each individual sample container, add the appropriate preservative, immediately cap, seal, and complete the sample container label information. Place all samples in a cooler with a "blue ice" ice pack. Samples must be transported at no more than 4 degrees centigrade.

4. Perform all required field measurements; note that it may take ten minutes or more for readings to stabilize. Using the aliquot sample, measure

the pH to the nearest 0.1 pH unit with a decontaminated probe. Measure conductivity and the temperature at the time of the conductivity reading with a decontaminated probe. Measure dissolved oxygen content. Evaluate turbidity and observe color. Determine alkalinity. Observe weather conditions. Record all values and observations on the Field Report form (Exhibit A) and/or Sample Integrity Data Sheet (Exhibit B) for the corresponding sealed sample.

4. All sampling devices and test probes shall be cleaned as required and decontaminated by a final rinse with pure deionized/ distilled water prior to subsequent sampling activities.

5. After completion of all sampling activities, the Task Leader shall record the completion time on the Field Report.

6. If a gauging station exists at the sampling site, observe the water depth as measured by the "Datapod" and verify by an overcheck with the survey rod or folding rule. Record all values. Check battery condition on the Datapod, and change the DSM and batteries if power and memory is not sufficient to last until the next servicing. Initial and date the servicing log on the Datapod.

3.3 Stream Velocity Measurements

1. Select a stream section no more that a half mile from a gauging station such that:

- the cross section to be measured lies within a straight reach,
- the stream bed at the cross section is relatively free from boulders,
- flow is relatively uniform,
- no tributaries or diversions exist between the gauging station and the section to be measured.

2. Assemble the flowmeter and check operation; locate the line of measurement across the stream and record the distance from an arbitrary entry point to the right and left edge of water (REW/LEW). Record time and gauged height of water from the closest associated station (include rod overcheck measurement as well) on the velocity measurement form (Exhibit C).

3. Wade the measurement line and record water velocities every two feet from REW to LEW (approximately 25 measurements). Meter height must be established at each measurement point; measure the depth using the meter's rod, multiply by 0.6, and subtract from the depth to obtain the required value. Be sure to stand downstream from the meter, and observe the velocity for a minimum of 40 seconds. Note that the velocities may fluctuate in turbulent water, so typical values should be recorded. Repeat the process for each measurement point until LEW is reached. Record completion time and gauge height on the velocity measurement form.

GOLDER ASSOCIATES
4104 148th Avenue NE
Redmond, Washington 98052

(206) 883-0777

Exhibit A

DATE	JOB NO.
PROJECT	
LOCATION	
CONTRACTOR	OWNER
WEATHER	TEMP. °at AM °at PM
PRESENT AT SITE	

O

HE FOLLOWING WAS NOTED:

OPIES TO

FIELD REPORT

SIGNED

Exhibit B

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146- - - -

Sampling Location

Technical Procedure Reference(s)

Type of Sampler

Date Time

Media Station

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of ___ subsamples across channel at depths ___ to ___ feet below water surface

Sample Description Baseline water quality of

Field Measurements on Sample (pH, conductivity, etc.) temperature ___ °C

pH ___ dissolved oxygen ___ mg/l

conductivity ___ umhos/cm turbidity ___ NTU

water level - held staff ___ staff gage ___ Datapod ___

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	none
500 ml		plastic bottle	sulfuric acid
250 ml		plastic bottle	nitric acid
250 ml	filtered	plastic bottle	nitric acid

WEATHER temperature wind

precipitation sunlight

Sampler (signature) Date

Supervisor (signature) Date

Golder Associates

DISCHARGE MEASUREMENT WITH CURRENT METER

Station No.__________

____

____

Date___________________, 19__ Surveyor________________________

Width_________Area_________Velocity__________Discharge__________

Gage Height (fixed)__________(held)_________(Datapod)__________

Method_______________No. sec.______G.H.change______in____hrs.

Conditions____

____

____

____

____

____

Distance from Initial Point	Stream Depth	depth of meter	height of meter	measured velocity	average velocity

GROUNDWATER SAMPLING PROCEDURE

1. METHOD DESCRIPTION

This method uses portable submersible electric pumps, air diaphragm pumps, or bailers of a suitable diameter and design to extract groundwater samples from the monitored interval. All downhole pumps or bailers shall be designed so that only suitable noncontaminating materials (such as glass, teflon, or appropriate grades of stainless steel) come into contact with the groundwater sample.

2. SAMPLING EQUIPMENT REQUIREMENTS

- o portable electric submersible pump or air diaphragm pump with all required tubing and accessories
- o electrical water measuring device or steel measuring tape
- o teflon or stainless steel bailer, with a bottom check valve
- o calibrated pH meter and probe
- o pocket thermometer
- o calibrated conductivity/temperature probe
- o calibrated dissolved oxygen meter
- o sufficient quantities of pure deionized distilled rinse water for in-process decontamination of bailers and probes
- o small quantity of nitric acid, for preservation of samples for trace metals analysis
- o field alkalinity test kit

3. SAMPLING PROCEDURE

3.1 Purge and Stabilize Well

1. Calculate the total well bore storage volume. Subtract the observed depth to water from the logged depth of the well to obtain the actual water column height; add the as-constructed volume of the sand/gravel pack around the well screen.

2. Wells may be sampled using bailers or portable submersible or air bladder style pumps. Either device may be used as a dedicated sampler, (i.e., left in the well and not used to sample other wells) or as a non-dedicated sampler, which may be used to sample other wells. A combination of dedicated and non-dedicated samplers may be used depending on individual well characteristics. Dedicated samplers must be decontaminated with a distilled/deionized water rinse prior to initial installation. Non-dedicated samplers must be similarly decontaminated prior to each use.

Use the sampling device to purge a minimum of two well bore volumes. Purge water must be released onto the surface of the ground at a location where it cannot re-enter the well bore. After two volumes have been purged, measure the conductivity and pH of the purged water at least three times with decontaminated pH, conductivity, and temperature probes to determine if conditions have stabilized. As a general guideline, well conditions will be considered stable if pH readings are within + 0.2 pH units, conductivity is within + 50 millimhos/cm, and temperature readings are within + 0.5 degrees centigrade. Continue pumping until stabilization occurs or five well volumes have been purged; if stabilization has not occurred after five well volumes, the decision to initiate sampling or continue to purge shall be as directed by the Task Leader. A summary of the stabilization process shall be entered in the Field Log along with a description of the well conditions and readings when purging is terminated.

If the well being sampled produces a low yield, it may not be possible to purge two well volumes due to the excessive time required for well recovery. In this case, evacuate at least one complete well volume and allow the well to recover sufficiently to collect a sample. As a general rule, if the well is bailed or pumped dry and does not recover to at least 50% of its initial water level within 30 minutes, use the alternate purging procedure just described. Appropriate entries should be made in the Field Report describing the situation and the actions taken.

3.2 Withdraw Samples

1. When the well has stabilized, the pump shall be activated to obtain groundwater samples, or a sample obtained with a decontaminated downhole bailer. Split the sample between two sample containers (one of which shall have an "M" preparation code for trace metals analysis) and a separate aliquot container for the pH, conductivity, temperature, alkalinity, and dissolved oxygen content measurements described in item 3 below. Immediately measure the temperature of the aliquot sample with a decontaminated pocket thermometer and record on a Field Report from (see Exhibit A).

2. After filling each individual sample container, immediately cap, seal, and record the identification number. Samples for metallic analysis shall be preserved prior to capping by adding nitric acid until the pH is less than 2. Place all samples in a cooler with an icepack that ensures an interior temperature of no more than 4 degrees centigrade. Complete the sample integrity data sheet (Exhibit B).

3. Adjust or calibrate the pH meter, conductivity tester, and dissolved oxygen meter as required. Using the aliquot sample, measure the pH to the nearest 0.1 pH unit with a decontaminated pH probe. Measure conductivity and the temperature at the time of the conductivity reading with a decontaminated probe. Measure dissolved oxygen content. Evaluate turbidity and determine color. Record all values and observations on the Field Report form and or sample integrity data sheet for the corresponding sealed sample.

4. Withdraw the downhole pump equipment from wells not equipped with dedicated sampling devices; all pumps, downhole accessories, bailers, water level measurement devices, and test probes shall be cleaned as required and decontaminated by a final rinse with deionized/distilled water prior to subsequent sampling activities.

5. After completion of all sampling activities, the Task Leader or Field Hydrologist shall ensure that the inner cap is installed on the well and shall lock the protective cover. Record the well closure time on the Field Report form.

GOLDER ASSOCIATES
4104 148th Avenue NE
Redmond, Washington 98052

(206) 883-0777

Exhibit A

DATE	JOB NO.
PROJECT	
LOCATION	
CONTRACTOR	OWNER
WEATHER	TEMP. °at AM °at PM
PRESENT AT SITE	

HE FOLLOWING WAS NOTED:

COPIES TO

FIELD REPORT

SIGNED

Exhibit B

SAMPLE INTEGRITY DATA SHEET

Plant/Site _____ Project No. _____

Site Location _____ Sample ID _____

Sampling Location _____

_____

Technical Procedure Reference(s) _____

Type of Sampler _____

Date _____ Time _____

Media _____ Station _____

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

_____

_____

_____

Sample Description _____

_____

_____

Field Measurements on Sample (pH, conductivity, etc.) _____

_____

_____

_____

Aliquot Amount	Container	Preservation/Amount

Sampler (signature) _____ Date _____

Supervisor (signature) _____ Date _____

Golder Associates

TP-1.4.6
TECHNICAL PROCEDURE FOR WATER LEVEL MEASUREMENT USING A WATER LEVEL SOUNDER OR TAPE MEASURE

1.0 PURPOSE

1.1 This technical procedure is to be used to establish a uniform procedure for measuring water levels in drill holes and piezometers.

2.0 APPLICABILITY

2.1 This technical procedure is applicable to all personnel measuring water levels.

3.0 DEFINITIONS

3.1 Electric Water Level Sounder (EWS). An instrument for measuring water levels in boreholes. An EWS is essentially an open circuit involving an ammeter and battery mounted on a reel on which insulated two-wire electric cord (calibrated by length) is wound. The circuit is closed when the exposed ends of the two wires are immersed in water. Amperage is registered on a meter on the reel.

4.0 REFERENCES

4.1 Cooley, R.L., et al, 1972, Hydrologic Engineering Methods for Water Resources Development, Vol. 10-Principles of Groundwater Hydrology, Section 6.01, U.S. Army Corps of Engineers (HEC-IHD-1000)

5.0 DISCUSSION

5.1 None

6.0 RESPONSIBILITY

6.1 Field Engineer/Geologist: Responsible for measurement in compliance with this technical procedure.

6.2 Task Leader: Responsible for:

- Direct supervision of personnel taking the measurements
- Assurance that equipment and material are available to permit accomplishment of the task

7.0 EQUIPMENT AND MATERIAL

7.1 Electric water-level sounder or measuring tape with a wetting surface.

7.2 Folding rule.

7.3 Field notebook or appropriate Water Level Reading forms (Exhibit A)

7.4 Data on well identification number and locations.

7.5 Spare battery for electric water-level meter.

7.6 Indelible ink pens

8.0 PROCEDURE

8.1 Record well identification number and measuring device type and serial number.

8.2 Each water level sounder or measuring tape used for recording water levels shall have the depth graduations checked with an independent folding rule or measuring tape for calibration prior to use.

8.3 Clean all downhole instruments and equipment before and after measurements between wells. Cleaning shall be with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic free distilled/deionized water.

8.4 Measure and record distance from ground level to top of casing or standpipe. Measure the vertical distance from the top of casing or standpipe to the point of the elevation survey mark (if different from top of casing or standpipe).

8.5 Turn on EWS, check battery, lower wire into borehole or standpipe and stop at depth where amperage indicates a completed circuit. Record length of wire below casing collar or top of standpipe to the nearest 0.01 foot. The markings on the wire line need to be independently checked with a measuring tape for accuracy, both above ground and down-hole.

8.6 If a measuring tape is used, lower the tape (with a weight attached) into the borehole. The tape must be lowered a sufficient length to be submerged within the well water and have it's wettable surface corresponding to the surface of the well water. The total length of the tape within the well (from the top of casing or standpipe) and the length of the wetted surface to the submerged end of the tape shall be recorded.

8.7 For verification of the precision of the instrumentation repeat the above process on one randomly selected well per day of active measurement.

8.8 Record date, time well designation, measuring devince and all measurements on a Water Level Readings Form (Exhibit A) in triplicate. The personnel making the measurement shall initial or aasign each measurement recorded. All Water Level Readings Forms shall be hand delivered to the Project Document Custodian.

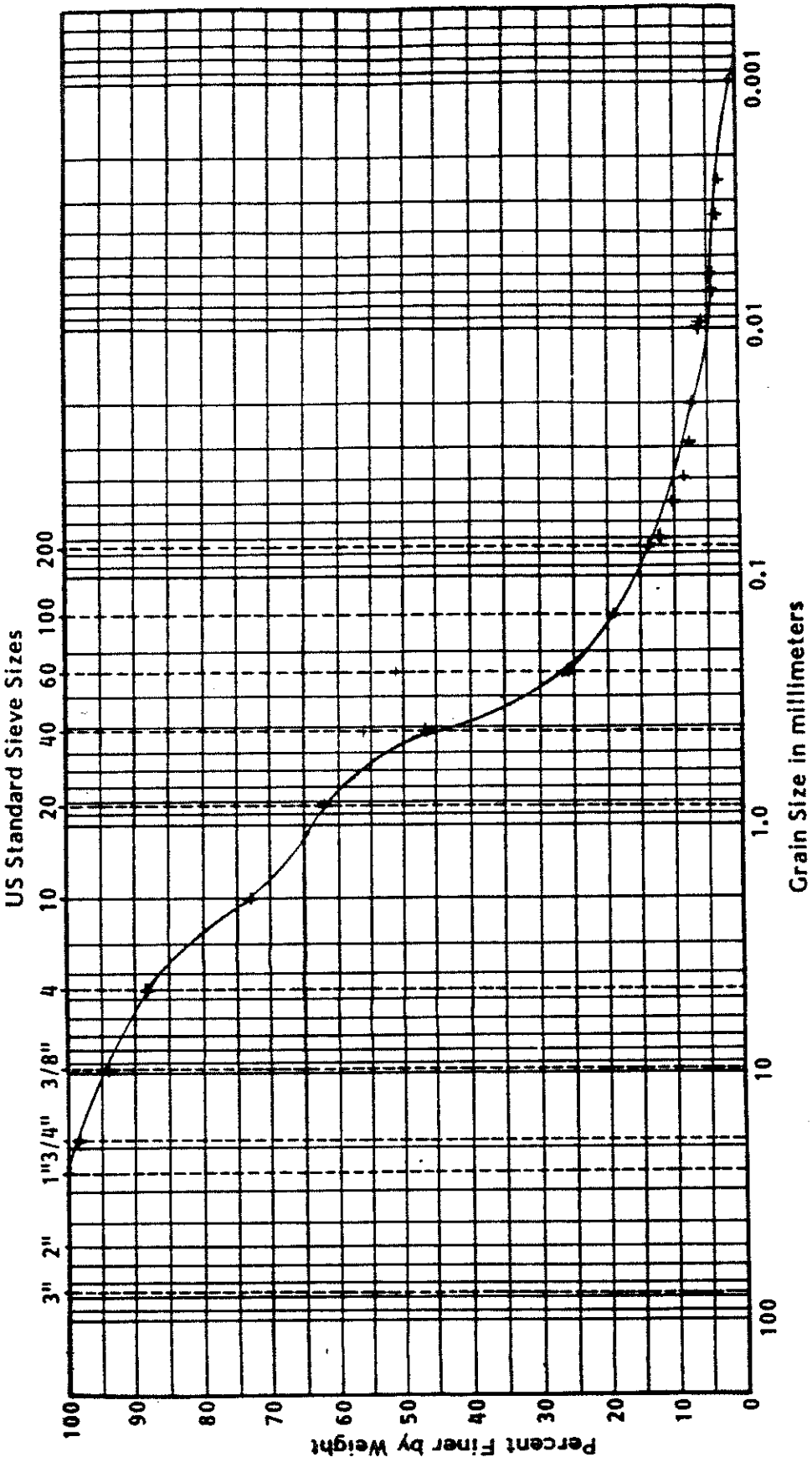
RECORD OF WATER LEVEL READINGS

Job. No. _____ Project Name _____ Location _____

Bore-Hole No.	Date	Time	Measuring Device/ Serial No.	Measurement Point (M.P.)	Water Level below M.P.	Correction to Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments

APPENDIX B

GRAIN SIZE ANALYSES



Boring No.	Elev. or Depth	W_n	W_L	W_p	I_p	Description or Classification
S-1						Dark greenish gray, Silty SAND, little gravel, (SM)

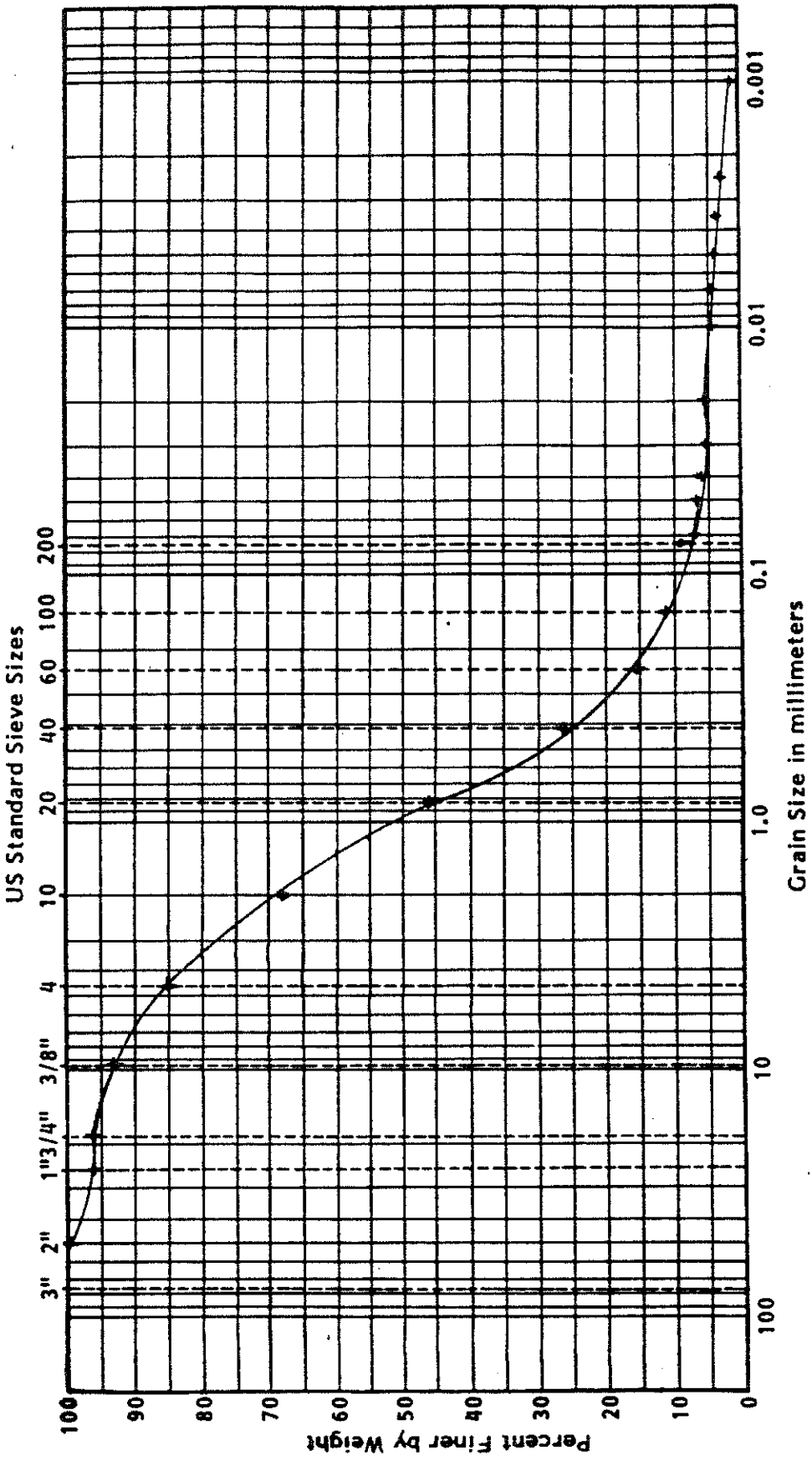
Figure

GRAIN SIZE DISTRIBUTION

Project Wishbone Hills

Project No. 883-2146 Date 9/13/88 Tested by KMM Approved by KKB

Golder Associates



Boring No.	Elev. or Depth	W_n	W_L	W_p	I_p	Description or Classification
S-2						Grayish black, Gravelly SAND, little silt, SW-SM

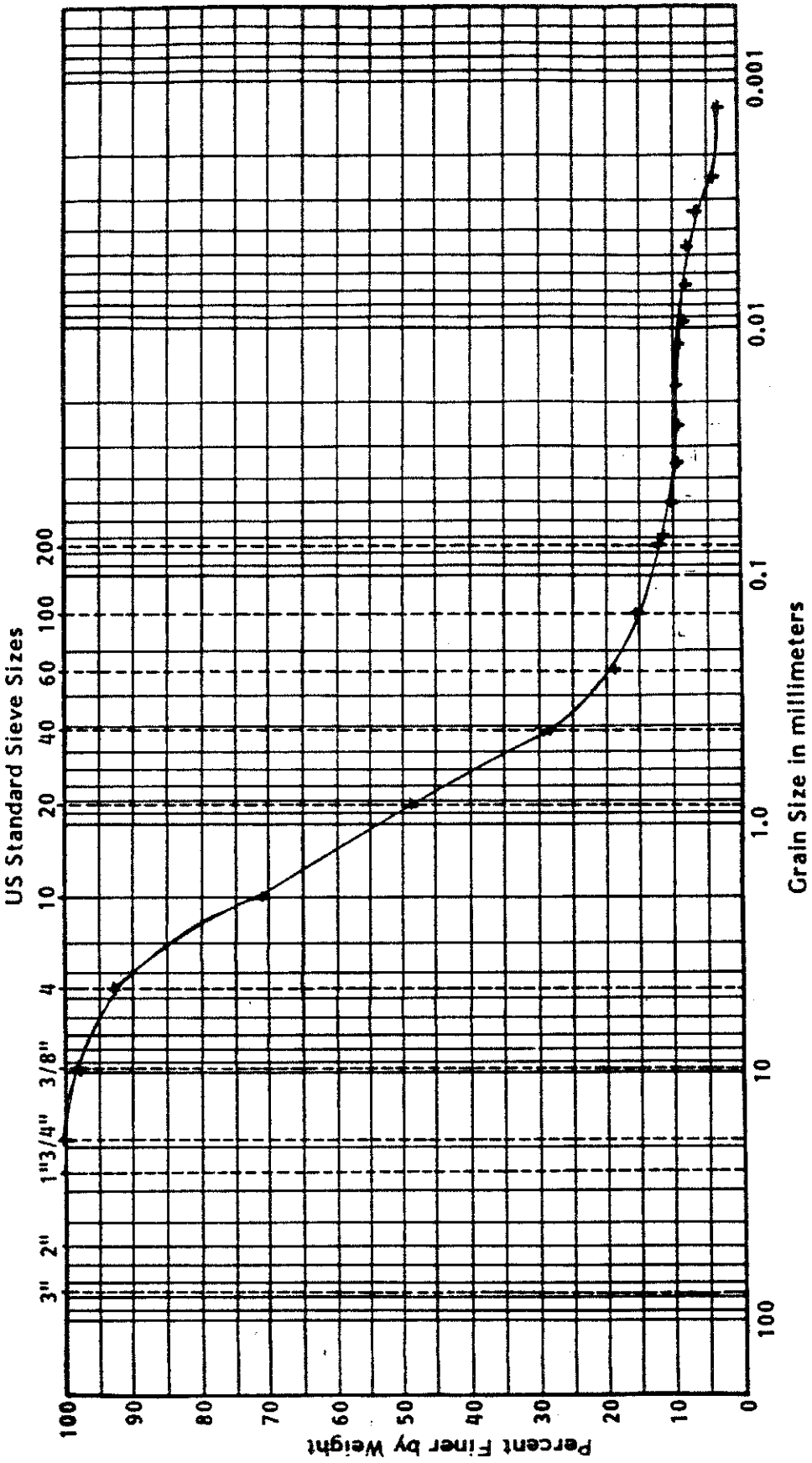
Figure

GRAIN SIZE DISTRIBUTION

Project Wishbone Hills

Project No. 883-2146 Date 9/13/88 Tested by KMM Approved by KRB

Golder Associates



Boring No.	Elev. or Depth	W_n	W_L	W_P	I_P	Description or Classification
S-3						Black, silty SAND, little gravel, SM

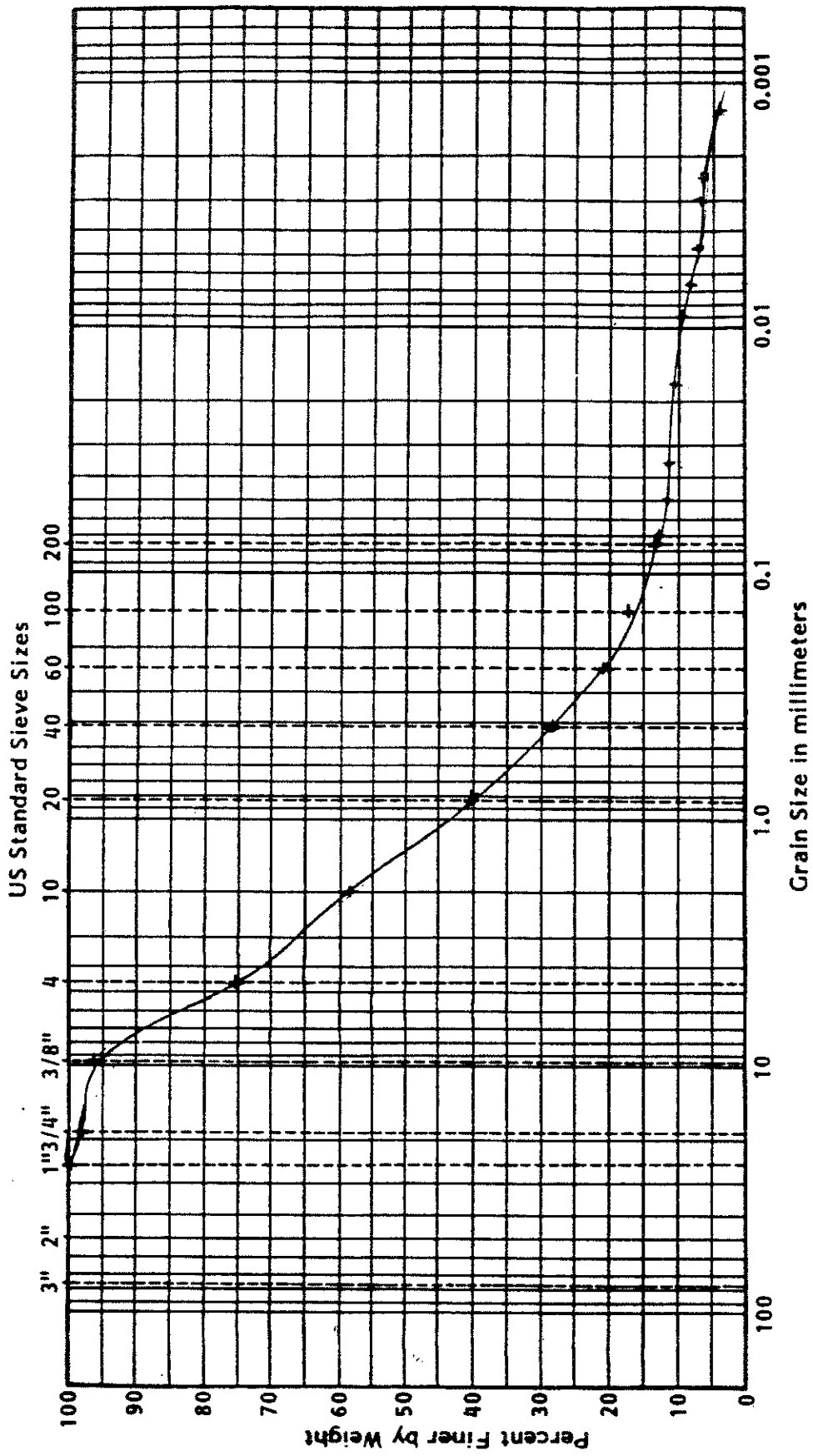
Figure

GRAIN SIZE DISTRIBUTION

Project Wishbone Hills

Project No. 883-2146 Date 9/13/88 Tested by KMM Approved by KMB

Golder Associates



Cobbles	Gravel		Sand			Fines
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

Boring No.	Elev. or Depth	W_n	W_L	W_p	I_p	Description or Classification
S-4						Black, Gravelly SAND, some silt, SM

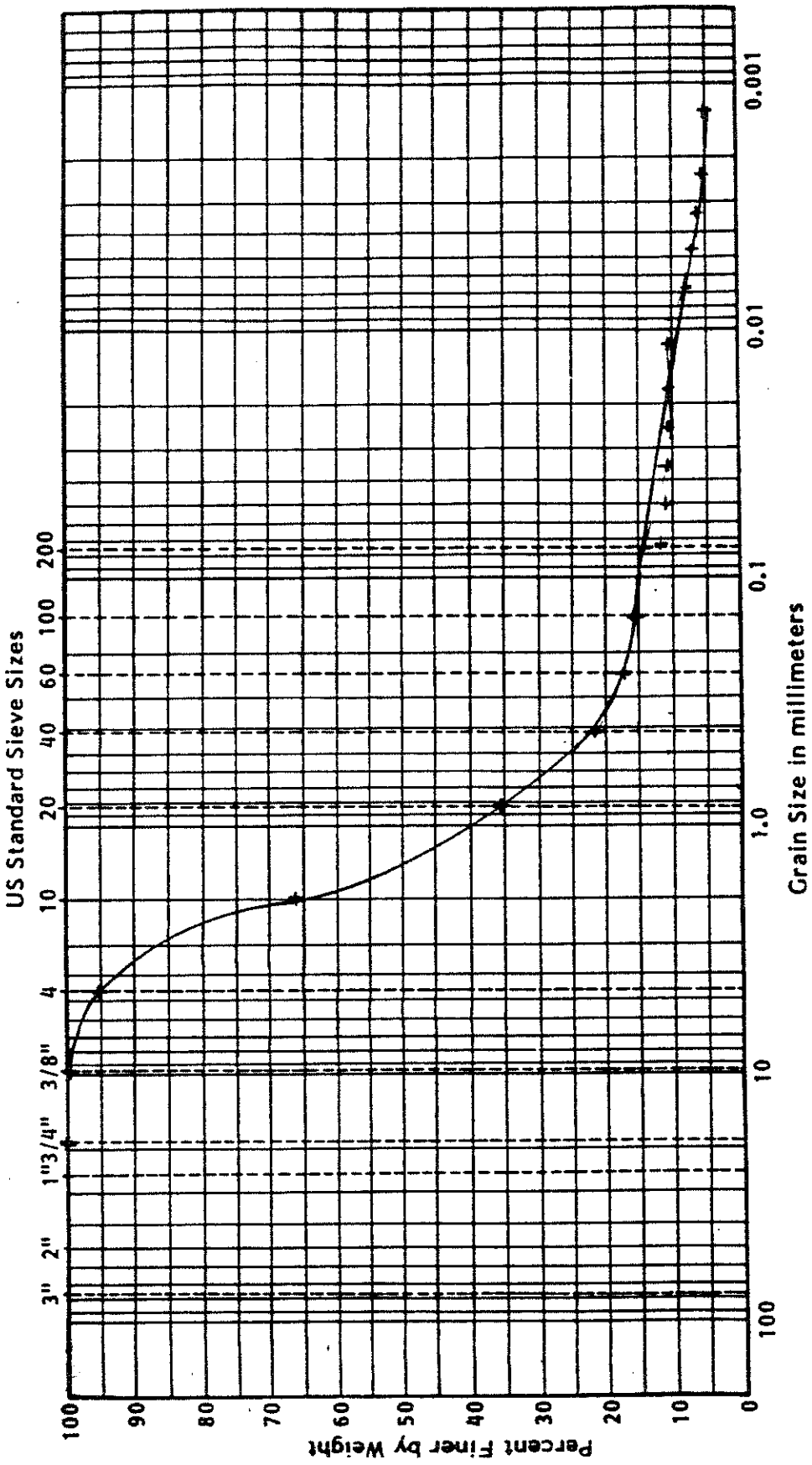
Figure

GRAIN SIZE DISTRIBUTION

Project Wishbone

Project No. 883-2146 Date 9/13/88 Tested by KMM Approved by KKB

Golder Associates



Boring No.	Elev. or Depth	W_n	W_L	W_P	I_P	Description or Classification
S-5						Black, Silty SAND, trace gravel, SM

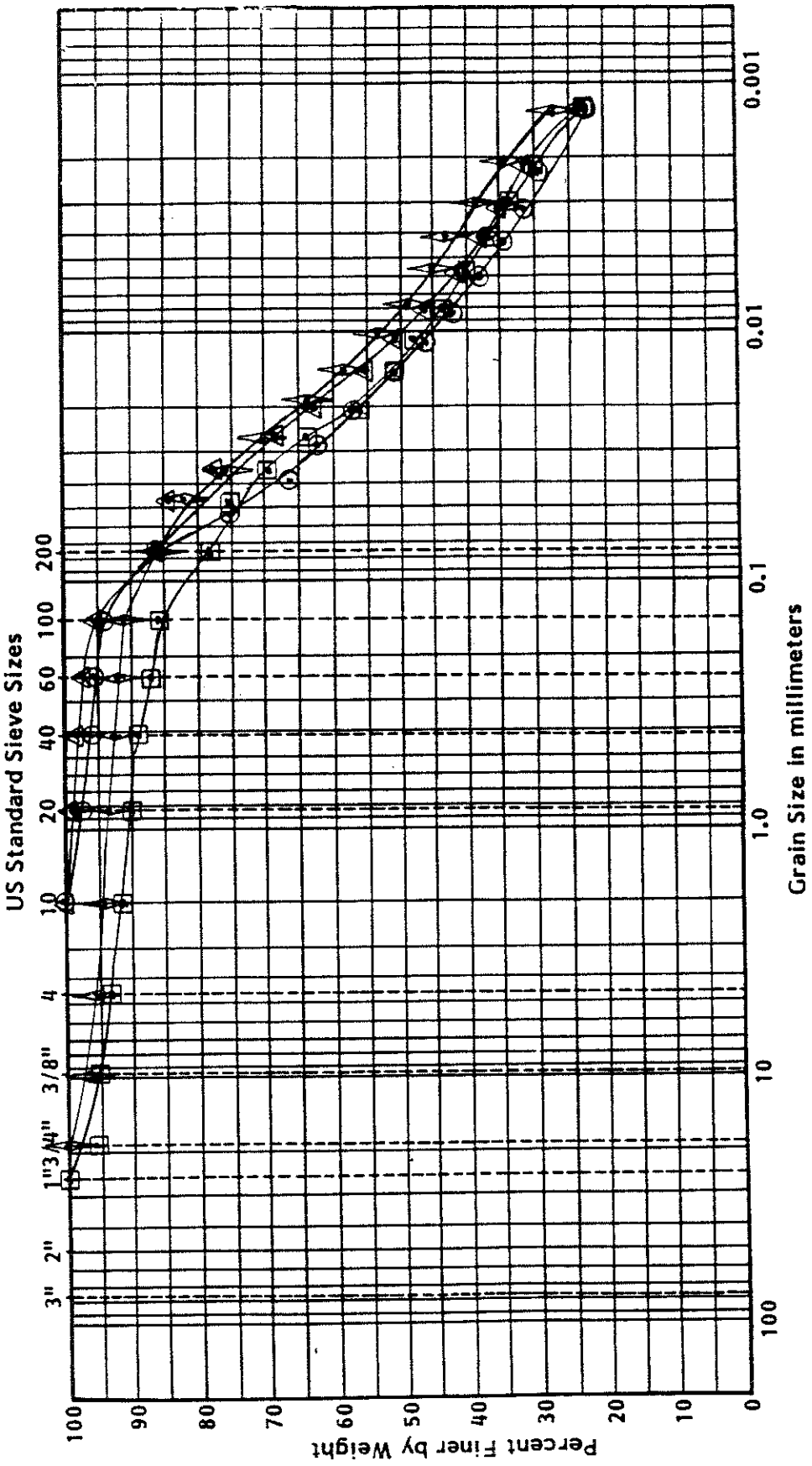
Figure

GRAIN SIZE DISTRIBUTION

Project

Project No. 883-2146 Date 9/13/88 Tested by KMM Approved by RLB

Golder Associates



Boring No.	Elev. or Depth	W_n	W_L	W_P	I_P	Description or Classification
H-88-10, S-1	○					Dusky yellowish brown, SILTY CLAY, some f. sand. (CL)
H-88-10, S-2	△					Dusky yellowish brown, SILTY CLAY, some f. sand. (CL)
H-88-10, S-3	□					Dusky yellowish brown, SILT / CLAY, some sand, little gravel. (CL)
H-88-10, S-4	◇					Dusky yellowish brown, SILTY CLAY, some sand, trace gravel. (CL)

Figure

GRAIN SIZE DISTRIBUTION

Project Wishbone Hills / Hydrol. / AK

Project No. 883-2146 Date 11-18-88 Tested by DPO Approved by KRB

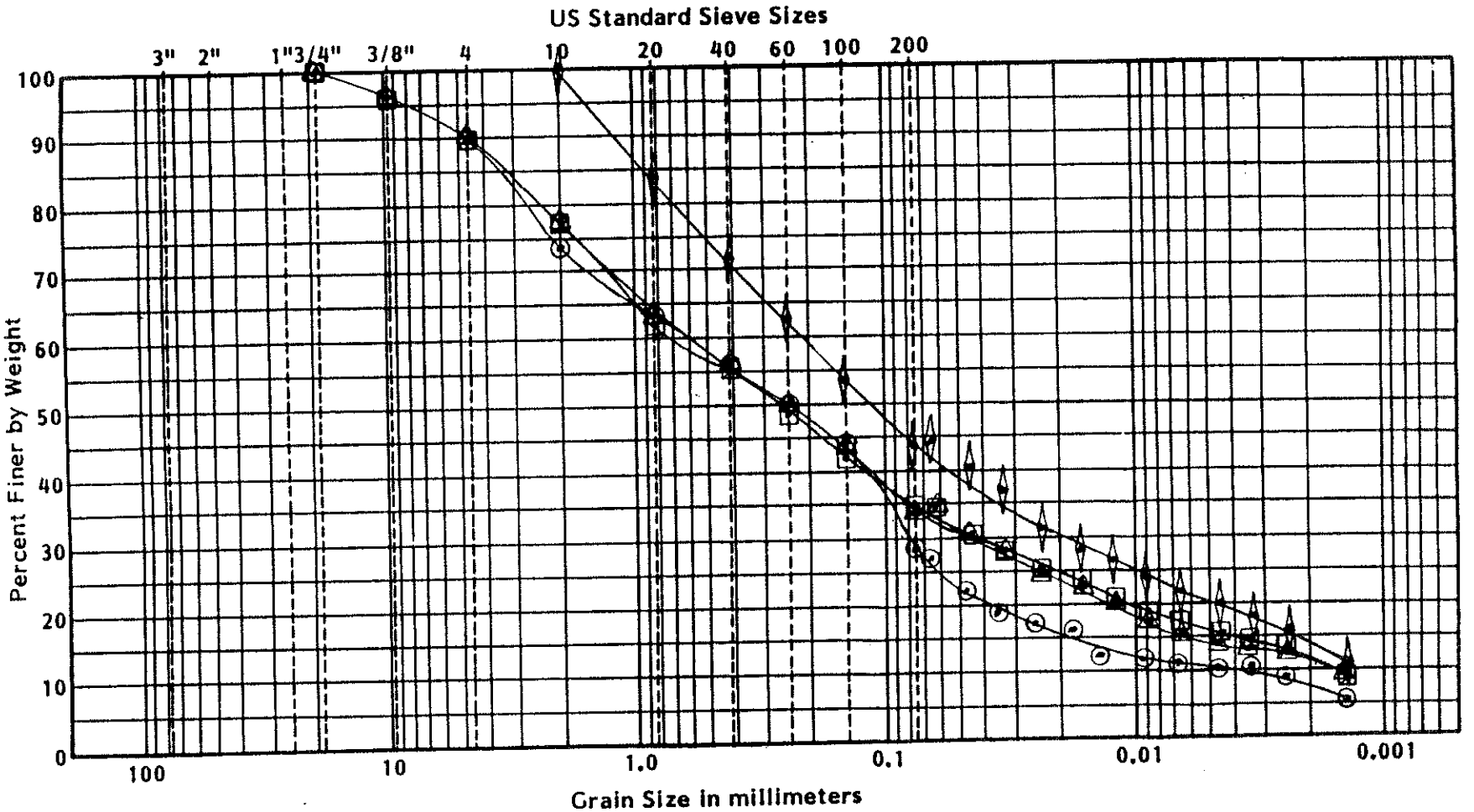
Golder Associates

Project: Wishbone Hills / Hydrol. / AK

Project No. 883-2146 Date 11-18-88 Tested by DPO Approved by KRB

Golder Associates

Figure
GRAIN SIZE DISTRIBUTION



Cobbles	Gravel		Sand			Fines
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

Boring No.	Elev. or Depth	W_n	W_L	W_p	I_p	Description or Classification
H-88-12, S-1	⊖ ⊖					Olive black, F-C SAND, some clayey silt, little f. gravel, trace organics. (SM)
H-88-12, S-2	△ △					Olive black, F-C SAND and CLAYEY SILT, little f. gravel, trace organics. (SM)
H-88-12, S-3	⊟ ⊟					Med. dark grey, F-C SAND and CLAYEY SILT, little f. gravel. (SM)
H-88-12, S-4	◊ ◊					Dusky yellowish brown, F-M SAND and CLAYEY SILT. (SM)

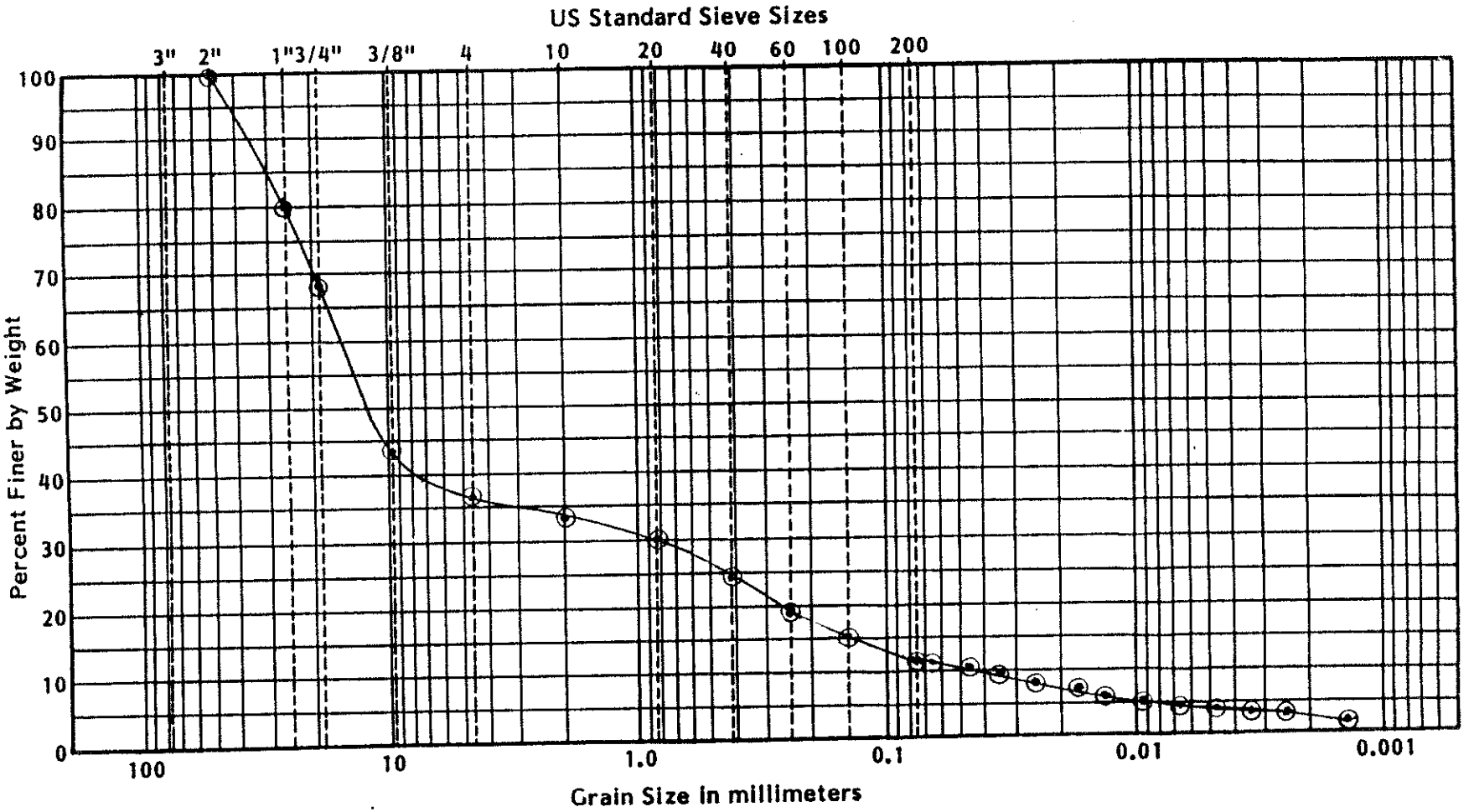
Project: Wishbone Hills / Hydrol. / AK

Project No. 883-2146 Date 11-18-88 Tested by DRO Approved by KMB

Golder Associates

Figure

GRAIN SIZE DISTRIBUTION



Cobbles	Gravel		Sand			Fines
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

Boring No.	Elev. or Depth	W_n	W_L	W_p	I_p	Description or Classification
H-88-21 S1 + S2						Dark yellowish brown, sandy GRAVEL, little silt. (GW-GM) $C_u = 372$ $C_z = 1.0$

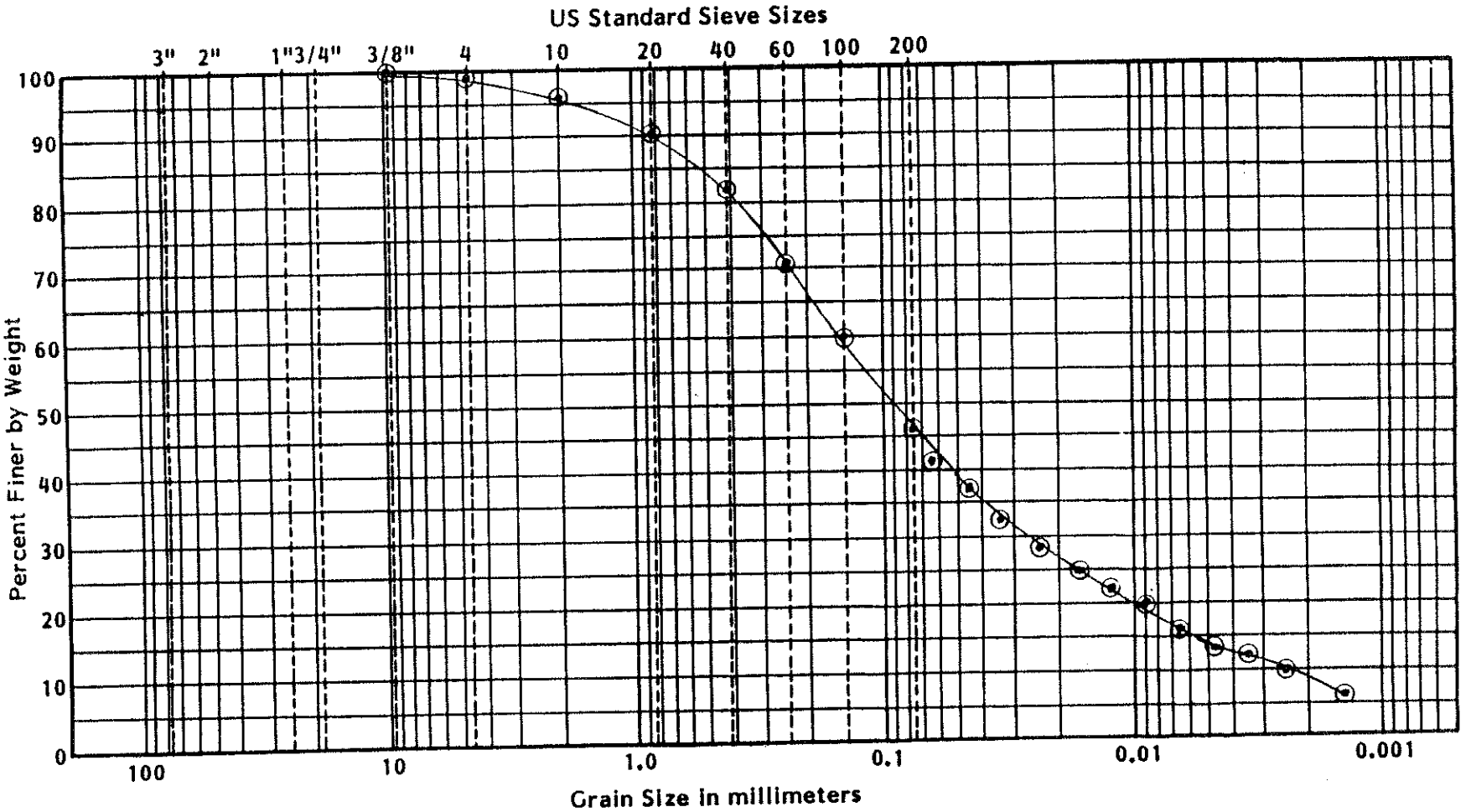
Project Wishbone Hills / Hydrol. / AK

Project No. 883-2146 Date 11-18-88 Tested by DRO Approved by KAB

Golder Associates

Figure

GRAIN SIZE DISTRIBUTION



Cobbles	Gravel		Sand			Fines
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

Boring No.	Elev. or Depth	W_n	W_L	W_p	I_p	Description or Classification
H-88-22 S1 + S2						Dark yellowish brown, F-M SAND and CLAYEY SILT, trace gravel. (SM)

APPENDIX C

LABORATORY ANALYTICAL DATA

SURFACE WATER SAMPLING
STATION #1

MOOSE CREEK

Sample Site: 883-2146-7-30-88-1
Lab No: 886643
Date Sampled: 07/30/88 @ 1339
Date Received: 08/03/88

Lab pH, s.u.	7.28
Lab Conductivity, umhos/cm @ 25C	69
Total Dissolved Solids (180), mg/l	28
Total Dissolved Solids (calc), mg/l	33
Boron, mg/l	0.04
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.002
Total Alkalinity as CaCO3, mg/l	24
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	27
Sodium Adsorption Ratio	0.13
Total Suspended Solids, mg/l	8.0
Settleable Solids, ml/l	<0.1
Turbidity, NTU	1.6

	mg/l	meq/l
Bicarbonate as HCO3	29	0.47
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.12	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	5.3	0.11
Calcium	9.2	0.46
Magnesium	1.1	0.09
Potassium	0.4	0.01
Sodium	1.6	0.07

Major Anions	0.63
Major Cations	0.63
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.17
Manganese	<0.02

Sample Site: 883-2146-83138-1
Lab No: 886861
Date Sampled: 08/31/88 @ 1105
Date Received: 09/02/88

Lab pH, s.u.	7.16
Lab Conductivity, umhos/cm @ 25C	78
Total Dissolved Solids (180), mg/l	24
Total Dissolved Solids (calc), mg/l	37
Boron, mg/l	0.05
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Alkalinity as CaCO3, mg/l	27
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	31
Sodium Adsorption Ratio	0.14
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	32	0.53
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	0.18	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	5.3	0.11
Calcium	11	0.53
Magnesium	1.0	0.08
Potassium	0.3	0.01
Sodium	1.8	0.08

Major Anions	0.70
Major Cations	0.70
Cation/Anion Difference	.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	<0.05
Manganese	<0.02

Sample Site: 883-2146-92388-1
Lab No: 886973
Date Sampled: 09/23/88 @ 1110
Date Received: 09/28/88

Lab pH, s.u.	7.42
Lab Conductivity, umhos/cm @ 25C	92
Total Dissolved Solids (180), mg/l	54
Total Dissolved Solids (calc), mg/l	46
Boron, mg/l	0.07
Fluoride, mg/l	0.10
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.008
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.011
Total Alkalinity as CaCO3, mg/l	31
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	36
Sodium Adsorption Ratio	0.18
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	38	0.62
Carbonate as CO3	0	0.00
Chloride	2.1	0.06
Nitrate as N, mg/l	0.21	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	8.2	0.17
Calcium	13	0.62
Magnesium	1.2	0.10
Potassium	0.4	0.01
Sodium	2.5	0.11

Major Anions	0.87
Major Cations	0.84
Cation/Anion Difference	1.75 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	<0.05
Manganese	<0.02

Sample Site: 883-2146-102188-1
Lab No: 887123
Date Sampled: 10/21/88 @ 1450
Date Received: 10/26/88

Lab pH, s.u.	7.05
Lab Conductivity, umhos/cm @ 25C	104
Total Dissolved Solids (180), mg/l	56
Total Dissolved Solids (calc), mg/l	55
Boron, mg/l	0.08
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.012
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.022
Total Alkalinity as CaCO3, mg/l	36
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	42
Sodium Adsorption Ratio	0.34
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	44	0.72
Carbonate as CO3	0	0.00
Chloride	3.2	0.09
Nitrate as N, mg/l	0.26	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	9.5	0.20
Calcium	14	0.68
Magnesium	1.9	0.16
Potassium	0.4	0.01
Sodium	5.1	0.22

Major Anions	1.03
Major Cations	1.07
Cation/Anion Difference	1.90 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.09
Manganese	<0.02

Sample Site: 883-2146-111888-1
Lab No: 887221
Date Sampled: 11/18/88 @ 1240
Date Received: 11/23/88

Lab pH, s.u.	7.17
Lab Conductivity, umhos/cm @ 25C	118
Total Dissolved Solids (180), mg/l	86
Total Dissolved Solids (calc), mg/l	56
Boron, mg/l	0.36
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.005
Total Alkalinity as CaCO3, mg/l	32
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	43
Sodium Adsorption Ratio	0.21
Color, c.u.	<1
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	39	0.64
Carbonate as CO3	0	0.00
Chloride	3.2	0.09
Nitrate as N, mg/l	0.31	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	14	0.29
Calcium	14	0.71
Magnesium	1.7	0.14
Potassium	0.4	0.01
Sodium	3.3	0.14

Major Anions	1.04
Major Cations	1.00
Cation/Anion Difference	1.96 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.11
Manganese	<0.02

Sample Site: 883-2146-12-20-88-1
Lab No: 887409
Date Sampled: 12/20/88 @ 1215
Date Received: 12/22/88

Lab pH, s.u.	7.53
Lab Conductivity, umhos/cm @ 25C	135
Total Dissolved Solids (180), mg/l	92
Total Dissolved Solids (calc), mg/l	64
Boron, mg/l	0.08
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	0.15
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.007
Total Alkalinity as CaCO3, mg/l	37
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	47
Sodium Adsorption Ratio	0.34
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	45	0.74
Carbonate as CO3	0	0.00
Chloride	5.0	0.14
Nitrate as N, mg/l	0.94	0.07
Nitrite as N, mg/l	<0.01	0.00
Sulfate	14	0.29
Calcium	16	0.81
Magnesium	1.5	0.12
Potassium	0.6	0.02
Sodium	5.2	0.23

Major Anions	1.24
Major Cations	1.18
Cation/Anion Difference	2.48 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.08
Manganese	<0.02

Sample Site: 883-2146-012789-1
Lab No: 897518
Date Sampled: 01/27/89 @ 1430
Date Received: 01/31/89

Lab pH, s.u.	7.31
Lab Conductivity, umhos/cm @ 25C	120
Total Dissolved Solids (180), mg/l	80
Total Dissolved Solids (calc), mg/l	65
Boron, mg/l	0.34
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	<0.001
Total Alkalinity as CaCO3, mg/l	33
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.27
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	40	0.65
Carbonate as CO3	0	0.00
Chloride	6.0	0.17
Nitrate as N, mg/l	0.65	0.05
Nitrite as N, mg/l	<0.01	0.00
Sulfate	16	0.34
Calcium	17	0.84
Magnesium	2.1	0.17
Potassium	<0.2	0.00
Sodium	4.4	0.19

Major Anions	1.21
Major Cations	1.20
Cation/Anion Difference	0.41 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.08
Manganese, mg/l	<0.02

Sample Site: 883-2146-2-24-89-1
Lab No: 897641
Date Sampled: 02/24/89 @ 1445
Date Received: 02/28/89

Lab pH, s.u.	7.33
Lab Conductivity, umhos/cm @ 25C	130
Total Dissolved Solids (180), mg/l	76
Total Dissolved Solids (calc), mg/l	66
Boron, mg/l	0.28
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<.1
Ortho Phosphorus as P, mg/l	0.008
Total Organic Phosphorus as P, mg/l	0.013
Total Phosphorus as P, mg/l	0.024
Total Alkalinity as CaCO3, mg/l	36
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.38
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	43	0.71
Carbonate as CO3	0	0.00
Chloride	8.2	0.23
Nitrate as N, mg/l	0.50	0.04
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	14	0.30
Calcium	8.1	0.40
Magnesium	7.3	0.60
Potassium	0.7	0.02
Sodium	6.1	0.27

Major Anions	1.28
Major Cations	1.29
Cation/Anion Difference	0.39 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	<0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-032289-1
Lab No: 897711
Date Sampled: 03/22/89 @ 1500
Date Received: 03/24/89

Lab pH, s.u.	7.51
Lab Conductivity, umhos/cm @ 25C	129
Total Dissolved Solids (180), mg/l	80
Total Dissolved Solids (calc), mg/l	72
Boron, mg/l	0.20
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.006
Total Alkalinity as CaCO3, mg/l	35
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	52
Sodium Adsorption Ratio	0.33
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	42	0.69
Carbonate as CO3	0	0.00
Chloride	9	0.26
Nitrate as N, mg/l	0.34	0.02
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	17	0.35
Calcium	18	0.92
Magnesium	1.5	0.12
Potassium	0.3	0.01
Sodium	5.6	0.24

Major Anions	1.32
Major Cations	1.29
Cation/Anion Difference	1.15 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	<0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-041589-1
Lab No: 897891
Date Sampled: 04/15/89 @ 1455
Date Received: 04/18/89

Lab pH, s.u.	7.81
Lab Conductivity, umhos/cm @ 25C	155
Total Dissolved Solids (180), mg/l	82
Total Dissolved Solids (calc), mg/l	88
Boron, mg/l	0.39
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.015
Total Organic Phosphorus as P, mg/l	0.023
Total Phosphorus as P, mg/l	0.045
Total Alkalinity as CaCO3, mg/l	51
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	46
Sodium Adsorption Ratio	0.96
Color, c.u.	<1
Total Suspended Solids, mg/l	6
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	62	1.02
Carbonate as CO3	0	0.00
Chloride	5.7	0.16
Nitrate as N, mg/l	0.69	0.05
Nitrite as N, mg/l	<0.01	0.00
Sulfate	18	0.38
Calcium	15	0.73
Magnesium	2.3	0.19
Potassium	1.4	0.03
Sodium	15	0.65

Major Anions	1.61
Major Cations	1.60
Cation/Anion Difference	0.31 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.12
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.66
Manganese, mg/l	0.05

Sample Site: 883-2146-5-16-89-1
Lab No: 898008
Date Sampled: 05/16/89 @ 1000
Date Received: 05/19/89

Lab pH, s.u.	7.68
Lab Conductivity, umhos/cm @ 25C	110
Total Dissolved Solids (180), mg/l	96
Total Dissolved Solids (calc), mg/l	67
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.020
Total Organic Phosphorus as P, mg/l	0.001
Total Phosphorus as P, mg/l	0.026
Total Alkalinity as CaCO3, mg/l	45
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	42
Sodium Adsorption Ratio	0.60
Color, c.u.	<1
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	54	0.89
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.89	0.06
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	12	0.25
Calcium	15	0.75
Magnesium	1.1	0.09
Potassium	0.7	0.02
Sodium	9.0	0.39

Major Anions	1.28
Major Cations	1.25
Cation/Anion Difference	1.19 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.06
Arsenic	<0.005	Lead	0.08
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.06
Manganese, mg/l	<0.02

Sample Site: 883-2146-06-19-89-1
Lab No: 898293
Date Sampled: 06/19/89 @ 1320
Date Received: 06/21/89

Lab pH, s.u.	6.72
Lab Conductivity, umhos/cm @ 25C	57
Total Dissolved Solids (180), mg/l	34
Total Dissolved Solids (calc), mg/l	28
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.007
Total Organic Phosphorus as P, mg/l	0.004
Total Phosphorus as P, mg/l	0.019
Total Alkalinity as CaCO3, mg/l	21
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	25
Sodium Adsorption Ratio	0.12
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	25	0.41
Carbonate as CO3	0.0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.14	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	6.0	0.12
Calcium	4.1	0.20
Magnesium	3.6	0.30
Potassium	0.1	<0.01
Sodium	1.3	0.06

Major Anions	0.57
Major Cations	0.56
Cation/Anion Difference	0.88 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.19
Manganese, mg/l	<0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILL Project No. 883-2146-

Site Location Sample ID 883-2146-7-30-88-1

Sampling Location MOOSE CREEK UPSTREAM

Technical Procedure Reference(s) NONE

Type of Sampler GRAB

Date 7/30/88 Time 1339

Media WATER Station 1

Sample Type: ✓grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) Spatial Composite (Cross-Section) Depth varies, Total Sample volume 1 gallon

Climatic Conditions: Cloudy, last rain 2 days prior to today, Flow - Average

Sample Description Baseline Water Quality Analysis of Moose Creek, upstream of proposed mine location.

Field Measurements on Sample (pH, conductivity, etc.)

Temperature: 9.5 °C Dissolved Oxygen: 11.7 mg/l

PH: 7.2 Conductivity: 70 mhos

Turbidity: Not Sampled

Aliquot Amount	Container	Preservative/Amount
1/2 Gal	Plastic Jar	None
500 ml	Plastic Jar	Sulfuric Acid
250 ml	Plastic Jar	Nitric Acid
250 ml	Plastic Jar	None (Needs Filtering)

Sampler (signature) Date 7-30-88 1445

Supervisor (signature) Date 7-30-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hill Project No. 883 2146

Site Location Moose Ck upstream Sample ID 883-2146-8-31-88-1

Sampling Location Moose Ck upstream of upstream gaging station

Technical Procedure Reference(s) none

Type of Sampler Grab with distilled water jug

Date 8-31-88 Time 11:05

Media water Station 1

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) 1 ft deep across channel

Sample Description baseline water quality in Moose Ck. Data Pad Depth 1.1 to 2.5± / Dye tracer is Pink

Cloudy, Windy ≈ 40°F

Field Measurements on Sample (pH, conductivity, etc.)

temperature	6.5 °C	pH	6.1
D.O.	11.4	conductivity	80
Turbidity	1.2 NTU		

Aliquot Amount	Container	Preservative/Amount
1/2 gal	plastic jug	none
500 ul	" "	sulfuric acid
250 ul	" "	nitric acid
250 ul	" " filtered	nitric acid

Sampler (signature) Christopher J Peck Date 8/31/88

Supervisor (signature) [signature] Date 9-1-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Datapod Status
Bat 5.3 Volts
Bat Unable to change
DSM 37% Full
DSM Not Changed

Plant/Site WISHBONE HILLS Project No. 883-2146
Site Location WISHBONE HILLS Sample ID 883-2146-9-23-88-1
Sampling Location Upstream Moose Creek approx. 20 ft upstream of Datapod

Technical Procedure Reference(s) G.L.s Memo dated 9/21/88
Type of Sampler Plastic distilled Water Jug
Date 9/23/88 Time 10:48
Media Water Station 7
Sample Type: grab time composite (space composite)

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples across channel at depths .1 to .8 feet below water surface through road crossing upstream of datapod.
NOTE: Environmental Surveyors were upstream at time of sampling doing a fish count

Sample Description Baseline water quality of Moose Creek

Transducer lightly covered in silt

Field Measurements on Sample (pH, conductivity, etc.) temperature 2.5°C
pH 7.29 dissolved oxygen 13.2 mg/l
conductivity 112 umhos/cm turbidity .7 NTU
water level - pipe held staff 1.4 staff gage 1.36 Datapod 1.52

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	✓	sulfuric acid
250 ml	plastic bottle	✓	nitric acid
250 ml filtered	plastic bottle	✓	nitric acid

WEATHER temperature 37°F wind NONE
precipitation NONE sunlight Clear Day: Station in shade during sampling

Sampler (signature) Christopher J. Paulsen Date 9/24/88
Supervisor (signature) [illegible] Date 27 Sept. 1988

Golder Associates

SAMPLE INTEGRITY DATA SHEET

DATA POD STATUS
DSM 40% Full Not Change
Bat 5.4 Volts Not Change

Plant/Site WISHBONE HILLS Project No. 883-2146
Site Location WISHBONE HILLS Sample ID 883-2146-10-22-88-1
Sampling Location Moose Creek Upstream
Sample taken ≈ 100 yds Downstream of Data pod
Technical Procedure Reference(s) G.L.S Memo Dated 9/21/88
Type of Sampler Plastic Distilled Water Jug
Date 10/22/88 Time 14:25
Media Water Station 1
Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek
Water is clear, Channel bottom contains no ice or slush, minor icing of shore rocks

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.5 °C
pH 6.39 dissolved oxygen 12.3 mg/l
conductivity 100 umhos/cm turbidity .65 NTU @ 16:30
water level -- held staff 1.2 staff gage 1.1 Datapod 1.257

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Northern Fork of Moose Creek just above datapod, contributing very little to total flow volume, it's at a very low stage, the depth ≈ 6-8"

WEATHER temperature 30°F wind 5 MPH Breeze
precipitation NONE sunlight Clear

Southern Cliff tributary still yellow in color, No Odor Station in the Sun
Slight foam along banks & floating ice

Sampler (signature) [signature] Date 10-23-88
Supervisor (signature) [signature] Date

Transducer level, Measure to Top of Pipe
DwStream 1.05
UpStream 1.30

Golder Associates

Golder Associates	SUBJECT WISHBONE HYDROLOGY		
	Job No. 883-2146	Made by M. MUSIAL	Date 10-24-88
	Ref.	Checked	Sheet 1 of 1
		Reviewed	

ALKALINITY TEST

SAMPLE SITE 883-2146-10-22-88-1

DATE SAMPLED 10-22-88 TIME SAMPLED 14:50

NOTE - ALKALINITY Measurements made in Lab 24+ hrs after sample Collected

DATE TESTED: 10/24/88 TIME TESTED: 0930

WARM Sample 10 min @ Room Temperature. No thermometer available ~ EST ROOM TEMP = 65°

PHENOLPHTHALEIN ALKALINITY

Color After Phenolphthalen — Colorless

TITRATE — Ø

⇒ P Alkalinity → Ø

Sulfuric Acid CARTRIDGE 0.1600

BROMCRESOL GREEN - METHYL RED

Color		Digits
Light Green	—	
✓ Light Greenish Blue-Gray pH 5.1	—	331 ✓
Light Violet GRAY pH 4.8	—	355
Light Pink pH 4.5	—	361

check EQUATION IN MANUAL

TOTAL ALKALINITY = (0.1)(331)

= 33.1 Mg/l as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-18-88-1

Sampling Location Moose Creek Upstream of Mine Site ≈ 300 Ft Downstream of Datapod

Technical Procedure Reference(s) Sampling QA Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/18/88 Time 2:10

Media Water Station 1

Sample Type: grab (time composite) space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Time ~~Spatial~~ composite of 10 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3 °C

@ 14:15 pH 7.17 dissolved oxygen 11.2 mg/l

conductivity 163 umhos/cm turbidity .58 NTU

water level - held staff 1.05' to the staff gage N/Measured Datapod 1.038'

Top of Pipe @ upstream edge,

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	In Anchorage Lab on 11/21/88 ✓ nitric acid

Note: pH/Conductivity Meter GAI ID # C0010

Field Measurements performed back in Car.

WEATHER temperature 40°F wind Gusting to 15mph

precipitation NONE sunlight Clear

Was unable to get filtering device to work @ 13:30

Sampler (signature) Christopher J. Poole Date 11/20/88

Supervisor (signature) JV Date 12/9/89

Golder Associates

Golder Associates

SUBJECT Wishbone		
Job No. 883-2146	Made by MWSLAC	Date 11-22-88
Ref.	Checked	Sheet 1 of 1
	Reviewed	

STA 1 11-22-88 1110 hrs

Alkalinity Test

Titration Cartridge 0.16 N_2SO_4

P ALK

Clear - P ALK = 0

T ALK

Lt grish Blu gray = 302 units

T ALK = 302 x 0.1 = 30.2 mg/ea $CaCO_3$ / l

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-20-88-1

Sampling Location Moose Creek Upstream
≅ 500 Ft downstream of Datapod

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0

Type of Sampler Distilled Water Jug

Date 12/20/88 Time 12:15

Media Water Station I

Sample Type: grab (time composite) space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.
Spatial composite of 5 subsamples across channel at depths 0 to .6 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1 °C
pH 7.25 dissolved oxygen 12.8 mg/l
conductivity 128 umhos/cm turbidity .36 NTU @ 11:07 on 12/22
water level - held staff .95 staff gage .86 Datapod .956

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 31°F wind NONE
precipitation Lightly Snowing sunlight High Overcast

Sampler (signature) Christopher J. Fairley Date 12/21/88

Supervisor (signature) Date

Golder Associates

Golder Associates	SUBJECT Wise Bore Hole - Hydrolab		
	Job No. Ref.	Made by Checked Reviewed	Date 12-20-88 Sheet of

WATER QUALITY TEST

ALKALINITY

STATION # 1

TIME/TESTED 18:08:02

TITRATION CARTRIDGE = 1.600

P. ALK

COLOR

CLEAR

P. ALK = 0

T. ALK

LT GRNISH BLU GRAY = 72

72 X 1.0 = 72.0 mg/L as $CaCO_3$

LT. VIOLET GRAY BLUE = 76

TO LT PINK = 81

T. ALK = 81 X 1.0 = 81.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-1-27-89-1

Sampling Location Moose Creek ≈ 75 ft upstream of the Data Pod. Note: Samples do not include water from the cliff tributary

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled Water Jug

Date 1/27/89 Time 14:30

Media Water Station 1

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to .3 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.0 °C
@ 9:05pm pH 7.36 dissolved oxygen 13.2 mg/l
conductivity 164 umhos/cm turbidity .2 NTU @ 7:30 pm 1/28
water level - held staff N/A staff gage Unreadable Datapod Not Working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature -30°F wind 5 mph
precipitation None sunlight Clear sunny Snowing in state

Sampler (signature) Christopher J. Fowler Date 1/30/89
Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKILINITY

STATION #1 - Sample Taken = 1-27-89 @ [illegible]
- Sample Tested = 1-28-89 @ [illegible]

TITRATION CARTRIDGE : 1.600

P. ALKILINITY

COLOR = CLEAR > P. ALK = 0

T. ALK

LT. GRNISH BLU GRAY: = 47 UNITS

T. ALK: 47 X 1.0 = 47 mg/L As $CaCO_3$

LT. VIOLET GRAY : = 49

TO LT. PINK : = 50

T. ALK : 50 X 1.0 = 50 mg/L As $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-2-24-89-1

Sampling Location Moose Crk. Upstream
≈200 Ft Downstream of Pataved below 2 big rocks

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled Water

Date 2/24/89 Time 14:45

Media Water Station 1

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C
@15:00 pH 6.71 dissolved oxygen 13.7 mg/l
conductivity 169 umhos/cm turbidity 1.1 NTU @20:50
water level - held staff N/A staff gage unreadable Datapod Not Working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 36°F wind 5 mph
precipitation NONE sunlight Partly Sunny

Sampler (signature) Christopher J Paulin Date 2/27/89
Supervisor (signature) [illegible] Date 3/15/89

Golder Associates

Golder Associates	SUBJECT [illegible]
	Job No. [illegible] Ref.
	Made by [illegible] Checked Reviewed
	Date [illegible] Sheet 1 of [illegible]

ALKALINITY

STATION: NO. 1

STATION I.D:

Sample Taken:
Sample Tested = 20:53

TITRATION CARTRIDGE = 1.600N

P. ALK -

color - CLEAR - P. ALK = 0

T. ALK -

LT. GREENISH BLUE GRAY = 23 UNITS

T. ALK = 23 X 1.0 = 23.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-22-89-1

Sampling Location Moose Creek ≈ 100 Ft below 2 big rocks ≈ 500 Ft down stream of Datapod

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 3/22/89 Time 15:00

Media Water Station 1

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0.5 °C

pH 7.33 dissolved oxygen 14.3 mg/l

conductivity 173 umhos/cm turbidity 0.5 NTU @ 11:47 3/23

water level - held staff Not Measured staff gage Unreadable Datapod Not Working

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
1000 ~~500~~ ml		plastic bottle	✓ sulfuric acid
250 ml		plastic bottle	✓ nitric acid
250 ml	filtered	plastic bottle	✓ nitric acid

WEATHER temperature 46°F wind None

precipitation None sunlight High Overcast

4-6" Snow Previous Night

Sampler (signature) Christopher J. Paulsen Date 3/23/89

Supervisor (signature) [illegible] Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No. 8832146 Ref.	Made by MWGRADERBER Checked Reviewed	Date 3-22-89 Sheet 1 of 1

ALKALINITY

STATION: #1

STATION I.D. = 8832146 · 3-22-89 - 1

Sample Taken: 3-22-89

Sample Tested: 21:18 3-22-89

P. ALK

COLOR - CLEAR - P. ALK = 0

T. ALK

LT. GREENISH BLUE GRAY = 30 UNITS

T. ALK = 30 x 1.0 = 30.0 mg/L as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-15-89-1

Sampling Location Moose Creek ≅ 100 Ft Downstream of two BIG conglomerate rocks; ≅ 1000 Ft Downstream Datapod

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -C-

Type of Sampler Plastic Distilled Water Jug

Date 4/15/89 Time 14:55

Media Water Station 1

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 7 subsamples across channel at depths 0 to .3 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C

pH 7.60 dissolved oxygen 13.4 mg/l

conductivity 187 umhos/cm turbidity 8.3 NTU @ 13:42 4/16

water level - held staff .75 staff gage .7 Datapod Not Working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 49°F wind 3-5 MPH

precipitation NONE sunlight Clear / Sunny

Sampler (signature) Christopher J. Hughes Date 4/16/89

Supervisor (signature) [illegible] Date 4/20/89

Golder Associates

4/16/89 Alkalinity on Station # 1 883-2146 CTP

Sample taken : 4/15 14:55
" Tested : 4/16 15:06

No Pink P. Alk. = Ø

Bl.-Gy 432 x .1 = T. Alk. = 43.2 mg/l $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-16-89-1

Sampling Location Moose Creek Upstream

100 Ft below 2 big Conglomerate rocks

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -C-

Type of Sampler Plastic Distilled Water Jar

Date 5/16/89 Time 10:00

Media Water Station 1

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 5 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C

pH 6.81 dissolved oxygen 13.6 mg/l

conductivity 134 umhos/cm turbidity 2.6 NTU @ 10:25

water level - held staff 1.03 Ft staff gage 1.04 Ft Datapod 1.16 Ft

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 39°F wind None

precipitation None sunlight Clear, In Shade

Rain w/in Past Some

Sampler (signature) Christopher J. Pauley Date 5/17/89

Supervisor (signature) [illegible] Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT May Water Quality Run		
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 1 of 7
	Reviewed	

ALKALINITY

Station # 1

Sample Taken = 10:00 5/17

Sample Tested = 16:17 5/17

Titration Cartridge .6 N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl.-Gy

#Units x Multiplier = 340 x .1 = 34.0 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-1

Sampling Location Moose Creek @ the footbridge, 200 Ft upstream of datapod

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. 0

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 13:20

Media Water Station 1

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 8 °C

pH 7.25 dissolved oxygen 12.4 mg/l

conductivity 59 umhos/cm turbidity 2.3 NTU @ 13:25 6/19

water level - held staff unable to measure to deep/swift staff gage 1.75 Datapod 2.013

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 71°F wind 5mph

precipitation NONE sunlight Sunny & Clear

Sampler (signature) Christopher L. Fuller Date June 20, 1989

Supervisor (signature) JV Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT	JUNE Water Quality Run	
Job No. 883-2146	Made by CJP	Date 6/20/89
Ref.	Checked	Sheet 1 of 7
	Reviewed	

ALKALINITY

Station # 1

Sample Taken = 13:20 6/19

Sample Tested = 13:20

Titration Cartridge .6 N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description - VT - GY

#Units x Multiplier = 185 x 0.1 = 18.5 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146-002

Site Location WISHBONE HILLS Sample ID 883-2146-7-20-89-1

Sampling Location Moose Creek Upstream in the truck crossing ≈ 50 Ft upstream of the Datapod

Technical Procedure Reference(s) Sampling Q. H. Plan Rev. 0

Type of Sampler Plastic Disposable Wide Jug

Date 7/20/89 Time 19:15

Media Water Station 1

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to 1.5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 7.5 °C
pH 7.10 dissolved oxygen 11.2 mg/l
conductivity 53 umhos/cm turbidity 3.5 NTU
water level - held staff 1.75 Ft staff gage 1.59 Ft Datapod 1.801 Ft

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 57° F wind 5-8 Breeze
precipitation None sunlight Clear

Sampler (signature) Christopher J. Paulo Date July 21, 1989
Supervisor (signature) [illegible] Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality		
Job No. 883-2146-002	Made by CJP	Date 7/21/89
Ref. McKinley Mining	Checked	Sheet 1 of 7
	Reviewed	

ALKALINITY

Station # 7

Sample Taken = 19:15 7/20

Sample Tested = 14:18 7/21

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/L

T. ALK -

Color Description - BL/Gy

#Units x Multiplier = 192 x .1 = 19.2 mg/L = T. ALK

SURFACE WATER SAMPLING
STATION #2

PREMIER CREEK

Sample Site: 883-2146-7-30-88-2
Lab No: 886644
Date Sampled: 07/30/88 @ 1504
Date Received: 08/03/88

Lab pH, s.u.	7.66
Lab Conductivity, umhos/cm @ 25C	108
Total Dissolved Solids (180), mg/l	50
Total Dissolved Solids (calc), mg/l	53
Boron, mg/l	0.03
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	<0.002
Total Organic Phosphorus as P, mg/l	0.007
Total Alkalinity as CaCO3, mg/l	50
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	47
Sodium Adsorption Ratio	0.22
Total Suspended Solids, mg/l	6.0
Settleable Solids, ml/l	<0.1
Turbidity, NTU	1.2

	mg/l	meq/l
Bicarbonate as HCO3	61	1.00
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.37	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	2.1	0.04
Calcium	13	0.66
Magnesium	3.4	0.28
Potassium	0.4	0.01
Sodium	3.4	0.15

Major Anions	1.10
Major Cations	1.10
Cation/Anion Difference	.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.41
Manganese	0.02

Sample Site: 883-2146-83188-2
Lab No: 886862
Date Sampled: 08/31/88 @ 1240
Date Received: 09/02/88

Lab pH, s.u.	7.57
Lab Conductivity, umhos/cm @ 25C	114
Total Dissolved Solids (180), mg/l	48
Total Dissolved Solids (calc), mg/l	55
Boron, mg/l	0.02
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	0.002
Total Alkalinity as CaCO3, mg/l	54
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.20
Total Suspended Solids, mg/l	4
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	65	1.07
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.34	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.8	0.02
Calcium	15	0.77
Magnesium	2.8	0.23
Potassium	0.3	0.01
Sodium	3.3	0.14

Major Anions	1.13
Major Cations	1.15
Cation/Anion Difference	0.88 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	0.03
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.09
Manganese	<0.02

Sample Site: 883-2146-92388-2
Lab No: 886974
Date Sampled: 09/23/88 @ 1642
Date Received: 09/28/88

Lab pH, s.u.	7.62
Lab Conductivity, umhos/cm @ 25C	97
Total Dissolved Solids (180), mg/l	52
Total Dissolved Solids (calc), mg/l	47
Boron, mg/l	<0.01
Fluoride, mg/l	0.10
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.008
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.018
Total Alkalinity as CaCO3, mg/l	43
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	41
Sodium Adsorption Ratio	0.22
Total Suspended Solids, mg/l	9
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	52	0.85
Carbonate as CO3	0	0.00
Chloride	0.4	0.01
Nitrate as N, mg/l	0.53	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	2.3	0.05
Calcium	13	0.66
Magnesium	1.9	0.16
Potassium	0.6	0.01
Sodium	3.2	0.14

Major Anions	0.95
Major Cations	0.97
Cation/Anion Difference	1.04 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.25
Manganese	<0.02

Sample Site: 883-2146-102188-2
Lab No: 887121
Date Sampled: 10/21/88 @ 1735
Date Received: 10/26/88

Lab pH, s.u.	7.10
Lab Conductivity, umhos/cm @ 25C	92
Total Dissolved Solids (180), mg/l	58
Total Dissolved Solids (calc), mg/l	49
Boron, mg/l	0.02
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.012
Total Organic Phosphorus as P, mg/l	0.014
Total Phosphorus as P, mg/l	0.042
Total Alkalinity as CaCO3, mg/l	46
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	45
Sodium Adsorption Ratio	0.21
Color, c.u.	<1
Total Suspended Solids, mg/l	4
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	56	0.92
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.57	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.8	0.02
Calcium	14	0.68
Magnesium	2.6	0.21
Potassium	0.3	0.01
Sodium	3.2	0.14

Major Anions	1.01
Major Cations	1.04
Cation/Anion Difference	1.46 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.35
Manganese	<0.02

Sample Site: 883-2146-111888-2
Lab No: 887222
Date Sampled: 11/18/88 @ 1650
Date Received: 11/23/88

Lab pH, s.u.	7.19
Lab Conductivity, umhos/cm @ 25C	98
Total Dissolved Solids (180), mg/l	78
Total Dissolved Solids (calc), mg/l	54
Boron, mg/l	0.28
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	0.08
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.004
Total Phosphorus as P, mg/l	0.013
Total Alkalinity as CaCO3, mg/l	52
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	48
Sodium Adsorption Ratio	0.20
Color, c.u.	<1
Total Suspended Solids, mg/l	10
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	63	1.03
Carbonate as CO3	0	0.00
Chloride	0.4	0.01
Nitrate as N, mg/l	0.49	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	2.1	0.04
Calcium	15	0.74
Magnesium	2.8	0.23
Potassium	0.3	0.01
Sodium	3.3	0.14

Major Anions	1.12
Major Cations	1.12
Cation/Anion Difference	.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.16
Manganese	<0.02

Sample Site: 883-2146-12-19-88-2
Lab No: 887410
Date Sampled: 12/19/88 @ 1540
Date Received: 12/22/88

Lab pH, s.u.	7.68
Lab Conductivity, umhos/cm @ 25C	103
Total Dissolved Solids (180), mg/l	70
Total Dissolved Solids (calc), mg/l	54
Boron, mg/l	0.01
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	0.35
Total Kjeldahl Nitrogen, mg/l	0.4
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.011
Total Alkalinity as CaCO3, mg/l	52
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	51
Sodium Adsorption Ratio	0.15
Color, c.u.	<1
Total Suspended Solids, mg/l	9
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	63	1.03
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.56	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.8	0.02
Calcium	15	0.76
Magnesium	3.0	0.25
Potassium	0.3	0.01
Sodium	2.6	0.11

Major Anions	1.11
Major Cations	1.13
Cation/Anion Difference	0.89 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.11
Manganese	<0.02

Sample Site: 883-2146-012989-2
Lab No: 897519
Date Sampled: 01/29/89 @ 1320
Date Received: 01/31/89

Lab pH, s.u.	7.74
Lab Conductivity, umhos/cm @ 25C	109
Total Dissolved Solids (180), mg/l	66
Total Dissolved Solids (calc), mg/l	55
Boron, mg/l	0.26
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	<0.001
Total Alkalinity as CaCO3, mg/l	51
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.23
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	62	1.02
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.58	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.2	0.03
Calcium	17	0.84
Magnesium	2.1	0.17
Potassium	<0.2	0.00
Sodium	3.7	0.16

Major Anions	1.12
Major Cations	1.17
Cation/Anion Difference	2.18 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.24
Manganese, mg/l	<0.02

Sample Site: 883-2146-012789-2 (DUPLICATE ANALYSES)
Lab No: 897522
Date Sampled: 01/29/89 @ 1320
Date Received: 01/31/89

Lab pH, s.u.	7.72
Lab Conductivity, umhos/cm @ 25C	107
Total Dissolved Solids (180), mg/l	68
Total Dissolved Solids (calc), mg/l	55
Boron, mg/l	0.32
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	<0.001
Total Alkalinity as CaCO3, mg/l	51
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.24
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	62	1.02
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.56	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.4	0.03
Calcium	16	0.80
Magnesium	2.6	0.21
Potassium	<0.2	0.00
Sodium	3.9	0.17

Major Anions	1.12
Major Cations	1.18
Cation/Anion Difference	2.61 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.21
Manganese, mg/l	<0.02

Sample Site: 883-2146-2-24-89-2
Lab No: 897642
Date Sampled: 02/24/89 @ 1840
Date Received: 02/28/89

Lab pH, s.u.	7.61
Lab Conductivity, umhos/cm @ 25C	102
Total Dissolved Solids (180), mg/l	70
Total Dissolved Solids (calc), mg/l	55
Boron, mg/l	0.21
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.005
Total Alkalinity as CaCO3, mg/l	58
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	50
Sodium Adsorption Ratio	0.27
Color, c.u.	<1
Total Suspended Solids, mg/l	4
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	70	1.15
Carbonate as CO3	0	0.00
Chloride	<1.0	<0.01
Nitrate as N, mg/l	0.60	0.04
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.6	0.01
Calcium	7.7	0.38
Magnesium	7.5	0.62
Potassium	0.6	0.02
Sodium	4.4	0.19

Major Anions	1.20
Major Cations	1.21
Cation/Anion Difference	0.41 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.04

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.07
Manganese, mg/l	<0.02

Sample Site: 883-2146-032189-2
Lab No: 897705
Date Sampled: 03/21/89 @ 1330
Date Received: 03/23/89

Lab pH, s.u.	7.68
Lab Conductivity, umhos/cm @ 25C	105
Total Dissolved Solids (180), mg/l	58
Total Dissolved Solids (calc), mg/l	59
Boron, mg/l	0.26
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.013
Total Phosphorus as P, mg/l	0.020
Total Alkalinity as CaCO3, mg/l	57
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	0.21
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	70	1.14
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.50	0.04
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.2	0.03
Calcium	15.7	0.79
Magnesium	3.2	0.26
Potassium	0.7	0.02
Sodium	3.5	0.15

Major Anions	1.23
Major Cations	1.22
Cation/Anion Difference	0.41 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.07
Manganese, mg/l	<0.02

Sample Site: 883-2146-032189-2 (Duplicate Analysis)
Lab No: 897706
Date Sampled: 03/21/89 @ 1330
Date Received: 03/23/89

Lab pH, s.u.	7.67
Lab Conductivity, umhos/cm @ 25C	108
Total Dissolved Solids (180), mg/l	64
Total Dissolved Solids (calc), mg/l	59
Boron, mg/l	0.20
Fluoride, mg/l	0.07
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.014
Total Phosphorus as P, mg/l	0.021
Total Alkalinity as CaCO3, mg/l	57
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	52
Sodium Adsorption Ratio	0.21
Color, c.u.	<1
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	70	1.14
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.49	0.04
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	2.1	0.04
Calcium	15.1	0.75
Magnesium	3.6	0.30
Potassium	0.4	0.01
Sodium	3.4	0.15

Major Anions	1.24
Major Cations	1.21
Cation/Anion Difference	1.22 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.06
Manganese, mg/l	<0.02

Sample Site: 883-2146-041489-2
Lab No: 897892
Date Sampled: 04/14/89 @ 1755
Date Received: 04/18/89

Lab pH, s.u.	7.55
Lab Conductivity, umhos/cm @ 25C	89
Total Dissolved Solids (180), mg/l	50
Total Dissolved Solids (calc), mg/l	44
Boron, mg/l	0.40
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	0.4
Ortho Phosphorus as P, mg/l	0.013
Total Organic Phosphorus as P, mg/l	0.036
Total Phosphorus as P, mg/l	0.084
Total Alkalinity as CaCO3, mg/l	41
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	39
Sodium Adsorption Ratio	0.23
Color, c.u.	<1
Total Suspended Solids, mg/l	10
Settleable Solids, ml/l	0.2

	mg/l	meq/l
Bicarbonate as HCO3	49	0.81
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.91	0.07
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.0	0.02
Calcium	13	0.66
Magnesium	1.3	0.11
Potassium	0.8	0.02
Sodium	3.2	0.14

Major Anions	0.92
Major Cations	0.93
Cation/Anion Difference	0.54 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	1.42
Manganese, mg/l	0.04

Sample Site: 883-2146-5-16-89-2
Lab No: 898009
Date Sampled: 05/16/89 @ 1915
Date Received: 05/19/89

Lab pH, s.u.	7.68
Lab Conductivity, umhos/cm @ 25C	77
Total Dissolved Solids (180), mg/l	72
Total Dissolved Solids (calc), mg/l	44
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.018
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.036
Total Alkalinity as CaCO3, mg/l	40
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	38
Sodium Adsorption Ratio	0.24
Color, c.u.	<1
Total Suspended Solids, mg/l	9
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	48	0.79
Carbonate as CO3	0	0.00
Chloride	<1.0	0.01
Nitrate as N, mg/l	0.93	0.07
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.9	0.04
Calcium	12	0.61
Magnesium	1.8	0.15
Potassium	0.7	0.02
Sodium	3.5	0.15

Major Anions	0.91
Major Cations	0.93
Cation/Anion Difference	1.09 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.06
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.06
Manganese, mg/l	<0.02

Sample Site: 883-2146-06-19-89-2
Lab No: 898294
Date Sampled: 06/19/89 @ 1610
Date Received: 06/21/89

Lab pH, s.u.	7.16
Lab Conductivity, umhos/cm @ 25C	106
Total Dissolved Solids (180), mg/l	48
Total Dissolved Solids (calc), mg/l	46
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.006
Total Phosphorus as P, mg/l	0.024
Total Alkalinity as CaCO3, mg/l	47
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	43
Sodium Adsorption Ratio	0.20
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	57	0.94
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.39	0.03
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.2	0.03
Calcium	6.9	0.34
Magnesium	6.4	0.53
Potassium	0.2	<0.01
Sodium	2.9	0.13

Major Anions	1.02
Major Cations	1.00
Cation/Anion Difference	0.99 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.55
Manganese, mg/l	<0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILL Project No. 883 - 2146

Site Location Sample ID 883 - 2146 - 7-30-88 - 2

Sampling Location Premier Cr. downstream near confluence

Technical Procedure Reference(s) None

Type of Sampler GRAB

Date 7-30-88 Time 1504

Media WATER Station 2

Sample Type: ✓grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) Spatial Composite

Sample Description Baseline water quality of Premier Cr.

Cloudy - last rain 2 days 48 hrs prior to today.

Field Measurements on Sample (pH, conductivity, etc.)

Temp: 11°C Dissolved Oxygen: 10.2 mg/l

pH: 7.8 Conductivity: 120 mhos

Turbidity: Not sampled

Aliquot Amount	Container	Preservative/Amount
1/2 Gal	Plastic Jar	None
500 ml	" "	Sulfuric Acid
250 ml	" "	Nitric Acid
250 ml	" "	None (Needs Filtering)

Sampler (signature) Date 7-30-88

Supervisor (signature) Date 7-30-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hill Project No. 883-2146

Site Location Premerier CK Sample ID 883-2146-8-31-88-2

Sampling Location CK just upstream of Confluence w/ Moose CK

Technical Procedure Reference(s) NONE

Type of Sampler Grab with Distilled Water Jug

Date 8-31-88 Time 12:33

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) 1 Ft deep across channel

Sample Description baseline water quality for Premerier CK

Cloudy, light rain, ≈ 40°c

Field Measurements on Sample (pH, conductivity, etc.)

Temp. 7°C pH 6.3

D.O. 11.5 mg/l conductivity 114 um

Turbidity 1.0 NTU

Aliquot Amount	Container	Preservative/Amount
½ gal	Plastic Jug	NONE
500 ml	"	Sulfuric Acid
250 ml	"	Nitric Acid
250 ml	"	Filtered Nitric Acid

Sampler (signature) [illegible] Date 8/31/88

Supervisor (signature) [illegible] Date 9-1-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-9-23-88-2

Sampling Location Premier Creek ≈ 10 ft upstream of confluence with moose Creek

Technical Procedure Reference(s) G.L. memo dated 9-21-88

Type of Sampler Plastic Distilled Water Jug

Date 9/23/88 Time 4:42 pm

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Premier Creek
Water slighty cloudy, leaves & small (less than 1" Dia.) Debris floating on

Field Measurements on Sample (pH, conductivity, etc.) temperature 6.5 °C

pH 7.32 dissolved oxygen 10.6 mg/l

conductivity 93 umhos/cm turbidity 7.2 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 52°F wind Lt Breeze

precipitation NONE sunlight Clear/Sunny

2 day Storm Event 9/20-9/22/88

Sampler (signature) Christopher A Paulsen Date 9/24/88

Supervisor (signature) [signature] Date 27 Sept 1988

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-21-88 2

Sampling Location Premier Creek
≈ 100 Ft upstream of confluence with Moose Ck.

Technical Procedure Reference(s) G.L.S Memo Dated 9/21/88

Type of Sampler Plastic Distilled Water Jug

Date 10/21/88 Time 17:35

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.5 °C

pH 6.30 dissolved oxygen 13.1 mg/l

conductivity 86 umhos/cm turbidity 2.6 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 33° wind None

✓ precipitation None sunlight Clear
Station in Shade

Sampler (signature) Christopher A Paulos Date 10-23-88

Supervisor (signature) [illegible] Date 10-27-88

Golder Associates

Golder Associates	SUBJECT WISHBONE HYDROLOGY		
	Job No. 883-2146 Ref.	Made by M. MUSIAL Checked Reviewed	Date 10-24-88 Sheet 1 of 1

ALKALINITY TEST

SAMPLE SITE: 883-2146-10-21-88-2

DATE SAMPLED: 10/21/88 TIME SAMPLED: 17:35

NOTE - Alkalinity Measurements performed in lab 124+ hrs after sampled.

DATE TESTED: 10/24/88 TIME TESTED: 1020

Warmed 20 min @ 65°F Room Temp.
No Thermometer Available to Meas Sample.

Phenophthalein Alkalinity
Color = Clear
TITRATE = 0 P Alkalinity = 0

Cartridge = 0.1600

Bromocresol Green - Methyl Red
Color - Light Green @ 4 Digits
- Light Greenish Blue Gray 435

Scale FACTOR = 0.1

Check Equation in Manual

TOTAL Alkalinity = (0.1)(435)
= 43.5 mg/l as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-18-88-2

Sampling Location Premier Creek
≈ 50' upstream of Confluence w/ Moose Ck

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/18/88 Time 16:50

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 5 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C

pH 7.29 dissolved oxygen 11.4 mg/l

conductivity 114 umhos/cm turbidity .84 NTU

water level - held staff N/A staff gage Unreadable Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle Filtered in Anchorage Lab on 11/21/88	✓ nitric acid

Field Parameters taken in car at 17:00

WEATHER temperature 19°F wind Lt breeze

precipitation None sunlight Clear, Dusk

Sampler (signature) Christopher J Pauley Date 11/20/88

Supervisor (signature) JV Date 12/9/89

Golder Associates

Golder Associates	SUBJECT Wishbone		
	Job No. 883-2146 Ref.	Made by M. Musick Checked Reviewed	Date 11-28-88 Sheet 1 of 1

ALKALINITY TEST STA #2

0.16 Cartridge
Insufficient Sample for 100 ml
∴ Use 25 ml Sample w/
digit Multiplier = 0.4

P ALK

Colorless – PALK = 0

T ALK

Lt greenish Blue Gray 123

TALK = 123 × 0.4 = 49.2 mg/L as $CaCO_3$

Note: Tested More than 1 week after sampling.

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-19-88-2

Sampling Location Premier Creek
≈ 200 Ft upstream of confluence with Moose Ck

Technical Procedure Reference(s) Sampling Q.A. Plan Rev -0-

Type of Sampler Plastic Distilled water Jug

Date 12/19/88 Time 16:18

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to .3 feet below water surface = 4"

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1°C
pH 7.49 dissolved oxygen 12.6 mg/l
conductivity 133 umhos/cm turbidity .7 NTU @ 11:14 on 12/22
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal. X	plastic bottle X	none X
500 ml X	plastic bottle X	sulfuric acid X
250 ml X	plastic bottle X	nitric acid X
250 ml X filtered	plastic bottle X	nitric acid X

WEATHER temperature 28 wind 10 mph
precipitation NONE sunlight Cloudy

Sampler (signature) Christopher J. Proctor Date 12/21/88
Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKALINITY

Sample Taken — STATION # 2

TESTED - 12-14-88
TIME 9:00 / 2100

TITRATION = 1.000

P. ALK

COLOR
CLEAR → P. ALK = 0

T. ALK

LT. GRAYSH BLU GRAY - 43

T. ALK : 43 X 1.0 = 43.0 mg/L
As $CaCO_3$

LT VIOLET GRAY BLU : 50

TO LT. PINK : 53
53 X 1.0 = 53.0 mg/L
As $CaCO_3$

T. ALK : 53.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-1-29-89-2

Sampling Location Premier Creek

≈250' upstream of confluence w/ Moose Creek

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 1/29/89 Time 13:20

Media Water Station 2

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 3 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3 °C

pH 7.20 dissolved oxygen 14.2? mg/l

conductivity 150 umhos/cm turbidity 1.0 NTU all Field Measurements @ 15:20 on 1/29

water level - held staff N/A staff gage unreadable Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature -2°F wind 5-10 mph Gusting to 25

precipitation None sunlight Clear & Sunny

Lots of blowing snow.

Sampler (signature) Christopher J. Pauley Date 1/30/89

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKALINITY

STATION #2

Sample Collected = 1-29-89 @ 13:20
Tested = 1-29-89 @ 15:31

Titration Cartridge = 1.600 NH_2SO_4

P. ALK

Color = Clear P. ALK = 0

T. ALK

Lt. Grnsh Blu Gray = 69 units

69 x 1.0 = 69 mg/L as $CaCO_3$

Lt Violet Gray = 82

To Lt. Pink = 86

T. ALK = 86 x 1.0 = 86 mg/L as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-2-24-89-2

Sampling Location Premier Cr ≅100' upstream confluence Moore Cr.; 20ft downstream of staff gage

Technical Procedure Reference(s) Sampling Q. A. Plan Rev. -0-

Type of Sampler Plastic Distilled H2O jug

Date 2/24/89 Time 1840

Media Water Station 2

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 7 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Premier Cr.

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C
pH 6.16 dissolved oxygen 14.0 mg/l
2181.50 conductivity 135 umhos/cm turbidity 2.6 NTU @ 21:19
water level - held staff N/A staff gage unreadable Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER slight temperature 24 wind None
precipitation None sunlight None Dark

Sampler (signature) Christopher J Pauley Date 2/27/89
Supervisor (signature) JD Date 3/15/89

Golder Associates

Golder Associates

SUBJECT		
Job No. / Ref.	Made by / Checked / Reviewed	Date / Sheet — of

ALKALINITY

STATION: NO. 2

STATION I.D:

TITRATION CARTRIDGE = 1.600N

Sample Taken:
Sample Tested = 21:19

P. ALK -

color - clear - P.ALK = 0

T. ALK -

LT. GREENISH BLUE GRAY = 39 UNITS

T.ALK = 39 x 1.0 = 39.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-21-89-2

Sampling Location Premier Creek ≈ 30 Ft upstream of staff gauge

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Glass Ball Jelly Jar

Date 3/21/89 Time 13:30

Media Water Station 2

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 18 subsamples across channel at depths 0 to .3 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0.5 °C

pH 6.11 dissolved oxygen 14.7 mg/l

conductivity 140 umhos/cm turbidity 0.5 NTU @ 15:00

water level - held staff N/A staff gage Unreadable Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
1000 ~~500~~ ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 38° F wind NONE

precipitation Light Snow sunlight Cloudy

Sampler (signature) Christopher J Pendley Date 3/23/89

Supervisor (signature) JU Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No. 8832146	Made by M. WERDERBER	Date 3-21-89
	Ref.	Checked	Sheet 1 of 1
		Reviewed	

ALKALINITY

STATION: #2

STATION I.D. = 8832146-3-21-89-2

Sample Taken: 3-21-89 13:30

TITRATION CARTRIDGE: 1.600 $N H_2SO_4$

Sample Tested: 3-21-89 22:33

P. ALK

COLOR - CLEAR - P. ALK. = 0

T. ALK

LT. GREENISH BLUE GRAY = 47 UNITS

T. ALK = 47 x 1.0 = 47.0 mg/L as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-14-89 2

Sampling Location Premier Creek

≈ 400 Ft upstream of Pk Ck confluence

Technical Procedure Reference(s) Sampling Q.A. Plan Rev -0-

Type of Sampler Plastic Distilled Water Jug

Date 4/14/89 Time 17:55

Media Water Station 2

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 2 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.0 °C

pH 7.65 dissolved oxygen 14.7 mg/l

conductivity 107 umhos/cm turbidity 16 NTU @ 22:14

water level - held staff N/A staff gage .6 Ft Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 47°F wind 2-3 mph.

precipitation NONE sunlight Clear/Cloudy

Sampler (signature) Christopher J. Pauley Date 4/16/89

Supervisor (signature) [illegible] Date 4/28/89

Golder Associates

4/14/89 Alkalinity on Station #2 883-2146
CJD

Sample tested: 23:53
" Taken: 17:55

No Pink P. ALK. = Ø

Bl.-Gy @ pH = 5.06 90 x .4 = T. ALK. = 36.0 mg/L
$CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-16-89-2

Sampling Location Premier Creek

≈ 100 Ft upstream of staff gage

Technical Procedure Reference(s) Sunoco O.A. Plan Eval -0-

Type of Sampler Plastic Distilled Water Jug

Date 5/16/89 Time 19:15

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 4 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 7 °C

pH 7.81 dissolved oxygen 12.0 mg/l

conductivity 86 umhos/cm turbidity 7.5 NTU

water level - held staff N/A staff gage .65 Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	none
500 ml	plastic bottle	sulfuric acid
250 ml	plastic bottle	nitric acid
250 ml filtered	plastic bottle	nitric acid

WEATHER temperature 48°F wind 1 MPH

precipitation NONE sunlight Partly Cloudy

Lt. Rain [illegible]

Sampler (signature) Christopher J Pauley Date 5/17/89

Supervisor (signature) JV Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT May Water Quality Run		
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 2 of 7
	Reviewed	

ALKALINITY

Station # 2

Sample Taken = 19:15 5/17

Sample Tested = 16:24 5/1

Titration Cartridge .6N

P. Alk -

Color Description - Clear

P. Alk. = Ø mg/l

T. Alk -

Color Description - Bl.-Gy

#Units x Multiplier = 347 x .1 = 34.7 mg/L = T. Alk

SAMPLE INTEGRITY DATA SHEET

ant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-2

Sampling Location Premier Creek

≈200Ft upstream of Mt. Ck Confluence

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. Ø

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 16:10

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 15 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Premier Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 9 °C

pH 7.82 dissolved oxygen 13.6 mg/l

conductivity 101 umhos/cm turbidity 3.5 NTU 13:09 6/20

water level - held staff N/A staff gage .6 Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 72°F wind NONE

precipitation NONE sunlight Clear & Sunny

mpler (signature) Christopher J. Pardy Date June 20, 1989

Supervisor (signature) JD Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT JUNE Water Quality Run		
Job No. 883-2146	Made by CJP	Date 6/20/89
Ref.	Checked	Sheet 2 of 7
	Reviewed	

ALKALINITY

Station # 2

Sample Taken = 16:10 6/1;

Sample Tested = 13:33

Titration Cartridge 0.6N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl.-Gy

#Units x Multiplier = 431 x 0.1 = 43.1 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146-002

Site Location WISHBONE HILLS Sample ID 883-2146-7-20-89-2

Sampling Location Pioneer Creek

≈ 200 Ft upstream of confluence with Wash Creek

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. Ø

Type of Sampler Plastic Distilled Water Jug

Date 7/20/89 Time 17:30

Media Water Station 2

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 2 subsamples across channel at depths Ø to 1 feet below water surface

Sample Description Baseline water quality of Pioneer Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 7 °C

pH 7.59 dissolved oxygen 11.8 mg/l

conductivity 95 umhos/cm turbidity 2.6 NTU @ 19:41

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 60°F wind None

precipitation None sunlight Cloudy

Sampler (signature) Christopher J. Fowler Date July 21, 1989

Supervisor (signature) JD Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality		
Job No. 883-2146-002	Made by GJP	Date 7/21/89
Ref. McKinley Mining	Checked	Sheet 2 of 7
	Reviewed	

ALKALINITY

Station # 2

Sample Taken = 17:30 7/20

Sample Tested = 14:22 7/2

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/L

T. ALK -

Color Description - Bl/Gy

#Units x Multiplier = 481 x .1 = 48.1 mg/L = T. ALK

SURFACE WATER SAMPLING
STATION #3

BUFFALO CREEK

Sample Site: 883-2146-7-30-88-3
Lab No: 886645
Date Sampled: 07/30/88 @ 1559
Date Received: 08/03/88

Lab pH, s.u.	7.07
Lab Conductivity, umhos/cm @ 25C	51
Total Dissolved Solids (180), mg/l	22
Total Dissolved Solids (calc), mg/l	21
Boron, mg/l	0.05
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	0.077
Total Alkalinity as CaCO3, mg/l	21
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	16
Sodium Adsorption Ratio	0.30
Total Suspended Solids, mg/l	48
Settleable Solids, ml/l	0.2
Turbidity, NTU	17

	mg/l	meq/l
Bicarbonate as HCO3	25	0.41
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.05	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.8	0.02
Calcium	1.1	0.05
Magnesium	3.3	0.27
Potassium	0.4	0.01
Sodium	2.8	0.12

Major Anions	0.45
Major Cations	0.45
Cation/Anion Difference	.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	2.43
Manganese	0.08

Sample Site: 883-2146-7-30-88-3 (Duplicate analysis)
Lab No: 886648
Date Sampled: 07/30/88 @ 1559
Date Received: 08/03/88

Lab pH, s.u.	7.03
Lab Conductivity, umhos/cm @ 25C	51
Total Dissolved Solids (180), mg/l	34
Total Dissolved Solids (calc), mg/l	26
Boron, mg/l	0.05
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.083
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	16
Sodium Adsorption Ratio	0.33
Total Suspended Solids, mg/l	46
Settleable Solids, ml/l	<0.1
Turbidity, NTU	17

	mg/l	meq/l
Bicarbonate as HCO3	26	0.43
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.05	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	2.5	0.05
Calcium	5.3	0.26
Magnesium	0.7	0.06
Potassium	0.4	0.01
Sodium	2.9	0.13

Major Anions	0.51
Major Cations	0.46
Cation/Anion Difference	5.15 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	2.40
Manganese	0.08

Sample Site: 883-2146-83188-3
Lab No: 886863
Date Sampled: 08/31/88 @ 1600
Date Received: 09/02/88

Lab pH, s.u.	6.67
Lab Conductivity, umhos/cm @ 25C	48
Total Dissolved Solids (180), mg/l	18
Total Dissolved Solids (calc), mg/l	24
Boron, mg/l	0.01
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	0.028
Total Alkalinity as CaCO3, mg/l	21
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	17
Sodium Adsorption Ratio	0.26
Total Suspended Solids, mg/l	22
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	26	0.42
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.6	0.01
Calcium	5.2	0.26
Magnesium	1.1	0.09
Potassium	0.4	0.01
Sodium	2.5	0.11

Major Anions	0.47
Major Cations	0.47
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	1.33
Manganese	0.03

Sample Site: 883-2146-83188-3 (Duplicate analysis)
Lab No: 886868
Date Sampled: 08/31/88 @ 1600
Date Received: 09/02/88

Lab pH, s.u.	6.64
Lab Conductivity, umhos/cm @ 25C	49
Total Dissolved Solids (180), mg/l	18
Total Dissolved Solids (calc), mg/l	24
Boron, mg/l	0.01
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	0.030
Total Alkalinity as CaCO3, mg/l	21
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	18
Sodium Adsorption Ratio	0.26
Total Suspended Solids, mg/l	18
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	26	0.42
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.4	0.01
Calcium	5.9	0.30
Magnesium	0.7	0.06
Potassium	0.4	0.01
Sodium	2.5	0.11

Major Anions	0.46
Major Cations	0.48
Cation/Anion Difference	2.13 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	1.33
Manganese	0.03

Sample Site: 883-2146-102188-3
Lab No: 887120
Date Sampled: 10/21/88 @ 1239
Date Received: 10/26/88

Lab pH, s.u.	6.65
Lab Conductivity, umhos/cm @ 25C	43
Total Dissolved Solids (180), mg/l	24
Total Dissolved Solids (calc), mg/l	24
Boron, mg/l	<0.01
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.3
Ortho Phosphorus as P, mg/l	0.012
Total Organic Phosphorus as P, mg/l	0.012
Total Phosphorus as P, mg/l	0.032
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	19
Sodium Adsorption Ratio	0.25
Color, c.u.	<1
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	26	0.43
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	<0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.4	0.01
Calcium	4.9	0.24
Magnesium	1.7	0.14
Potassium	0.3	0.01
Sodium	2.5	0.11

Major Anions	0.47
Major Cations	0.50
Cation/Anion Difference	3.09 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.13
Manganese	<0.02

Sample Site: 883-2146-111988-3
Lab No: 887223
Date Sampled: 11/19/88 @ 1140
Date Received: 11/23/88

Lab pH, s.u.	6.56
Lab Conductivity, umhos/cm @ 25C	48
Total Dissolved Solids (180), mg/l	40
Total Dissolved Solids (calc), mg/l	25
Boron, mg/l	0.28
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	0.013
Total Phosphorus as P, mg/l	0.021
Total Alkalinity as CaCO3, mg/l	23
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	20
Sodium Adsorption Ratio	0.27
Color, c.u.	<1
Total Suspended Solids, mg/l	8
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	28	0.46
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.03	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.6	0.01
Calcium	4.9	0.25
Magnesium	1.7	0.14
Potassium	0.3	0.01
Sodium	2.7	0.12

Major Anions	0.49
Major Cations	0.52
Cation/Anion Difference	2.97 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.16
Manganese	<0.02

Sample Site: 883-2146-12-19-88-3
Lab No: 887411
Date Sampled: 12/19/88 @ 1200
Date Received: 12/22/88

Lab pH, s.u.	7.17
Lab Conductivity, umhos/cm @ 25C	50
Total Dissolved Solids (180), mg/l	38
Total Dissolved Solids (calc), mg/l	22
Boron, mg/l	0.01
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	0.42
Total Kjeldahl Nitrogen, mg/l	1.6
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	0.009
Total Alkalinity as CaCO3, mg/l	24
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	19
Sodium Adsorption Ratio	0.14
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	29	0.48
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.04	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	<1.0	0.00
Calcium	1.6	0.08
Magnesium	3.8	0.31
Potassium	0.2	0.01
Sodium	1.4	0.06

Major Anions	0.51
Major Cations	0.46
Cation/Anion Difference	5.15 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.03
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.15
Manganese	<0.02

Sample Site: 883-2146-12-19-88-3 (Duplicate analysis)
Lab No: 887416
Date Sampled: 12/19/88 @ 1200
Date Received: 12/22/88

Lab pH, s.u.	7.03
Lab Conductivity, umhos/cm @ 25C	49
Total Dissolved Solids (180), mg/l	22
Total Dissolved Solids (calc), mg/l	23
Boron, mg/l	0.02
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	0.56
Total Kjeldahl Nitrogen, mg/l	1.2
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.010
Total Phosphorus as P, mg/l	0.010
Total Alkalinity as CaCO3, mg/l	23
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	19
Sodium Adsorption Ratio	0.14
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	28	0.46
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.05	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.0	0.02
Calcium	3.2	0.16
Magnesium	2.8	0.23
Potassium	0.2	0.01
Sodium	1.4	0.06

Major Anions	0.50
Major Cations	0.46
Cation/Anion Difference	4.17 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.04
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.16
Manganese	<0.02

Sample Site: 883-2146-012789-3
Lab No: 897520
Date Sampled: 01/27/89 @ 1145
Date Received: 01/31/89

Lab pH, s.u.	7.23
Lab Conductivity, umhos/cm @ 25C	48
Total Dissolved Solids (180), mg/l	30
Total Dissolved Solids (calc), mg/l	25
Boron, mg/l	0.26
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	<0.001
Total Alkalinity as CaCO3, mg/l	23
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	20
Sodium Adsorption Ratio	0.25
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	28	0.46
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.21	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.6	0.01
Calcium	5.7	0.28
Magnesium	1.5	0.12
Potassium	<0.2	0.00
Sodium	2.5	0.11

Major Anions	0.52
Major Cations	0.51
Cation/Anion Difference	0.97 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.29
Manganese, mg/l	<0.02

Sample Site: 883-2146-2-24-89-3
Lab No: 897643
Date Sampled: 02/24/89 @ 1650
Date Received: 02/28/89

Lab pH, s.u.	6.67
Lab Conductivity, umhos/cm @ 25C	53
Total Dissolved Solids (180), mg/l	32
Total Dissolved Solids (calc), mg/l	23
Boron, mg/l	0.22
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.3
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	<.001
Total Phosphorus as P, mg/l	0.004
Total Alkalinity as CaCO3, mg/l	23
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	17
Sodium Adsorption Ratio	0.29
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	27	0.45
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.12	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	<1.0	0.01
Calcium	3.1	0.15
Magnesium	2.3	0.19
Potassium	0.3	0.01
Sodium	2.7	0.12

Major Anions	0.49
Major Cations	0.47
Cation/Anion Difference	2.08 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.03

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.10
Manganese, mg/l	<0.02

Sample Site: 883-2146-2-24-89-3
Lab No: 897645 (Duplicate Analysis)
Date Sampled: 02/24/89 @ 1650
Date Received: 02/28/89

Lab pH, s.u.	6.70
Lab Conductivity, umhos/cm @ 25C	57
Total Dissolved Solids (180), mg/l	32
Total Dissolved Solids (calc), mg/l	22
Boron, mg/l	0.19
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.004
Total Phosphorus as P, mg/l	0.006
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	17
Sodium Adsorption Ratio	0.24
Color, c.u.	<1
Total Suspended Solids, mg/l	11
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	27	0.44
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.09	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.2	<0.01
Calcium	3.0	0.15
Magnesium	2.3	0.19
Potassium	0.3	0.01
Sodium	2.4	0.10

Major Anions	0.47
Major Cations	0.45
Cation/Anion Difference	2.17 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.07

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.10
Manganese, mg/l	<0.02

Sample Site: 883-2146-032189-3
Lab No: 897710
Date Sampled: 03/21/89 @ 1823
Date Received: 03/24/89

Lab pH, s.u.	6.74
Lab Conductivity, umhos/cm @ 25C	45
Total Dissolved Solids (180), mg/l	32
Total Dissolved Solids (calc), mg/l	24
Boron, mg/l	0.25
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.004
Total Phosphorus as P, mg/l	0.013
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	18
Sodium Adsorption Ratio	0.31
Color, c.u.	<1
Total Suspended Solids, mg/l	2.5
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	27	0.44
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.06	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.4	0.01
Calcium	5.0	0.25
Magnesium	1.2	0.10
Potassium	0.2	0.01
Sodium	3.0	0.13

Major Anions	0.49
Major Cations	0.49
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.09
Manganese, mg/l	<0.02

Sample Site: 883-2146-041589-3
Lab No: 897893
Date Sampled: 04/15/89 @ 1900
Date Received: 04/18/89

Lab pH, s.u.	6.52
Lab Conductivity, umhos/cm @ 25C	46
Total Dissolved Solids (180), mg/l	20
Total Dissolved Solids (calc), mg/l	29
Boron, mg/l	0.40
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.010
Total Organic Phosphorus as P, mg/l	0.018
Total Phosphorus as P, mg/l	0.033
Total Alkalinity as CaCO3, mg/l	23
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	23
Sodium Adsorption Ratio	0.25
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	27	0.45
Carbonate as CO3	0	0.00
Chloride	2.1	0.06
Nitrate as N, mg/l	0.10	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	2.7	0.06
Calcium	5.7	0.28
Magnesium	2.2	0.18
Potassium	0.2	0.01
Sodium	2.7	0.12

Major Anions	0.58
Major Cations	0.59
Cation/Anion Difference	0.85 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	0.03
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.07
Manganese, mg/l	<0.02

Sample Site: 883-2146-5-16-89-3
Lab No: 898010
Date Sampled: 05/16/89 @ 1150
Date Received: 05/19/89

Lab pH, s.u.	7.09
Lab Conductivity, umhos/cm @ 25C	41
Total Dissolved Solids (180), mg/l	42
Total Dissolved Solids (calc), mg/l	23
Boron, mg/l	<0.01
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.4
Ortho Phosphorus as P, mg/l	0.016
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.026
Total Alkalinity as CaCO3, mg/l	20
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	15
Sodium Adsorption Ratio	0.26
Color, c.u.	<1
Total Suspended Solids, mg/l	6
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	24	0.39
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.06	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.4	0.03
Calcium	4.6	0.23
Magnesium	1.0	0.08
Potassium	0.4	0.01
Sodium	2.5	0.11

Major Anions	0.45
Major Cations	0.43
Cation/Anion Difference	2.27 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	<0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-5-16-89-3 (DUPLICATE ANALYSIS)
Lab No: 898013
Date Sampled: 05/16/89 @ 1150
Date Received: 05/19/89

Lab pH, s.u.	7.07
Lab Conductivity, umhos/cm @ 25C	40
Total Dissolved Solids (180), mg/l	48
Total Dissolved Solids (calc), mg/l	22
Boron, mg/l	<0.01
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.015
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.026
Total Alkalinity as CaCO3, mg/l	20
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	15
Sodium Adsorption Ratio	0.25
Color, c.u.	<1
Total Suspended Solids, mg/l	5
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	24	0.39
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.06	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.0	0.02
Calcium	5.4	0.27
Magnesium	0.5	0.04
Potassium	0.4	0.01
Sodium	2.4	0.10

Major Anions	0.44
Major Cations	0.42
Cation/Anion Difference	2.33 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	<0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-06-19-89-3
Lab No: 898295
Date Sampled: 06/19/89 @ 1920
Date Received: 06/21/89

Lab pH, s.u.	6.62
Lab Conductivity, umhos/cm @ 25C	46
Total Dissolved Solids (180), mg/l	14
Total Dissolved Solids (calc), mg/l	24
Boron, mg/l	<0.01
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.001
Total Phosphorus as P, mg/l	0.025
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	20
Sodium Adsorption Ratio	0.23
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	26	0.43
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	2.1	0.04
Calcium	2.4	0.12
Magnesium	3.3	0.27
Potassium	0.2	0.01
Sodium	2.4	0.10

Major Anions	0.50
Major Cations	0.50
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.21
Manganese, mg/l	<0.02

Sample Site: 883-2146-06-19-89-3
Lab No: 898298 (Duplicate)
Date Sampled: 06/19/89 @ 1920
Date Received: 06/21/89

Lab pH, s.u.	6.67
Lab Conductivity, umhos/cm @ 25C	44
Total Dissolved Solids (180), mg/l	10
Total Dissolved Solids (calc), mg/l	23
Boron, mg/l	<0.01
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	0.09
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.005
Total Organic Phosphorus as P, mg/l	0.009
Total Phosphorus as P, mg/l	0.025
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	18
Sodium Adsorption Ratio	0.23
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	26	0.43
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	<0.01	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.2	0.03
Calcium	2.3	0.12
Magnesium	3.0	0.25
Potassium	0.2	0.01
Sodium	2.3	0.10

Major Anions	0.48
Major Cations	0.48
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.17
Manganese, mg/l	<0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILL Project No. 883-2146

Site Location _____ Sample ID 883-2146-7-30-88-3

Sampling Location Buffalo Cr. upstream below Wishbone Lk.

Technical Procedure Reference(s) None

Type of Sampler Grab

Date 7-30-88 Time 15:42

Media WATER Station 3

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) Spatial Composite

Cloudy - Last Rain 48 hours

Sample Description Baseline water quality Buffalo Cr.

Field Measurements on Sample (pH, conductivity, etc.)

Temp: 14°C Dissolved Oxygen: 7.9 mg/L

PH: 6.6 Conductivity: 52 mhos

Turbidity: Not Sampled

Aliquot Amount	Container	Preservative/Amount
1/2 GAL	Rustic Jar	None
500 ML	" "	Sulfuric Acid
250 ml	" "	Nitric Acid
250ml	" "	None (Needs Filtering)

Sampler (signature) [signature] Date 7-30-88

Supervisor (signature) [signature] Date 7-30-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hill Project No. 883-2146

Site Location Buffalo Ck Sample ID 883-2146-8-31-88-3

Sampling Location Buffalo Ck downstream of Wishbone

Technical Procedure Reference(s) None

Type of Sampler Grab w/ Plastic Distilled Water Jug

Date 8/31/88 Time 4:35

Media Water Station 3

Sample Type: (grab) time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) 5 inches deep in middle of Ck

Sample Description Baseline water quality for Buffalo Ck

Cloudy, ≈ 45°F

Field Measurements on Sample (pH, conductivity, etc.)

Temp 10°C pH 5.9

D.O. 9.8 Conductivity 45

Turbidity 20.0 NTU

Aliquot Amount	Container	Preservative/Amount
1/2 gal	Plastic Jug	NONE
500 ml	"	Sulfuric Acid
250 ml	"	Nitric Acid
250 ml	"	Filtered Nitric Acid

Sampler (signature) Christopher J Poole Date 8/31/88

Supervisor (signature) [illegible] Date 9-1-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-21-88-3 OLD

Sampling Location Buffalo Creek
± 200 Ft Downstream from Wishbone Lake

Technical Procedure Reference(s) G.L.S Memo Dated 9/21/88

Type of Sampler Plastic Distilled Water Jug

Date 10/21/88 Time 12:39

Media Water Station 3 OLD

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Water is clear, some of the fine sediment on the creek bottom is gone

Field Measurements on Sample (pH, conductivity, etc.) temperature 3 °C

pH 6.06 dissolved oxygen 11.8 mg/l

conductivity 40 umhos/cm turbidity .65 NTU @ 14:50

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Turbidity measured back in the truck.

WEATHER temperature 30° F wind 10-15 MPH
precipitation NONE sunlight Clear
Station in Shade

Sampler (signature) Christopher J Pauley Date 10-23-88

Supervisor (signature) [signature] Date 10-23-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-21-88-3 PK

Sampling Location Buffalo Creek
Just above 1st Fork downstream from Canyon Exit

Technical Procedure Reference(s) G.L.S Memo Dated 9/21/88

Type of Sampler Plastic Distilled Water Jug

Date 10/21/88 Time 14:42

Media Water Station 3 Pink

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Water is Clear

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C

pH 6.78 dissolved oxygen 12.9 mg/l

conductivity 37 umhos/cm turbidity .68 NTU @ 14:56

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container		Preservation/Amount
half gal.		plastic bottle	N/A	none
500 ml		plastic bottle	N/A	sulfuric acid
250 ml		plastic bottle	N/A	nitric acid
250 ml	filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 40°F wind Light Breeze

precipitation NONE sunlight Clear
Station in The Sun

Sampler (signature) Christopher J Pauley Date 10-23-88

Supervisor (signature) [illegible] Date 10-27-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site: WISHBONE HILLS Project No. 883-2146

Site Location: WISHBONE HILLS Sample ID 883-2146-10-21-88-3 B1

Sampling Location: Buffalo Creek
3 20 ft from canyon exit

Technical Procedure Reference(s): G.L.S Memo dated 9/21/88

Type of Sampler: Plastic Distilled Water Jug

Date: 10/21/88 Time: 15:11

Media: Water Station: 3 Blue

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description: Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C
pH 6.28 dissolved oxygen 12.1 mg/l
conductivity 036 umhos/cm turbidity — NTU
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	N/A	none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 38°F wind None
precipitation NONE sunlight Clear
Station in Shade

Sampler (signature): Christopher J Parker Date 10/23/88

Supervisor (signature): [signature] Date 10-27-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-7-88-3

Sampling Location Buffalo Creek approx. 3500 ft upstream of road crossing, at creeks exit from a canyon.

Technical Procedure Reference(s) G.L. memo dated 9/21/88

Type of Sampler Plastic Distilled Water Jug

Date 10/7/88 Time 10:00

Media Water Station 3 New location

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 4 °C

pH 6.72 dissolved oxygen 11.2 mg/l

conductivity 43 umhos/cm turbidity Not Meas. NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	N/A	none
500 ml	plastic bottle	"	sulfuric acid
250 ml	plastic bottle	"	nitric acid
250 ml filtered	plastic bottle	"	nitric acid

WEATHER temperature 38°F wind Light Breeze

precipitation None sunlight Overcast

4-6" of new fallen snow

Sampler (signature) Christopher Paulsen Date 10/8/88

Supervisor (signature) [signature] Date 10-13-88

Golder Associates

Golder Associates	SUBJECT WISHBONE HYDROLOGY		
	Job No. 883-2146 Ref.	Made by M. MUSIAL Checked Reviewed	Date 10-24-88 Sheet 1 of 1

ALKALINITY TEST

SAMPLE SITE: 883-2146-10-21-88-3

DATE SAMPLED: 10/21/88 TIME SAMPLED: 12:39

NOTE – Alkalinity Measurements performed in Lab 124+ hrs after sampled.

DATE TESTED: 10/24/88 TIME TESTED: 1100

Warmed 25 min @ 65°F Room Temp

No Thermometer to Meas. Sample

P Alkalinity

Color – Clear

Titrate = 0 P Alkalinity = 0

Cartridge = 0.1600

BROMO CRESOL GREEN – METHYL RED

Color	Titrate
Light Green	0
Light Greenish Blue Gray	190
Light Pink GRAY	210 ✓
Light Pink	228

SCALE FACTOR = 0.1

GREG – PLS NOTE THAT WE MUST CHECK EQ. VS MANUAL!

Total Alkalinity = 0.1 (210)

= 21.0 mg/l as $CaCO_3$

use 190 ∴ Tot alk = 0.1 x 190 = 0.19 mg/l as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-19-88-3

Sampling Location Buffalo Creek near Wishbone Lake

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/19/88 Time 10:40

Media Water Station 3

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Grab ~~Spatial~~ composite of 3 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature / °C *

pH 7.01 dissolved oxygen 11.2 mg/l

conductivity 51 umhos/cm turbidity 0.3 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

* Note: Field Parameters measured in car at 12:20

Filtered with a Power filter, using .45 paper, GAI ID # H0022

WEATHER temperature 10°F wind Light 0-2 mph

precipitation None sunlight Clear, shade

Sampler (signature) Christopher J Dailey Date 11/20/88

Supervisor (signature) JD Date 12/9/89

Golder Associates

Golder Associates	SUBJECT Wishbone		
	Job No. 883-2146 Ref.	Made by MWSIAC Checked Reviewed	Date 11-22-88 Sheet 1 of 1

Alkalinity Test STA 3 TEST 10:15 hrs 11-22

Titration Cartridge 0.16 N H_2SO_4

P ALK –

Clear PALK = ∅

T ALK

Lt grnish Blu Gray = 112 units

TALK = 112 × 0.1 = 11.2 mg/l as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-A-88-3

Sampling Location Buffalo Creek ≈ 500 Ft Downstream of Wishbone Lake

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 12/19/88 Time 12:00

Media Water Station 3

Sample Type: grab time composite space composite

Sample Acquisition Measurements (~~depth, volume of static~~ well water and purged water, etc.)

Spatial composite of 4 subsamples across channel at depths 0 to .15 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 7 °C

pH 7.12 dissolved oxygen 11.4 mg/l

conductivity 57 umhos/cm turbidity .25 NTU 12/22 11:17

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Sulfuric acide

WEATHER temperature 29°C wind 10-20 MPH

precipitation None sunlight Cloudy

Sampler (signature) Christopher A. Paulin Date 12/21/88

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKALINITY - STATION #3 - TESTED 11-23-88

TITRATION CARTRIDGE = 1.600 NH_2SO_4

P. ALK

color
CLEAR → P. ALK = 0

T. ALK

LT. GRAYISH BLUE GRAY = 12

12 X 1.0 = 12.0 mg/L
as $CaCO_3$

LT VIOLET GRAY = 18
TO
LT. PINK = 21 21 X 1.0 = 21.0 mg/L
as $CaCO_3$

T. ALK = 21.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-1-27-89-3

Sampling Location Buffalo Creek ≈ 25' Downstream of the Canyon Exit

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled Water Jug

Date 1/27/89 Time 11:45

Media Water Station 3

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .3 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3.5 °C

@ 8:59pm pH 7.09 dissolved oxygen 14.0 mg/l

conductivity 66 umhos/cm turbidity .25 NTU @ 7:30 AM 1/28

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature -20°F wind NONE

precipitation NONE sunlight Clear sunny

Sampler (signature) Christopher J Fowler Date 1/30/89

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKALINITY

STATION #3

- Sample Taken: 1-27-89 @ 11:45
- Sample Tested: 1-28-89 @ [illegible]

TITRATION CARTRIDGE 1.600

P. ALK

Color: clear → P. ALK = 0

T. ALK

LT. GRAYISH BLU GRAY: 22 units

T. ALK: 22 x 1.0 = 22 mg/L As $CaCO_3$

LT VIOLET GRAY : 24

To LT PINK: : 30

T. ALK: 30 x 1.0 = 30 mg/L As $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-2-24-89-3

Sampling Location Buffalo Creek
≈ 200 ft downstream of Wishbone Lake

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled Water Jug

Date 2/24/89 Time 16:50

Media Water Station 3

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 30 subsamples across channel at depths 0 to .1 feet below water surface

Note: Creek very shallow barely covering small rocks thus reason for many subsamples

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature Ø °C
@17:15 pH 5.60 dissolved oxygen 10.2 mg/l
conductivity 59 umhos/cm turbidity .9 NTU @ 21:24
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	✓ sulfuric acid
250 ml		plastic bottle	✓ nitric acid
250 ml	filtered	plastic bottle	✓ nitric acid

WEATHER temperature 24°F wind 1-2 MPH
precipitation None sunlight Cloudy Sun 30-40%

Sampler (signature) Christopher J. Pooley Date 2/27/89
Supervisor (signature) JV Date 3/15/89

Golder Associates

Golder Associates	SUBJECT February W.Q. Run		
	Job No. 983-2146 Ref.	Made by R.W. Checked Reviewed	Date 2/24/89 Sheet 3 of 6

ALKALINITY

STATION: No. 3

STATION I.D:

TITRATION CARTRIDGE = 1.600 N

Sample Taken =
Sample Tested = 21:21

P. ALK -

color - clear P. ALK = 0

T. ALK -

LT. GREENISH BLUE GRAY - 11 UNITS

T. ALK = 11 x 1.0 = 11.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-21-89-3

Sampling Location ≈ 500 feet below Wishbone Lake on Buffalo Creek

Technical Procedure Reference(s) Sampling Q.A. Plan Rev -0-

Type of Sampler 400ML Glass Jar

Date 3-21-89 Time 18:23

Media WATER Station #3

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 15 subsamples across channel at depths 0 to .1 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3.°C

pH 5.94 dissolved oxygen 11.3 mg/l

conductivity 049 umhos/cm turbidity Not measured missed it NTU CJP 3/23/89

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container	Preservation/Amount
half gal.	✓	plastic bottle	✓ none
1000 ~~500~~ ml	✓	plastic bottle	✓ sulfuric acid
250 ml	✓	plastic bottle	✓ nitric acid
250 ml	✓ filtered	plastic bottle	✓ nitric acid

WEATHER temperature 30° wind 0

precipitation SNOWING sunlight 0

Sampler (signature) M. WERDERBER Date 3-21-89 CJP 3/23/

Supervisor (signature) JD Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No. 883-2146	Made by	Date 3-21-89
	Ref.	Checked	Sheet of
		Reviewed	

ALKALINITY

STATION: #3

STATION I.D. = 88832146-3-21-89-3

Sample Taken: 18 23 3-21-89

Sample Tested: 23 01 3-21-89

P. ALK

COLOR - CLEAR - P. ALK = 0

T. ALK

LT. GREENISH BLUE GRAY = 60 UNITS

T. ALK = 60 X 1.0 = 60.0 mg/L as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-15-89-3

Sampling Location Buffalo Creek ≈ 300 Ft downstream of Wishbone Lake

Technical Procedure Reference(s) Sampling D.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Tub

Date 4/15/89 Time 19:00

Media Water Station 3

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 15 subsamples across channel at depths 0 to .1 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature Ø °C

pH 6.26 dissolved oxygen 9.3 mg/l

conductivity 53 umhos/cm turbidity .8 NTU @ 18:40 4/16

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 38°F wind 5-10 MPH

precipitation NONE sunlight Cloudy

Sampler (signature) Christopher J. Pauley Date 4/16/89

Supervisor (signature) [illegible] Date 4/28/89

Golder Associates

4/16/89 Alkalinity on Station # 3 883-2146
CJP

Sample Taken: 4/15 19:00
" Tested: 4/16 15:18

No Pink P. Alk. = Ø

Bl-Gy 176 x .1 = T. Alk. = 17.6 mg/l $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-16-89-3

Sampling Location Buffalo Creek below rock overhang
[illegible] Lake

Technical Procedure Reference(s) [illegible]

Type of Sampler Plastic Distilled Water Jug

Date 5/16/89 Time 11:50

Media Water Station 3

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 5 °C
pH 7.17 dissolved oxygen 13.4 mg/l
conductivity 45 umhos/cm turbidity 1.5 NTU @ 13:25
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 49° F wind 1-3 mph
precipitation NONE sunlight Partly Cloudy

Sampler (signature) Christopher J Paulos Date 5/17/89
Supervisor (signature) [illegible] Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT May Water Quality Run		
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 3 of 7
	Reviewed	

ALKALINITY

Station # 3

Sample Taken = 11:50 5/17

Sample Tested = 16:32 5/17

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl.-Gy

#Units x Multiplier = 160 x .1 = 16.0 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-3

Sampling Location Buffalo Creek
½ 700 Ft downstream of Wishbone Lake

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. 0

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 19:20

Media Water Station 3

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 10 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 15 °C
pH 6.97 dissolved oxygen 8.2 mg/l
conductivity 45 umhos/cm turbidity 1.6 NTU 13:06 6/20
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	✓ sulfuric acid
250 ml		plastic bottle	✓ nitric acid
250 ml	filtered	plastic bottle	✓ nitric acid

WEATHER temperature 66°F wind NONE
precipitation NONE sunlight High overcast In shade

Sampler (signature) Christopher L. Parker Date June 20, 1989

Supervisor (signature) [illegible] Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT	JUNE Water Quality Run	
Job No. 883-2146	Made by CJP	Date 6/20/89
Ref.	Checked	Sheet 3 of 7
	Reviewed	

ALKALINITY

Station # 3

Sample Taken = 19:20 6/19

Sample Tested = 13:40

Titration Cartridge Ø.6N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl - Gy

#Units x Multiplier = 17.8 x Ø.1 = 17.8 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146-002

Site Location WISHBONE HILLS Sample ID 883-2146-7-20-89-3

Sampling Location Buffalo Creek
≈ 200 Ft downstream from Wishbone Lake

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic 250 ml Jar

Date 7/20/89 Time 13:40

Media Water Station 3

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 15 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 12 °C
pH 6.50 dissolved oxygen 6.3 mg/l
conductivity 45 umhos/cm turbidity 2.0 NTU
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	✓	sulfuric acid
250 ml	plastic bottle	✓	nitric acid
250 ml filtered	plastic bottle	✓	nitric acid

WEATHER temperature 55°F wind None
precipitation Storm 18 sunlight Cloudy

Sampler (signature) Christopher J. Parks Date July 21, 1989
Supervisor (signature) JD Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality		
Job No. 883-2146-002 Ref. McKinley Mining	Made by CJP Checked Reviewed	Date 7/21/89 Sheet 3 of 7

ALKALINITY

Station # 3

Sample Taken = 13:40 7/2

Sample Tested = 14:29 7/2

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/L

T. ALK -

Color Description - Bl/Gy

#Units x Multiplier = 214 x .1 = 21.4 mg/L = T. ALK

SURFACE WATER SAMPLING
STATION #4

BUFFALO CREEK

Golder Associates

Sample Site: 883-2146-7-30-88-4
Lab No: 886646
Date Sampled: 07/30/88 @ 1700
Date Received: 08/03/88

Lab pH, s.u.	7.33
Lab Conductivity, umhos/cm @ 25C	64
Total Dissolved Solids (180), mg/l	30
Total Dissolved Solids (calc), mg/l	30
Boron, mg/l	<0.01
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.08
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	<0.002
Total Organic Phosphorus as P, mg/l	0.006
Total Alkalinity as CaCO3, mg/l	28
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	23
Sodium Adsorption Ratio	0.27
Total Suspended Solids, mg/l	5.0
Settleable Solids, ml/l	<0.1
Turbidity, NTU	0.58

	mg/l	meq/l
Bicarbonate as HCO3	34	0.55
Carbonate as CO3	0	0.00
Chloride	0.4	0.01
Nitrate as N, mg/l	0.58	0.04
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.0	0.02
Calcium	7.2	0.36
Magnesium	1.2	0.10
Potassium	0.5	0.01
Sodium	3.1	0.13

Major Anions	0.62
Major Cations	0.60
Cation/Anion Difference	1.64 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.13
Manganese	<0.02

Sample Site: 883-2146-83188-4
Lab No: 886864
Date Sampled: 08/31/88 @ 1509
Date Received: 09/02/88

Lab pH, s.u.	7.02
Lab Conductivity, umhos/cm @ 25C	67
Total Dissolved Solids (180), mg/l	34
Total Dissolved Solids (calc), mg/l	32
Boron, mg/l	0.02
Fluoride, mg/l	0.06
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.010
Total Alkalinity as CaCO3, mg/l	31
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	26
Sodium Adsorption Ratio	0.25
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	37	0.61
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.18	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.4	0.01
Calcium	7.4	0.37
Magnesium	1.8	0.15
Potassium	0.4	0.01
Sodium	3.0	0.13

Major Anions	0.65
Major Cations	0.66
Cation/Anion Difference	0.76 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.48
Manganese	<0.02

Sample Site: 883-2146-92388-4
Lab No: 886975
Date Sampled: 09/23/88 @ 1435
Date Received: 09/28/88

Lab pH, s.u.	7.15
Lab Conductivity, umhos/cm @ 25C	56
Total Dissolved Solids (180), mg/l	40
Total Dissolved Solids (calc), mg/l	26
Boron, mg/l	<0.01
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.3
Ortho Phosphorus as P, mg/l	0.010
Total Organic Phosphorus as P, mg/l	0.008
Total Phosphorus as P, mg/l	0.019
Total Alkalinity as CaCO3, mg/l	21
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	19
Sodium Adsorption Ratio	0.25
Total Suspended Solids, mg/l	7
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	25	0.41
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.01	0.00
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.8	0.02
Calcium	5.3	0.27
Magnesium	1.3	0.11
Potassium	0.6	0.01
Sodium	2.6	0.11

Major Anions	0.51
Major Cations	0.50
Cation/Anion Difference	0.99 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.15
Manganese	<0.02

Sample Site: 883-2146-102188-4
Lab No: 887122
Date Sampled: 10/21/88 @ 1614
Date Received: 10/26/88

Lab pH, s.u.	6.98
Lab Conductivity, umhos/cm @ 25C	46
Total Dissolved Solids (180), mg/l	28
Total Dissolved Solids (calc), mg/l	24
Boron, mg/l	<0.01
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.010
Total Organic Phosphorus as P, mg/l	0.007
Total Phosphorus as P, mg/l	0.025
Total Alkalinity as CaCO3, mg/l	22
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	20
Sodium Adsorption Ratio	0.25
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	27	0.44
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.10	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	<0.1	0.00
Calcium	4.9	0.25
Magnesium	1.7	0.14
Potassium	0.2	0.01
Sodium	2.6	0.11

Major Anions	0.48
Major Cations	0.51
Cation/Anion Difference	3.03 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.12
Manganese	<0.02

Sample Site: 883-2146-111988-4
Lab No: 887224
Date Sampled: 11/19/88 @ 1345
Date Received: 11/23/88

Lab pH, s.u.	6.65
Lab Conductivity, umhos/cm @ 25C	48
Total Dissolved Solids (180), mg/l	48
Total Dissolved Solids (calc), mg/l	28
Boron, mg/l	0.30
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.006
Total Phosphorus as P, mg/l	0.013
Total Alkalinity as CaCO3, mg/l	26
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	23
Sodium Adsorption Ratio	0.25
Color, c.u.	<1
Total Suspended Solids, mg/l	6
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	31	0.51
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.16	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.2	0.03
Calcium	6.1	0.31
Magnesium	1.8	0.15
Potassium	0.2	0.01
Sodium	2.8	0.12

Major Anions	0.57
Major Cations	0.59
Cation/Anion Difference	1.72 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.002	Zinc	0.04
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.15
Manganese	<0.02

Sample Site: 883-2146-111988-4 (DUPLICATE ANALYSES)
Lab No: 887228
Date Sampled: 11/19/88 @ 1345
Date Received: 11/23/88

Lab pH, s.u.	6.69
Lab Conductivity, umhos/cm @ 25C	50
Total Dissolved Solids (180), mg/l	54
Total Dissolved Solids (calc), mg/l	29
Boron, mg/l	0.30
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.007
Total Phosphorus as P, mg/l	0.016
Total Alkalinity as CaCO3, mg/l	27
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	24
Sodium Adsorption Ratio	0.27
Color, c.u.	<1
Total Suspended Solids, mg/l	9
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	32	0.53
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.16	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	1.2	0.03
Calcium	6.0	0.30
Magnesium	2.1	0.17
Potassium	0.2	0.01
Sodium	2.9	0.13

Major Anions	0.59
Major Cations	0.61
Cation/Anion Difference	1.67 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	0.002	Zinc	0.03
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.16
Manganese	<0.02

Sample Site: 883-2146-19-88-4
Lab No: 887412
Date Sampled: 12/19/88 @ 1431
Date Received: 12/22/88

Lab pH, s.u.	7.33
Lab Conductivity, umhos/cm @ 25C	64
Total Dissolved Solids (180), mg/l	22
Total Dissolved Solids (calc), mg/l	29
Boron, mg/l	<0.01
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	0.27
Total Kjeldahl Nitrogen, mg/l	0.4
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.008
Total Alkalinity as CaCO3, mg/l	29
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	24
Sodium Adsorption Ratio	0.16
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<1.0

	mg/l	meq/l
Bicarbonate as HCO3	35	0.58
Carbonate as CO3	0	0.00
Chloride	<1.0	0.00
Nitrate as N, mg/l	0.21	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	<1.0	0.01
Calcium	7.3	0.36
Magnesium	1.5	0.12
Potassium	<0.2	0.00
Sodium	1.9	0.08

Major Anions	0.61
Major Cations	0.56
Cation/Anion Difference	4.27 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.18
Manganese	<0.02

Sample Site: 883-2146-032089-4
Lab No: 897704
Date Sampled: 03/20/89 @ 1230
Date Received: 03/23/89

Lab pH, s.u.	6.63
Lab Conductivity, umhos/cm @ 25C	61
Total Dissolved Solids (180), mg/l	32
Total Dissolved Solids (calc), mg/l	32
Boron, mg/l	0.12
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.017
Total Phosphorus as P, mg/l	0.027
Total Alkalinity as CaCO3, mg/l	30
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	24
Sodium Adsorption Ratio	0.35
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	36	0.59
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.29	0.02
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.2	0.03
Calcium	6.9	0.34
Magnesium	1.7	0.14
Potassium	0.3	0.01
Sodium	3.9	0.17

Major Anions	0.66
Major Cations	0.66
Cation/Anion Difference	.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	0.09
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	0.02	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.20
Manganese, mg/l	<0.02

Sample Site: 883-2146-041489-4
Lab No: 897894
Date Sampled: 04/14/89 @ 1210
Date Received: 04/18/89

Lab pH, s.u.	6.89
Lab Conductivity, umhos/cm @ 25C	58
Total Dissolved Solids (180), mg/l	34
Total Dissolved Solids (calc), mg/l	28
Boron, mg/l	0.32
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.020
Total Organic Phosphorus as P, mg/l	0.028
Total Phosphorus as P, mg/l	0.054
Total Alkalinity as CaCO3, mg/l	25
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	21
Sodium Adsorption Ratio	0.24
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	30	0.49
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.41	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.4	0.01
Calcium	7.5	0.38
Magnesium	0.5	0.04
Potassium	1.5	0.04
Sodium	2.5	0.11

Major Anions	0.56
Major Cations	0.57
Cation/Anion Difference	0.88 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.10
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.17
Manganese, mg/l	<0.02

Sample Site: 883-2146-041489-4 (DUPLICATE ANALYSIS)
Lab No: 897896
Date Sampled: 04/14/89 @ 1210
Date Received: 04/18/89

Lab pH, s.u.	6.89
Lab Conductivity, umhos/cm @ 25C	59
Total Dissolved Solids (180), mg/l	34
Total Dissolved Solids (calc), mg/l	28
Boron, mg/l	0.36
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.020
Total Organic Phosphorus as P, mg/l	0.028
Total Phosphorus as P, mg/l	0.056
Total Alkalinity as CaCO3, mg/l	24
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	21
Sodium Adsorption Ratio	0.22
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	29	0.48
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.41	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	0.0	0.00
Calcium	7.1	0.36
Magnesium	0.7	0.06
Potassium	1.5	0.04
Sodium	2.4	0.10

Major Anions	0.55
Major Cations	0.56
Cation/Anion Difference	0.90 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.10
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.17
Manganese, mg/l	<0.02

Sample Site: 883-2146-5-16-89-4
Lab No: 898011
Date Sampled: 05/16/89 @ 1416
Date Received: 05/19/89

Lab pH, s.u.	7.21
Lab Conductivity, umhos/cm @ 25C	43
Total Dissolved Solids (180), mg/l	48
Total Dissolved Solids (calc), mg/l	21
Boron, mg/l	<0.01
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.6
Ortho Phosphorus as P, mg/l	0.027
Total Organic Phosphorus as P, mg/l	0.004
Total Phosphorus as P, mg/l	0.032
Total Alkalinity as CaCO3, mg/l	19
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	16
Sodium Adsorption Ratio	0.28
Color, c.u.	<1
Total Suspended Solids, mg/l	7
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	23	0.38
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.10	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	0.8	0.02
Calcium	4.6	0.23
Magnesium	1.1	0.09
Potassium	0.4	0.01
Sodium	2.5	0.11

Major Anions	0.43
Major Cations	0.44
Cation/Anion Difference	1.15 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	<0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-06-19-89-4
Lab No: 898296
Date Sampled: 06/19/89 @ 1510
Date Received: 06/21/89

Lab pH, s.u.	6.65
Lab Conductivity, umhos/cm @ 25C	53
Total Dissolved Solids (180), mg/l	8
Total Dissolved Solids (calc), mg/l	26
Boron, mg/l	<0.01
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.04
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.006
Total Phosphorus as P, mg/l	0.019
Total Alkalinity as CaCO3, mg/l	24
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	21
Sodium Adsorption Ratio	0.24
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	29	0.47
Carbonate as CO3	0	0.00
Chloride	1.1	0.03
Nitrate as N, mg/l	0.05	<0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	1.9	0.04
Calcium	3.0	0.15
Magnesium	3.3	0.27
Potassium	0.1	<0.01
Sodium	2.6	0.11

Major Anions	0.54
Major Cations	0.53
Cation/Anion Difference	0.93 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.07
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.02

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.12
Manganese, mg/l	<0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILL Project No. 883-2146-

Site Location Sample ID 883-2146-7-30-88-4

Sampling Location Buffalo Cr. downstream

Technical Procedure Reference(s) NONE

Type of Sampler GRAB

Date 7-30-88 Time 645

Media WATER Station 4

Sample Type: ✓ grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) Spatial Composite

Climate: Overcast last rain 48 hours prior to sampling

Sample Description Baseline Water Quality Buffalo Cr.

Field Measurements on Sample (pH, conductivity, etc.)

Temp: 9.5°C Dissolved Oxygen: 12 mg/l

PH: 6.5 Conductivity: 59 umhos

Turbidity: Not Sampled

Aliquot Amount	Container	Preservative/Amount
1/2 Gallon	Plastic Jug	None
500 ml	" "	Sulfric Acid
250 ml	" "	Nitric Acid
250 ml	" "	None (Needs Filtering)

Sampler (signature) [signature] Date 7-30-88

Supervisor (signature) [signature] Date 7-30-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hill Project No. 883-2146

Site Location Buffalo CK Sample ID 883-2146-8-31-88-4

Sampling Location Buffalo CK just upstream of flume

Technical Procedure Reference(s)

Type of Sampler Plastic Distilled Water Jug

Date 8/31/88 Time 2:50

Media Station 4

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.)

Sample Description

Flume Stage = .11 Ft Datapod 0.60 Ft Checks w/Stilling Well
Cloudy, Occasional Sprinkles, ≈ 45°C

Field Measurements on Sample (pH, conductivity, etc.)

Temp 8.5°C pH 6.3
O.D. 10.2 Conductivity 64
Turbidity 0.47 NTU

Aliquot Amount	Container	Preservative/Amount
1/2 gal	Plastic Jug	NONE
500 ml	"	Sulfuric Acid
250 ml	"	Nitric Acid
250 ml	"	Filtered Nitric Acid
	"	

Sampler (signature) Christopher J Paulos Date 8/31/88

Supervisor (signature) [illegible] Date 9-1-88

Golder Associates

YSI 95 10 Full
DSM Changed
Bat 4.9 Volts
Bat Changed
New Bat @ 6.2 Volts

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-9-23-88-4

Sampling Location Buffalo Creek Flume ≈ 10ft upstream of flume

Technical Procedure Reference(s) G.L. memo dated 9/21/88

Type of Sampler Distilled Water Jug

Date 9/23/88 Time 2:35

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples ~~across~~ in channel at depths 0 to .5 feet below water surface just to the left of flume (looking upstream) in a sharp bend

Sample Description Baseline water quality of Buffalo Creek
NOTES: Stilling well cloudy, could not see bottom of well clearly
0.5 Ft of debris across upstream edge of flume, branch dam (see photo)
Water was extremelly yellow in color

Field Measurements on Sample (pH, conductivity, etc.) temperature 6.5 °C
pH 6.88 dissolved oxygen 10.4 mg/l
conductivity 48 umhos/cm turbidity 2.7 NTU

Before Dam Removed water level - held staff 1.2 FT in Still well staff gage 0.7 Datapod 1.17

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	✓	sulfuric acid
250 ml	plastic bottle	✓	nitric acid
250 ml filtered	plastic bottle	✓	nitric acid

NOTE! High water witnessed by Doug & Bob of Dames and Moore on 9/22 (See Photos for Wat Line
They read 1.4Ft @ 12 Noon on 9/22/88
≈ 1"-3" of fine sediment in corners of flume, cleaned out on 9/23

WEATHER temperature 51°F wind Lt. Breeze
precipitation None sunlight Clear/Sunny

NOTE: 2 day Storm Event from 9/20 - 9/22/88

Sampler (signature) Christopher A Prusha Date 9/24/88

Supervisor (signature) [signature] Date 27 Sept 1988

After Dam Removed 3:30pm Water Level held 1.25 Staff in Well Staff gage .725 Datapod 1.191

Golder Associates

- DSM 34% FULL - NOT CHANGED
- BATS 5.4 VOLTS NOT CHANGED

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-21-88-4

Sampling Location Buffalo CREEK
No. #4 20 ft UP STREAM of FLUME

Technical Procedure Reference(s) G.L.S Memo Dated 9/21/88

Type of Sampler PLASTIC DISTILLED WATER JUG

Date 10-21-88 Time 1600 4:06

Media WATER Station No. #4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Buffalo CREEK

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C
pH 6.02 dissolved oxygen 12.2 mg/l
conductivity 041 umhos/cm turbidity 0.58 NTU
water level - held staff .7 HELD STAFF ON TOP OF TRANSDUCER staff gage .33 . Datapod .651

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

16:16 PM. STILLING WELL HAD 1/4" SHEET of ICE, it was removed
Bottom of well covered with a thin layer of fine sediment, tube between well (Co
WEATHER temperature 40° wind 5-10 MPH
precipitation NONE sunlight clear - SHADY

Sampler (signature) Christopher J. Parker Date 10-23-88
Supervisor (signature) G. Laird Date 10-27-88

and flume contains sediment also, approximately a dozen worms reside in the well.

Golder Associates

Golder Associates	SUBJECT WISHBONE HYDROLOGY		
	Job No. 883-2146 Ref.	Made by M. MUSIAL Checked Reviewed	Date 10-24-88 Sheet 1 of 1

ALKALINITY TEST

SAMPLE SITE: 883-2146-10-21-88-4

DATE SAMPLED: 10/21/88 TIME SAMPLED: 4:14

NOTE – Alkalinity Measurements performed in lab 72+ hrs after sampled.

DATE TESTED: 10/24/88 TIME TESTED: 1035

Warmed 15 min @ 65°F Room Temp
No Thermometer to measure Sample

P Alkalinity –

Color – Clear
TITRATE = 0 P Alkalinity = 0

Cartridge = 0.1600

BROMOCRISOL GREEN – METHYL RED

Color	TITRIATE
Light Green	0
Light Greenish Blue Gray	190
Light Pink	210

SCALE FACTOR = 0.1

check EQUATION IN MANUAL

TOTAL ALKALINITY = 0.1 (190)
= 19.0 mg/L as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-19-88-4

Sampling Location Buffalo Creek Flume
≈ 1000 feet upstream of Flume

Technical Procedure Reference(s) Sampling Q.A. Plan, Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/19/88 Time 13:45

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Grab ~~Spatial~~ composite of 3 subsamples across channel at depths 0 to .1 feet below water surface

Sample Description Baseline water quality of Buffalo CK.

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.0 °C

pH 7.2 dissolved oxygen 11.6 mg/l

conductivity 59 umhos/cm turbidity .5 NTU

water level - held staff .15 Ft In Flume staff gage Unreadable Datapod Not Working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Field Parameters Performed in car at 14:15

WEATHER temperature 20°F wind 0-5 mph

precipitation NONE sunlight High Overcast

Sampler (signature) Christopher J. Parks Date 11/20/88

Supervisor (signature) JD Date 12/9/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hydrology		
	Job No 883-2146 Ref.	Made by MWSIAC Checked Reviewed	Date 11-22-88 Sheet 1 of 1

Alkalinity — STA 4 1030 hrs 11-22-88

Titration Cartridge = 0.16 N H_2SO_4

PALK

Clear PALK = 0

T ALK

Light, Grnish Blu Gray — 226 units

T ALK = 226 x 0.1 = 22.6 Mg/L as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-19-88-4

Sampling Location BUFFALO Creek ≈ 250 Ft upstream of the Flume

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 12/19/88 Time 14:30

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 2 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1 °C

pH 7.19 dissolved oxygen 13.5 mg/l

conductivity 85 umhos/cm turbidity .65 NTU @ 18:00 12/22

water level - held staff .04 Ft staff gage unreadable Datapod Not operating

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	✓ sulfuric acid
250 ml		plastic bottle	✓ nitric acid
250 ml	filtered	plastic bottle	✓ nitric acid

WEATHER temperature 32° F wind 5-10 mph Gusting 20 mph

precipitation NONE sunlight Cloudy

Sampler (signature) Christopher J. Paulus Date 12/21/88

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKALINITY STATION #4 TESTED 12-19-88

TITRATION CARTRIDGE = 1.600 NH_2SO_4

P. ALK

Color
CLEAR → P. ALK = 0

T. ALK

LT. GRNISH BLU GRAY : 24

24 X 1.0 = 24.0 mg/L

LT VIOLET GRAY

TO LT. PINK : 32

T. ALK : 32 X 1.0 = 32.0 mg/L

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-20-89-4

Sampling Location Buffalo Creek ≈ 300 Ft upstream of the flume.

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Clear Plastic 400ml jar

Date 3/20/89 Time 12:30

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 30 subsamples across channel at depths 0 to -1 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.0 °C

pH 6.29 dissolved oxygen 7.2 mg/l

conductivity 62 umhos/cm turbidity 0.5 NTU @ 21:55

water level - held staff Not Measured staff gage Unreadable Datapod Not working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
1000 ~~500~~ ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 40°F wind Light breeze down here. ≈ 10-15 MPH Up on the Bench

precipitation NONE sunlight Partial, High Overcast

Sampler (signature) Christopher J. Pauley Date 3/23/89

Supervisor (signature) J.J. Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hill - Hydrology		
	Job No. 883-2146	Made by	Date 3/20/89
	Ref.	Checked	Sheet of
		Reviewed	

ALKALINITY

STATION: #4

STATION I.D. = 8832146-3-20-89-4

Sample Taken: 12:30

TITRATION CARTRIDGE: .1600 NH_2SO_4

Sample Tested: 10:07 3-20-89

P. ALK

COLOR - CLEAR - P. ALK = 0

T. ALK

LT. GREENISH BLUE GRAY = 224 UNITS

T. ALK = 224 X 0.1 = 22.4 mg/L as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-14-89-4

Sampling Location Buffalo Creek ≅ 400 ft upstream of the flume

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 4/14/89 Time 12:10

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Buffalo Creek
Note: Water taken ≅ 20 Ft upstream of last monthly sampling spot.
Water taken ≅ 30 Ft downstream of a 5 Ft water fall area.

Field Measurements on Sample (pH, conductivity, etc.) temperature 2.0 °C
pH 6.54 dissolved oxygen 12.2 mg/l
conductivity 69 umhos/cm turbidity 4 NTU @ 22:19
water level - held staff N/A staff gage unreadable Datapod Inoperative

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 40°F wind Lt Breeze Inoff
precipitation NONE sunlight Thin Overcast

Sampler (signature) Christopher G Pauley Date 4/16/89
Supervisor (signature) [illegible] Date 4/28/89

Golder Associates

91 17187 Alkalinity on Station # 4 CJP

Sample Taken : 12:10
" Tested : 23:43

No Pink Color P. Alk = ϕ

Bl.-Gy @ pH = 5.11 203 x .1 = T. Alk. = 20.3 mg/L $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-16-89-4

Sampling Location Buffalo Cr. ~ 20 Ft upstream of the flume

Technical Procedure Reference(s) Sampling O.H. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 5/16/89 Time 14:16

Media Water Station 4

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 2 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 5.0 °C

pH 7.05 dissolved oxygen 13.6 mg/l

conductivity 47 umhos/cm turbidity 2.4 NTU @ 15:05

water level - held staff 1.07 staff gage .645 Datapod 1.113

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Note: Some of the heavier settleable solids (sample) remained in the sampler, they settled out to fast.

WEATHER temperature 58°F wind 1-5 mph

precipitation None sunlight Clear & Sunny
Lt Rain during the past 24 hrs

Sampler (signature) Christopher J Pauley Date 5/17/89

Supervisor (signature) JV Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT	May Water Quality Run	
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 4 of 7
	Reviewed	

ALKALINITY

Station # 4

Sample Taken = 14:16 5/1

Sample Tested = 16:39 5/1

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/l

T. ALK -

Color Description - Br.-Gy

#Units x Multiplier = 157 x .1 = 15.7 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-4

Sampling Location Buffalo Creek
≈ 10 Ft upstream of the Flume

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. 0

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 15:10

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 5 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 8.5 °C
pH 7.22 dissolved oxygen 13 mg/l
conductivity 53 umhos/cm turbidity .4 NTU @ 13:04 6/20
water level - held staff .7 Ft staff gage .24 Ft Datapod .736

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Turbidity seems low, but that's what the machine read.

WEATHER temperature 72°F wind 1-2 mph
precipitation None sunlight Clear & Sunny

Sampler (signature) Christopher J Pauley Date June 20, 1989
Supervisor (signature) [illegible] Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT	JUNE Water Quality Run	
Job No. 883-2146	Made by CJP	Date 6/20/89
Ref.	Checked	Sheet 4 of 7
	Reviewed	

ALKALINITY

Station # 4

Sample Taken = 15:10 6/19

Sample Tested = 13:46

Titration Cartridge Ø.6N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description -

#Units x Multiplier = 216 x Ø.1 = 21.6 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146-002

Site Location WISHBONE HILLS Sample ID 883-2146-7-20-89-4

Sampling Location Buffalo Creek
≅ 15 ft upstream of the flume

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler 250 ml Plastic Jar

Date 7/20/89 Time 15:15

Media Water Station 4

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 10 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Buffalo Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 6.5 °C
pH 6.85 dissolved oxygen 11.1 mg/l
conductivity 61 umhos/cm turbidity 1.4 NTU @ 19:46
water level - held staff .55 ft staff gage .12 ft Datapod .553 ft

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	✓	sulfuric acid
250 ml	plastic bottle	✓	nitric acid
250 ml filtered	plastic bottle	✓	nitric acid

WEATHER temperature 60°F wind [illegible]
precipitation [illegible] sunlight [illegible]

Sampler (signature) Christopher J. Pauley Date July 21, 1989

Supervisor (signature) JV Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality		
Job No. 883-2146-002	Made by CJP	Date 7/21/89
Ref. McKinley Mining	Checked	Sheet 4 of 7
	Reviewed	

ALKALINITY

Station # 4

Sample Taken = 15:15 ?

Sample Tested = 14:37 ?

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK = Ø mg/L

T. ALK -

Color Description - Bl/Gy

#Units x Multiplier = 292 x 0.1 = 29.2 mg/L = T. ALK

SURFACE WATER SAMPLING
STATION #5

MOOSE CREEK

Sample Site: 883-2146-7-30-88-5
Lab No: 886647
Date Sampled: 07/30/88 @ 1800
Date Received: 08/03/88

Lab pH, s.u.	7.43
Lab Conductivity, umhos/cm @ 25C	86
Total Dissolved Solids (180), mg/l	40
Total Dissolved Solids (calc), mg/l	41
Boron, mg/l	0.04
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	<0.002
Total Organic Phosphorus as P, mg/l	0.002
Total Alkalinity as CaCO3, mg/l	31
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	32
Sodium Adsorption Ratio	0.23
Total Suspended Solids, mg/l	4.0
Settleable Solids, ml/l	<0.1
Turbidity, NTU	1.2

	mg/l	meq/l
Bicarbonate as HCO3	37	0.61
Carbonate as CO3	0	0.00
Chloride	1.4	0.04
Nitrate as N, mg/l	0.13	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	6.0	0.12
Calcium	11	0.54
Magnesium	1.3	0.11
Potassium	0.5	0.01
Sodium	3.1	0.13

Major Anions	0.78
Major Cations	0.79
Cation/Anion Difference	0.64 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.14
Manganese	<0.02

Sample Site: 883-2146-83188-5
Lab No: 886865
Date Sampled: 08/31/88 @ 1900
Date Received: 09/02/88

Lab pH, s.u.	7.09
Lab Conductivity, umhos/cm @ 25C	93
Total Dissolved Solids (180), mg/l	42
Total Dissolved Solids (calc), mg/l	46
Boron, mg/l	0.05
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.002
Total Organic Phosphorus as P, mg/l	0.005
Total Alkalinity as CaCO3, mg/l	34
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	36
Sodium Adsorption Ratio	0.22
Total Suspended Solids, mg/l	3
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	41	0.68
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	0.12	0.01
Nitrite as N, mg/l	<0.01	0.00
Sulfate	7.0	0.15
Calcium	12	0.60
Magnesium	1.5	0.12
Potassium	0.8	0.02
Sodium	3.0	0.13

Major Anions	0.89
Major Cations	0.87
Cation/Anion Difference	1.14 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.07
Manganese	<0.02

Sample Site: 883-2146-92388-5
Lab No: 886976
Date Sampled: 09/23/88 @ 1915
Date Received: 09/28/88

Lab pH, s.u.	7.59
Lab Conductivity, umhos/cm @ 25C	116
Total Dissolved Solids (180), mg/l	82
Total Dissolved Solids (calc), mg/l	61
Boron, mg/l	0.03
Fluoride, mg/l	0.10
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.2
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.010
Total Alkalinity as CaCO3, mg/l	45
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	42
Sodium Adsorption Ratio	0.47
Total Suspended Solids, mg/l	3
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	54	0.89
Carbonate as CO3	0	0.00
Chloride	1.8	0.05
Nitrate as N, mg/l	0.25	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	9.5	0.20
Calcium	14	0.68
Magnesium	1.8	0.15
Potassium	0.5	0.01
Sodium	7.0	0.30

Major Anions	1.16
Major Cations	1.14
Cation/Anion Difference	0.87 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.11
Manganese	<0.02

Sample Site: 883-2146-92388-5 (DUPLICATE)
Lab No: 886979
Date Sampled: 09/23/88 @ 1915
Date Received: 09/28/88

Lab pH, s.u.	7.66
Lab Conductivity, umhos/cm @ 25C	118
Total Dissolved Solids (180), mg/l	76
Total Dissolved Solids (calc), mg/l	62
Boron, mg/l	0.04
Fluoride, mg/l	0.09
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.012
Total Alkalinity as CaCO3, mg/l	45
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	41
Sodium Adsorption Ratio	0.50
Total Suspended Solids, mg/l	4
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	54	0.89
Carbonate as CO3	0	0.00
Chloride	2.5	0.07
Nitrate as N, mg/l	0.24	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	9.5	0.20
Calcium	14	0.68
Magnesium	1.8	.0.15
Potassium	0.5	0.01
Sodium	7.3	0.32

Major Anions	1.18
Major Cations	1.16
Cation/Anion Difference	0.85 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Mercury	<0.001
Arsenic	<0.005	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Lead	<0.02		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.11
Manganese	<0.02

Sample Site: 883-2146-102188-5
Lab No: 887119
Date Sampled: 10/21/88 @ 1015
Date Received: 10/26/88

Lab pH, s.u.	7.16
Lab Conductivity, umhos/cm @ 25C	108
Total Dissolved Solids (180), mg/l	60
Total Dissolved Solids (calc), mg/l	62
Boron, mg/l	0.06
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.010
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.022
Total Alkalinity as CaCO3, mg/l	45
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	47
Sodium Adsorption Ratio	0.37
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	55	0.90
Carbonate as CO3	0	0.00
Chloride	2.5	0.07
Nitrate as N, mg/l	0.31	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	9.1	0.19
Calcium	14	0.72
Magnesium	2.6	0.21
Potassium	0.4	0.01
Sodium	5.8	0.25

Major Anions	1.18
Major Cations	1.19
Cation/Anion Difference	0.42 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.05
Manganese	<0.02

Sample Site: 883-2146-102188-5 (DUPLICATE ANALYSES)
Lab No: 887124
Date Sampled: 10/21/88 @ 1015
Date Received: 10/26/88

Lab pH, s.u.	7.14
Lab Conductivity, umhos/cm @ 25C	109
Total Dissolved Solids (180), mg/l	62
Total Dissolved Solids (calc), mg/l	61
Boron, mg/l	0.05
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.010
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.020
Total Alkalinity as CaCO3, mg/l	45
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	47
Sodium Adsorption Ratio	0.37
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	54	0.89
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.31	0.02
Nitrite as N, mg/l	<0.01	0.00
Sulfate	8.6	0.18
Calcium	14	0.71
Magnesium	2.7	0.22
Potassium	0.4	0.01
Sodium	5.8	0.25

Major Anions	1.17
Major Cations	1.19
Cation/Anion Difference	0.85 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	<0.01
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.08
Manganese	<0.02

Sample Site: 883-2146-111988-5
Lab No: 887225
Date Sampled: 11/19/88 @ 1520
Date Received: 11/23/88

Lab pH, s.u.	7.02
Lab Conductivity, umhos/cm @ 25C	107
Total Dissolved Solids (180), mg/l	96
Total Dissolved Solids (calc), mg/l	67
Boron, mg/l	0.46
Fluoride, mg/l	0.03
Ammonia Nitrogen as N, mg/l	0.36
Total Kjeldahl Nitrogen, mg/l	0.5
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	0.003
Total Phosphorus as P, mg/l	0.007
Total Alkalinity as CaCO3, mg/l	48
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	52
Sodium Adsorption Ratio	0.32
Color, c.u.	<1
Total Suspended Solids, mg/l	4
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	58	0.95
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.39	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	12	0.24
Calcium	16	0.81
Magnesium	2.9	0.24
Potassium	0.4	0.01
Sodium	5.3	0.23

Major Anions	1.30
Major Cations	1.29
Cation/Anion Difference	0.39 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.02
Copper	<0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.08
Manganese	<0.02

Sample Site: 883-2146-12-20-88-5
Lab No: 887413
Date Sampled: 12/20/88 @ 1620
Date Received: 12/22/88

Lab pH, s.u.	7.62
Lab Conductivity, umhos/cm @ 25C	118
Total Dissolved Solids (180), mg/l	68
Total Dissolved Solids (calc), mg/l	67
Boron, mg/l	0.09
Fluoride, mg/l	0.02
Ammonia Nitrogen as N, mg/l	0.15
Total Kjeldahl Nitrogen, mg/l	0.7
Ortho Phosphorus as P, mg/l	0.003
Total Organic Phosphorus as P, mg/l	0.008
Total Phosphorus as P, mg/l	0.008
Total Alkalinity as CaCO3, mg/l	47
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	53
Sodium Adsorption Ratio	0.28
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	57	0.94
Carbonate as CO3	0	0.00
Chloride	3.9	0.11
Nitrate as N, mg/l	0.43	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	11	0.22
Calcium	17	0.83
Magnesium	2.7	0.22
Potassium	0.5	0.01
Sodium	4.5	0.20

Major Anions	1.30
Major Cations	1.26
Cation/Anion Difference	1.56 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Lead	<0.02
Arsenic	<0.005	Mercury	<0.001
Barium	<0.5	Selenium	<0.005
Cadmium	<0.002	Zinc	0.02
Copper	0.01		

Trace Metals (Total Concentrations), mg/l

Chromium	<0.02
Iron	0.08
Manganese	<0.02

Sample Site: 883-2146-012989-5
Lab No: 897521
Date Sampled: 01/29/89 @ 1030
Date Received: 01/31/89

Lab pH, s.u.	7.58
Lab Conductivity, umhos/cm @ 25C	121
Total Dissolved Solids (180), mg/l	74
Total Dissolved Solids (calc), mg/l	74
Boron, mg/l	0.35
Fluoride, mg/l	0.08
Ammonia Nitrogen as N, mg/l	0.05
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	<0.001
Total Organic Phosphorus as P, mg/l	<0.001
Total Phosphorus as P, mg/l	<0.001
Total Alkalinity as CaCO3, mg/l	48
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	55
Sodium Adsorption Ratio	0.35
Color, c.u.	<1
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	59	0.96
Carbonate as CO3	0	0.00
Chloride	5.0	0.14
Nitrate as N, mg/l	0.47	0.03
Nitrite as N, mg/l	<0.01	0.00
Sulfate	13	0.28
Calcium	18	0.88
Magnesium	2.8	0.23
Potassium	0.8	0.02
Sodium	6.0	0.26

Major Anions	1.41
Major Cations	1.39
Cation/Anion Difference	0.71 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.10
Manganese, mg/l	<0.02

Sample Site: 883-2146-2-24-89-5
Lab No: 897644
Date Sampled: 02/24/89 @ 1100
Date Received: 02/28/89

Lab pH, s.u.	7.60
Lab Conductivity, umhos/cm @ 25C	150
Total Dissolved Solids (180), mg/l	90
Total Dissolved Solids (calc), mg/l	72
Boron, mg/l	0.27
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	0.10
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.001
Total Organic Phosphorus as P, mg/l	0.002
Total Phosphorus as P, mg/l	0.003
Total Alkalinity as CaCO3, mg/l	51
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	57
Sodium Adsorption Ratio	0.36
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	62	1.01
Carbonate as CO3	0	0.00
Chloride	5.7	0.16
Nitrate as N, mg/l	0.49	0.04
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	12	0.26
Calcium	8.7	0.43
Magnesium	8.8	0.72
Potassium	0.6	0.02
Sodium	6.2	0.27

Major Anions	1.47
Major Cations	1.44
Cation/Anion Difference	1.03 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	0.2	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-032289-5
Lab No: 897712
Date Sampled: 03/22/89 @ 1015
Date Received: 03/24/89

Lab pH, s.u.	7.72
Lab Conductivity, umhos/cm @ 25C	135
Total Dissolved Solids (180), mg/l	90
Total Dissolved Solids (calc), mg/l	78
Boron, mg/l	0.29
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	0.02
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.004
Total Phosphorus as P, mg/l	0.010
Total Alkalinity as CaCO3, mg/l	51
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	59
Sodium Adsorption Ratio	0.34
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	62	1.02
Carbonate as CO3	0	0.00
Chloride	6.7	0.19
Nitrate as N, mg/l	0.38	0.03
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	13	0.27
Calcium	19	0.94
Magnesium	2.9	0.24
Potassium	0.5	0.01
Sodium	6.0	0.26

Major Anions	1.51
Major Cations	1.45
Cation/Anion Difference	2.03 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-041589-5
Lab No: 897895
Date Sampled: 04/15/89 @ 1030
Date Received: 04/18/89

Lab pH, s.u.	7.67
Lab Conductivity, umhos/cm @ 25C	144
Total Dissolved Solids (180), mg/l	74
Total Dissolved Solids (calc), mg/l	77
Boron, mg/l	0.36
Fluoride, mg/l	0.05
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.1
Ortho Phosphorus as P, mg/l	0.012
Total Organic Phosphorus as P, mg/l	0.020
Total Phosphorus as P, mg/l	0.040
Total Alkalinity as CaCO3, mg/l	52
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	51
Sodium Adsorption Ratio	0.59
Color, c.u.	<1
Total Suspended Solids, mg/l	2
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	63	1.04
Carbonate as CO3	0	0.00
Chloride	4.3	0.12
Nitrate as N, mg/l	0.68	0.05
Nitrite as N, mg/l	<0.01	0.00
Sulfate	13	0.26
Calcium	15	0.77
Magnesium	3.2	0.26
Potassium	0.9	0.02
Sodium	9.7	0.42

Major Anions	1.47
Major Cations	1.47
Cation/Anion Difference	0.00 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	0.08
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.30
Manganese, mg/l	<0.02

Sample Site: 883-2146-5-16-89-5
Lab No: 898012
Date Sampled: 05/16/89 @ 2120
Date Received: 05/19/89

Lab pH, s.u.	7.61
Lab Conductivity, umhos/cm @ 25C	107
Total Dissolved Solids (180), mg/l	88
Total Dissolved Solids (calc), mg/l	66
Boron, mg/l	<0.01
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	<0.01
Total Kjeldahl Nitrogen, mg/l	0.6
Ortho Phosphorus as P, mg/l	0.020
Total Organic Phosphorus as P, mg/l	0.027
Total Phosphorus as P, mg/l	0.001
Total Alkalinity as CaCO3, mg/l	47
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	44
Sodium Adsorption Ratio	0.51
Color, c.u.	<1
Total Suspended Solids, mg/l	1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	57	0.94
Carbonate as CO3	0	0.00
Chloride	2.8	0.08
Nitrate as N, mg/l	0.78	0.06
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	9.5	0.20
Calcium	15	0.75
Magnesium	1.7	0.14
Potassium	0.6	0.02
Sodium	7.8	0.34

Major Anions	1.28
Major Cations	1.25
Cation/Anion Difference	1.19 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	<0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	<0.05
Manganese, mg/l	<0.02

Sample Site: 883-2146-06-19-89-5
Lab No: 898297
Date Sampled: 06/19/89 @ 1100
Date Received: 06/21/89

Lab pH, s.u.	6.76
Lab Conductivity, umhos/cm @ 25C	63
Total Dissolved Solids (180), mg/l	40
Total Dissolved Solids (calc), mg/l	32
Boron, mg/l	<0.01
Fluoride, mg/l	0.04
Ammonia Nitrogen as N, mg/l	0.03
Total Kjeldahl Nitrogen, mg/l	<0.1
Ortho Phosphorus as P, mg/l	0.006
Total Organic Phosphorus as P, mg/l	0.005
Total Phosphorus as P, mg/l	0.020
Total Alkalinity as CaCO3, mg/l	26
Total Acidity as CaCO3, mg/l	<1
Total Hardness as CaCO3, mg/l	27
Sodium Adsorption Ratio	0.15
Color, c.u.	<1
Total Suspended Solids, mg/l	<1
Settleable Solids, ml/l	<0.1

	mg/l	meq/l
Bicarbonate as HCO3	31	0.51
Carbonate as CO3	0	0.00
Chloride	0.7	0.02
Nitrate as N, mg/l	0.15	0.01
Nitrite as N, mg/l	<0.01	<0.01
Sulfate	5.3	0.11
Calcium	4.3	0.21
Magnesium	4.0	0.33
Potassium	0.3	0.01
Sodium	1.8	0.08

Major Anions	0.65
Major Cations	0.63
Cation/Anion Difference	1.56 %

Trace Metals (Dissolved Concentrations), mg/l

Aluminum	<0.1	Iron	<0.05
Arsenic	<0.005	Lead	<0.02
Barium	<0.5	Manganese	<0.02
Cadmium	<0.002	Mercury	<0.001
Chromium	<0.02	Selenium	<0.005
Copper	<0.01	Zinc	0.01

Trace Metals (Total Concentrations), mg/l

Chromium, mg/l	<0.02
Iron, mg/l	0.29
Manganese, mg/l	<0.02

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILL Project No. 883- 2146

Site Location Sample ID 883-2146-7-30-88-S

Sampling Location Downstream Moose Cr.

Technical Procedure Reference(s) None

Type of Sampler Grab

Date 7-30-88 Time 1748

Media WATER Station 5

Sample Type: ✓ grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) Spatial Composite.

Last rain previously, 48 hrs prior

Sample Description Baseline Water Quality Moose Cr

Field Measurements on Sample (pH, conductivity, etc.)

Temp: 10.5°C Dissolved Oxygen: 10.2 mg/l

PH: 6.9 Conductivity: 84 mhos

Turbidity: Not Sampled

Aliquot Amount	Container	Preservative/Amount
½ (Tal)	Plastic Jar	None
500ml	" "	Sulfuric Acid
250ml	" "	Nitric Acid
250ml	" "	None (Needs Filtering)

Sampler (signature) Date 7-30-88

Supervisor (signature) Date 7-30-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hill Project No. 883 2146

Site Location Moose Ck down stream Sample ID 883 2146 831 885

Sampling Location Moose Ck at down stream gaging station

Technical Procedure Reference(s) none

Type of Sampler grab

Date 8-31-88 Time 7:00 pm

Media water Station 5

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) 1 ft across channel

weather cloudy 55°

Sample Description

Datapod stage = staff stage = 1.95+

Field Measurements on Sample (pH, conductivity, etc.)

temp	9°C	conductivity	91 umhos
DO	8.5 mg/l	pH	6.5
turbidity	0.75		

Aliquot Amount	Container	Preservative/Amount
1/2 gal	plastic jug	none
500 ml	" "	sulfuric acid
250 ml	" "	nitric acid
250 ml	" " filtered	nitric acid

Sampler (signature) Christopher J Pauley Date 8/31/88

Supervisor (signature) [signature] Date 9-1-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Bat 5.3 Volts
Bat Changed
DSM 61% Full
DSM Changed

Plant/Site WISHBONE HILLS
Project No. 883-2146
Site Location WISHBONE HILLS
Sample ID 883-2146-9-23-88-5
Sampling Location Moose Creek down stream station

Technical Procedure Reference(s) G.L. memo dated 9/21/88
Type of Sampler Distilled Water Jug
Date 9/23/88
Time 7:30 PM
Media Water
Station 5
Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 13 subsamples across channel at depths 0 to 1.0 feet below water surface out in the main channel

Sample Description Baseline water quality of Moose Creek
Water at highest stage observed to date, small flow coming down channel above dead fish, Water exhibits a Yellow/Gr color, bottom of channel barely visible.

Field Measurements on Sample (pH, conductivity, etc.) temperature 6 °C
pH 7.36
dissolved oxygen 12.6 mg/l
conductivity 115 umhos/cm
turbidity 5.0 NTU
water level - held staff Not Meas. to Deep staff gage 1.9
Datapod 2.011

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

NOTE: Tree covering tranducer completly submerged (See Photos)

WEATHER temperature 37°F
wind NONE
precipitation NONE
sunlight Station In Shade
2 day Storm Event 9/20-9/22/88 Cloudy/Sunny Day

Sampler (signature) Christopher J. Dreher
Date 9/24/88
Supervisor (signature)
Date 27 Sept 1988

Golder Associates

DSM 69% Full Not Changed
Bat 5.3 Volts Not Changed

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-21-88-5

Sampling Location Moose Creek Downstream
≈ 50 Ft Downstream of Datapod

Technical Procedure Reference(s) G.L.S Memo Dated 9/21/88

Type of Sampler Plastic Distilled Water Jug

Date 10/21/88 Time 10:50

Media Water Station 5

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Moose Creek
Water is clear, surface ice to 1.5" thick forming in calm areas.

Field Measurements on Sample (pH, conductivity, etc.) temperature Ø °C
pH 6.31 dissolved oxygen 13.8 mg/l
conductivity 109 umhos/cm turbidity 0.65 NTU @ 11:50
water level - held staff 2.25 staff gage 2.2 Datapod 2.26'

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Note: Turbidity & Filtering Performed back in the truck
Old Staff gage was removed

WEATHER temperature 20°F wind None
precipitation None sunlight Clear
Station in the Shade

Sampler (signature) Christopher J Poulsen Date 10/24/88
Supervisor (signature) [signature] Date 10-27-88

Golder Associates

Golder Associates	SUBJECT WISHBONE HYDROLOGY		
	Job No. 883-2146 Ref.	Made by M. MUSIAL Checked Reviewed	Date 10-24-88 Sheet 1 of 1

ALKALINITY TEST

SAMPLE SITE: 883-2146-10-21-88-5

DATE SAMPLED: 10/21/88 TIME SAMPLED: 10:15

NOTE - Alkalinity Measurements performed in Lab 124+ hrs after sampled.

DATE TESTED: 10/24/88 TIME TESTED: 1127

Sample warmed 24 min @ 65°F Room Temp.
No Thermometer to Measure Sample Temp

P Alkalinity

Color = clear
TITRATE = 0 P Alkalinity = 0

Bromocresol Green Methyl Red

Color	Titrate
Light Green	0
Light Greenish Blue Gray	375
Light Pink	437

Scale Factor = 0.1

GREG - PLS note that we need to check against manual

TOTAL Alkalinity = 0.1 (375)
= 37.5 mg/l as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-A-88-5

Sampling Location Moose Creek downstream of Mine Site
≈ 50 Ft Down stream of Datapod

Technical Procedure Reference(s) Sampling QA Plan, Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/19/88 Time 15:20

Media Water Station 5

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Time ~~Spatial~~ composite of 5 subsamples across channel at depths 0 to 1 feet
below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3 °C

pH 7.09 dissolved oxygen 11.2 mg/l

conductivity 132 umhos/cm turbidity .3 NTU

water level - held staff Not Measured staff gage Un Readable Datapod 5.703'

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

Field Parameters Performed in Car at 16:38

WEATHER temperature 20°F wind 0-2 MPH
precipitation NONE sunlight High Overcast

Sampler (signature) Christopher L Parker Date 11/20/88

Supervisor (signature) [illegible] Date 12/9/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hydrology —		
	Job No. 883-2146 Ref.	Made by MWSIAC Checked Reviewed	Date 11-22-88 Sheet 1 of 1

STA #5 Sample

Alkalinity —

Test 1000 hrs 11-22-88

TITRATION CARTRIDGE 0.16 $N H_2SO_4$

PALK —

Color - Clear PAlk = 0

TALK

Color

Light-greenish-blue gray pH = 5.1

446 units × 0.1 = 44.6 mg/l as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-20-88-5

Sampling Location Moose Creek
≈200Ft Downstream of the Datapod

Technical Procedure Reference(s) Sampling Q.H. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 12/20/88 Time 16:20

Media Water Station 5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 5 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C

pH 7.14 dissolved oxygen 13.2 mg/l

conductivity 148 umhos/cm turbidity .24 NTU @ 6:05 12/22

water level - held staff unable staff gage unreadable Datapod NOT Logging

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 25°F wind NONE

precipitation NONE sunlight Cloudy & Dark

Sampler (signature) Christopher J Vanlen Date 12/21/88

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

Golder Associates

SUBJECT	West Bank Wells - Hydrology	
Job No.	Made by	Date 12-20-88
Ref.	Checked	Sheet of
	Reviewed	

WATER QUALITY TEST

ALKALINITY — STATION = 5 — TIME TESTED 18:41:38

TITRATION: 1.600

P. ALK

COLOR

CLEAR — P. ALK = 0

T. ALK

LT GRNSH BLU GRAY: 39

39 X 1.0 = 39.0 mg/L as $CaCO_3$

LT VIOLET BLUE GRAY: 46

LT. TO PINK .51

T. ALK. : 51 X 1.0 = 51.0 mg/L

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No.	Made by	Date 12-20-88
	Ref.	Checked	Sheet of
		Reviewed	

WATER QUALITY TEST

ALKALINITY

STATION #6

TIME TESTED 18:27:04

TITRATION CONTROL: 1.600

P. ALK

COLOR

CLEAR

P. ALK = 0

T. ALK

LT. GARNET BLU GRAY: 38 38 × 1.0 = 38.0 mg/L as $CaCO_3$

LT VIOLET BLUE GRAY: 41

LT TO PINK = 46

T. ALK: 46 × 1.0 = 46.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site: WISHBONE HILLS Project No.: 883-2146

Site Location: WISHBONE HILLS Sample ID: 883-2146-1-29-89-5

Sampling Location: Moose Creek Downstream
~ 200 Ft Downstream of Datapod

Technical Procedure Reference(s): Sampling Q.A. Plan Rev. -0-

Type of Sampler: Plastic Distilled Water Jug

Date: 12/29/89 Time: 10:30

Media: Water Station: 5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description: Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature / °C

pH 7.30 dissolved oxygen 15+ ? mg/l

conductivity 180 umhos/cm turbidity .23 NTU all Field measurements 15:20 on 1/29

water level - held staff N/A staff gage unreadable Datapod not working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature ~29°F wind 2-3 mph

precipitation NONE sunlight Clear & Sunny
Station in Shade

Sampler (signature): Christopher A Pauley Date: 1/30/89

Supervisor (signature): [illegible] Date: [illegible]

Golder Associates

ALKALINITY

STATION # 5

Sample Collected: 1-29-89 @ 10:30
Tested: 1-29-89 @ 15:56

TITRATION CARTRIDGE = 1.600 NH_2SO_4

P. ALK

Color : Clear : P. ALK : 0

T. ALK

LT. GRNSH Blu GRAY : 42 UNITS

42 x 1.0 = 42 mg/L As $CaCO_3$

LT. VIOLET GRAY : 47

TO LT. PINK : 50 50 x 1.0 : 50 mg/L As $CaCO_3$

T. ALK = 50 mg/L As $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-2-24-89-5

Sampling Location MOOSE CR. DOWNSTREAM, APPROX 100' BELOW DATA POT

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled water Jug

Date 2/24/89 Time 11:00

Media Water Station #5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

~~Spatial~~ composite of 2 subsamples across channel at depths 0 to 0.5 feet below water surface

Sample Description Baseline water quality of MOOSE CREEK

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C

@ 12:45 pH 6.26 dissolved oxygen 12.4 mg/l

conductivity 171 umhos/cm turbidity 0.5 NTU @ 22:55

water level - held staff N/A staff gage unreadable Datapod Not working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 25°F wind 1-2 MPH

precipitation NONE sunlight Cloudy

Sampler (signature) Christopher J. Fuller Date 2/27/89

Supervisor (signature) JV Date 3/15/89

Golder Associates

Golder Associates	SUBJECT [illegible]
	Job No. 883-246 / Ref. / Made by [illegible] / Checked / Reviewed / Date 2/24/89 / Sheet 4 of 6

ALKALINITY

STATION: NO. 5

STATION I.D.:

TITRATION CARTRIDGE =

Sample Taken =
Sample Tested = 23.06

P. ALK -

color - CLEAR - P.ALK = 0

T. ALK -

LT. GREENISH BLUE GRAY = 40 UNITS

T. ALK = 40 x 1.0 = 40.0 mg/L

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-22-89-5

Sampling Location Moose Creek ½ 50 Ft downstream of Datapad

Technical Procedure Reference(s) Sampling Q.A. Rev -0-

Type of Sampler Plastic Distilled Water Jug

Date 3/22/89 Time 10:15

Media Water Station 5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C

pH 7.2 dissolved oxygen 14.2 mg/l

conductivity 189 umhos/cm turbidity 0.5 NTU @ 11:40 3/23

water level - held staff Unable staff gage Unreadable Datapod Not working

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
~~500~~ 1000 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 38°F wind 1mph

precipitation 4-6" Snow Previous Night sunlight Partly Cloudy

Sampler (signature) Christopher J Pauley Date 3/23/89

Supervisor (signature) JD Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No. 8832146	Made by MWarderzer	Date 3-22-89
	Ref.	Checked	Sheet 1 of 1
		Reviewed	

ALKALINITY

STATION: #5

STATION I.D. = 883214 5-3-22-89-5

Sample Taken: 3-22-89

Sample Tested: 2:21 3-22-89

P. ALK

COLOR - CLEAR - P.ALK = 0

T. ALK

LT. GREENISH BLUE GRAY = 35 UNITS

T. ALK = 35 x 1.0 = 35.0 mg/L as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-15-89-5

Sampling Location Moose Creek

≈ 75' Downstream of the Datapod

Technical Procedure Reference(s) Sampling G.H Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 4/15/89 Time 10:30

Media Water Station 5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 3 subsamples across channel at depths 0 to ~3 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1 °C

pH 7.80 dissolved oxygen 14.0 mg/l

conductivity 168 umhos/cm turbidity 4.5 NTU @ 14:03 4/16

water level - held staff 2.3' ICE staff gage NONE Datapod Under repair

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	✓ sulfuric acid
250 ml		plastic bottle	✓ nitric acid
250 ml	filtered	plastic bottle	✓ nitric acid

WEATHER temperature 44°F wind None

precipitation NONE sunlight Clear / Sunny

Sampler (signature) Christopher J Parker Date 4/16/89

Supervisor (signature) JD Date 4/28/89

Golder Associates

4/16/89 Alkalinity on Station #5 883-2146
CJP

Sample Taken: 4/15 10:30
" Tested: 4/16 14:50

No Pink P. Alk. = ∅

Bl-Gy 450 x .1 = T. Alk. = 45 mg/l $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-[illegible]-16-89-5

Sampling Location Moose Creek downstream

≈ 50 Ft downstream of data pod

Technical Procedure References(s) Sampling & H. Plan Rev. -0-

Type of Sampler Distilled Water Jug

Date 5/16/89 Time 21:20

Media Water Station 5

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 2 subsamples across channel at depths 0 to -4 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 8 °C

pH 7.47 dissolved oxygen 10.6 mg/l

conductivity 120 umhos/cm turbidity 2.7 NTU @ 22:00

water level - held staff [illegible] staff gage 2.5 Ft Datapod 2.771 ft.

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature [illegible] °F wind [illegible]

precipitation [illegible] sunlight [illegible]

Sampler (signature) Christopher A. Pauley Date 5/17/89

Supervisor (signature) JR Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT	May Water Quality Run	
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 5 of 7
	Reviewed	

ALKALINITY

Station # 5

Sample Taken = 21:20 5/17

Sample Tested = 16:46 5/17

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl-Gy

#Units x Multiplier = 446 x .1 = 44.6 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-5

Sampling Location Moose Creek
≈ 200 Ft downstream of Dam and

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. 0

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 11:00

Media Water Station 5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .5 feet below water surface ≈ 5' out from REW

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 6 °C
pH 7.25 dissolved oxygen 13.— mg/l
conductivity 68 umhos/cm turbidity 3.8 NTU @ 12:35 6/19
water level - held staff To Deep to measure staff gage 3.2 Ft Datapod 4.061 Ft

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	✓ sulfuric acid
250 ml	plastic bottle	✓ nitric acid
250 ml filtered	plastic bottle	✓ nitric acid

WEATHER temperature 59°F wind 5mph
precipitation NONE sunlight Clear

Sampler (signature) Christopher J Pauly Date June 20, 1989
Supervisor (signature) JD Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT	JUNE Water Quality RUN	
Job No. 883-2146	Made by CJP	Date 6/20/89
Ref.	Checked	Sheet 5 of 7
	Reviewed	

ALKALINITY

Station # 5

Sample Taken = 11:00 6/19

Sample Tested = 13:51

Titration Cartridge Ø.6N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description - BL - Gy

#Units x Multiplier = 223 x Ø.1 = 22.3 mg/L = T. ALK

SAMPLE INTEGRITY DATA SHEET

..ant/Site WISHBONE HILLS Project No. 883-2146-002

Site Location WISHBONE HILLS Sample ID 883-2146-7-20-89-5

Sampling Location Moose Creek downstream @ the Intake

Technical Procedure Reference(s)

Type of Sampler Plastic Distilled Water Jug

Date 7/20/89 Time 11:45

Media Water Station 5

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 2 subsamples across channel at depths 0 to 2 feet below water surface

Sample Description Baseline water quality of

Field Measurements on Sample (pH, conductivity, etc.) temperature 6.5 °C

pH 6.59 dissolved oxygen 11.6 mg/l

conductivity 71 umhos/cm turbidity 3.4 NTU @ 9:45

water level - held staff Not measured staff gage 2.45 Ft Datapod 3.474 Ft

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	✓ sulfuric acid
250 ml		plastic bottle	✓ nitric acid
250 ml	filtered	plastic bottle	✓ nitric acid

WEATHER temperature 56°F wind NONE

precipitation Rain for the past [illegible] sunlight Cloudy

Sampler (signature) Christopher J Paulo Date July 21, 1989

Supervisor (signature) JV Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality		
Job No. 883-2146-002	Made by GJP	Date 7/21/89
Ref. McKinley Mining	Checked	Sheet 5 of 7
	Reviewed	

ALKALINITY

Station # 5

Sample Taken = 11:15 7/21

Sample Tested = 14:42 7/21

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/L

T. ALK -

Color Description - Bl/Gy

#Units x Multiplier = 254 x Ø.1 = 25.4 mg/L = T. ALK

SURFACE WATER SAMPLING
STATION #6

MOOSE CREEK

Sample Site: 883-2146-83188-6
Lab No: 886866
Date Sampled: 08/31/88 @ 1220
Date Received: 09/02/88

Total Suspended Solids, mg/l.....	1
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	38

Sample Site: 883-2146-92388-6
Lab No: 886977
Date Sampled: 09/23/88 @ 1600
Date Received: 09/28/88

Total Suspended Solids, mg/l.....	2
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	70

Sample Site: 883-2146-102288-6
Lab No: 887118
Date Sampled: 10/22/88 @ 1155
Date Received: 10/26/88

Total Suspended Solids, mg/l.....	1
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	58

Sample Site: 883-2146-111888-6
Lab No: 887226
Date Sampled: 11/18/88 @ 1450
Date Received: 11/23/88

Total Suspended Solids, mg/l.....	2
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	94

Sample Site: 883-2146-12-20-88-6
Lab No: 887414
Date Sampled: 12/20/88 @ 1450
Date Received: 12/22/88

Total Dissolved Solids (180), mg/l.....	54
Total Suspended Solids, mg/l.....	<1
Settleable Solids, ml/l.....	<0.1

Sample Site: 883-2146-2-25-89-6
Lab No: 897646
Date Sampled: 02/24/89 @ 1345
Date Received: 02/28/89

Total Suspended Solids, mg/l.....	2
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	84

Sample Site: 883-2146-3-20-89-6
Lab No: 897702
Date Sampled: 03/20/89 @ 1010
Date Received: 03/23/89

Total Suspended Solids, mg/l.....	<1
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	90

Sample Site: 883-2146-041489-6
Lab No: 897897
Date Sampled: 04/14/89 @ 1410
Date Received: 04/18/89

Total Suspended Solids, mg/l.....	3
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	68

Sample Site: 883-2146-5-16-89-6
Lab No: 898014
Date Sampled: 05/16/89 @ 1545
Date Received: 05/19/89

Total Suspended Solids, mg/l.....	8.0
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	86

Sample Site: 883-2146-06-19-89-6
Lab No: 898299
Date Sampled: 06/19/89 @ 1230
Date Received: 06/21/89

Total Dissolved Solids (180), mg/l.....	48
Total Suspended Solids, mg/l.....	6
Total Settleable Solids, ml/l.....	<1

Sample Site: 883-2146-07-20-89-6
Lab No: 898487 (Duplicate Analysis)
Date Sampled: 07/20/89 @ 1812
Date Received: 07/24/89

Total Dissolved Solids (180), mg/l.....	18
Total Suspended Solids, mg/l.....	2
Total Settleable Solids, ml/l.....	<0.1

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hill Project No. 883-2146

Site Location Moose CK Sample ID 883-2146-8-31-88-6

Sampling Location Moose CK upstream of confluence w/ Buffalo CK

Technical Procedure Reference(s) NONE

Type of Sampler Grab with distilled water jug

Date 8-31-88 Time

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) 2 Ft deep across channel

Sample Description

Cloudy, windy ≈ 40°F

Field Measurements on Sample (pH, conductivity, etc.)

Temp. 7°C pH 6.3

D.O. 11.6 mg/l Conductivity 85 µMhos

Turbidity 2.3 NTU

Aliquot Amount	Container	Preservative/Amount
1/2 gal.	Plastic Jug	NONE

Sampler (signature) [signature] Date 8/31/88

Supervisor (signature) [signature] Date 9-1-88

Golder Associates

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-9-23-88-6

Sampling Location Moose Creek upstream of confluence w/ Buffalo Ck.

Technical Procedure Reference(s) G.L. memo dated 9/21/88

Type of Sampler Distilled Water Jug

Date 9/23/88 Time 4:00 pm

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 5 subsamples 1/3 of the way across channel at depths 0 to 1 feet below water surface.

Sample Description Baseline water quality of Moose Creek

Water slightly turbid but still clear

Field Measurements on Sample (pH, conductivity, etc.) temperature 8.5 °C

pH 7.02 dissolved oxygen 10.2 mg/l

conductivity 110 umhos/cm turbidity 2.4 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	✓	Preservation/Amount
half gal.	plastic bottle		none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 52°F wind Lt. Breeze

precipitation NONE sunlight clear/SUNNY

2 day Storm Event 9/20-9/22/88

Sampler (signature) Christopher J. Pauley Date 9/24/88

Supervisor (signature) [signature] Date 27 Sept 1988

Golder Associates

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-22-88-6

Sampling Location Moose Creek
Above confluence with Buffalo Creek

Technical Procedure Reference(s) G.L. Memo dated 9/21/88

Type of Sampler Distilled water Jug

Date 10/22/88 Time 11:55

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 2 subsamples across channel at depths 0 to 2' feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C
pH 6.30 dissolved oxygen 14.8 mg/l
conductivity 111 umhos/cm turbidity .5 NTU @ 12:06
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	N/A sulfuric acid
250 ml		plastic bottle	N/A nitric acid
250 ml	filtered	plastic bottle	N/A nitric acid

WEATHER temperature 32° wind 5-10mph
precipitation None sunlight Clear
Station in the Sun

Sampler (signature) Christopher J Parker Date 10/23/88

Supervisor (signature) [signature] Date 10-27-88

Golder Associates

Golder Associates	SUBJECT WISHBONE HYDROLOGY		
	Job No. 883-2146 Ref.	Made by M. MUSIAL Checked Reviewed	Date 10-24-88 Sheet 1 of 1

ALKALINITY TEST

SAMPLE SITE: 883-2146-10-22-88-6

DATE SAMPLED: 10/22/88 TIME SAMPLED: 11:55

NOTE - Alkalinity Measurements performed in lab 72+ hrs after sampled.

DATE TESTED: 10/24/88 TIME TESTED: 1000

Warmed 30 min @ 65°F Room Temp

No Thermometer to meas. Sample Temp.

Phenophthalein Alkalinity

Colorless

Titrate = ϕ P Alkalinity = ϕ

Cartridge = 0.1600

Bromcresol Green - Methyl Red

Color Light Green

Lt Greenish Blue Gray pH=5.1

	Digits
	ϕ
	330

Scale FACTOR = 0.1

Check EQ. vs. Manual

TOTAL Alkalinity = 0.1 (330)

= 33.0 mg/L as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-18-88-6

Sampling Location Moose Creek upstream of Buffalo CK confluence

Technical Procedure Reference(s) Sampling QA Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/18/88 Time 14:50

Media Water Station 6

Sample Type: grab (time composite) space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Time ~~Spatial~~ composite of 5 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3.5 °C

pH 7.22 dissolved oxygen 11.4 mg/l

conductivity 138 umhos/cm turbidity .78 NTU @15:14

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 15°F wind 5-10MPH

precipitation NONE sunlight Clear, Sunny

Sampler (signature) Christopher A. Paulin Date 11/20/88

Supervisor (signature) [illegible] Date 12/9/88

Golder Associates

Golder Associates	SUBJECT Wishbone Hydrology		
	Job No. 883-2146	Made by MWSLAC	Date 11-22-88
	Ref.	Checked	Sheet 1 of 1
		Reviewed	

Alkalinity Test STA 6 11-22-88 1050 hrs

TITRATION CARTRIDGE = 0.16 NH_2SO_4

PALK

Clear PALK = 0

T ALK

Lt. greenish Blu Grey = 402 units

T ALK = 402 x 0.1 = 40.2 mg/l as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-20-93-6

Sampling Location Moose Creek
≈ 50' upstream of Buffalo Ck confluence

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled Water Jug

Date 12/22/88 Time 14:50

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 2 subsamples across channel at depths 0 to .2 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C

pH 7.40 dissolved oxygen 13.9 mg/l

conductivity 148 umhos/cm turbidity .44 NTU @ 6:10 12/22

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	✓	Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 30°F wind None
precipitation Light Snow sunlight High Overcast

Sampler (signature) Christopher J Parker Date 12/21/88

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-2-24-89-6

Sampling Location Moose Creek
just above confluence with Buffalo CK.

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Distilled Water Jug

Date 2/24/89 Time 13:46

Media Water Station 6

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 2 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Ck

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C

@ 13:50 pH 6.66 dissolved oxygen 13.7 mg/l

conductivity 181 umhos/cm turbidity .55 NTU @ 22:59

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 32°F wind Lt. Breeze 5 mph

precipitation NONE sunlight Cloudy Occasional sun

Sampler (signature) Christopher J Parker Date 2/27/89

Supervisor (signature) JD Date 3/15/89

Golder Associates

Golder Associates	SUBJECT Fairbanks N.O. Dump		
	Job No. 903-1460 Ref.	Made by RW Checked Reviewed	Date 2/24/90 Sheet 5 of 6

ALKALINITY

STATION: NO. 6

STATION I.D:

TITRATION CARTRIDGE:

Sample Taken:
Sample Tested = 22.58

P. ALK -

color - CLEAR - P. ALK = 0

T. ALK -

LT. GREENISH BLUE GRAY - 36 UNITS

T ALK = 36 X 1.0 = 36.0 %

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-20-89-6

Sampling Location Moose Creek @ 50 Ft upstream of confluence with Buffalo Creek

Technical Procedure Reference(s) Sampling Q.A. Plan Rev -0-

Type of Sampler Plastic Distilled Water Jug

Date 3/20/89 Time 10:10

Media Water Station 6

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 4 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0.5 °C

@ 10:10 pH 7.10 dissolved oxygen 14.0 mg/l

conductivity 155 umhos/cm turbidity 0.9 NTU @ 22:05

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 33°F wind 5-10 mph

precipitation None sunlight Light / High Overcast / Partly Sunny

Sampler (signature) Christopher J. Fenlon Date 3/23/89

Supervisor (signature) [illegible] Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No. 883-2146 Ref.	Made by Checked Reviewed	Date 3/20/89 Sheet of

ALKALINITY

STATION: #6

STATION I.D. = 8832146-3-20-89-6

Sample Taken: 10:10

TITRATION CORRIDAGE: 1.600 NH_2SO_4

Sample Tested: 10:31
3-20-89

P. ALK

COLOR - CLEAR : P.ALK = 0

T. ALK

LT. GREENISH BLUE GRAY = 34 UNITS

T. ALK = 34 x 1.0 = 34.0 mg/L as $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-14-89-6

Sampling Location Moose Creek ≈ 100 Ft upstream of confluence with Eagle River

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 4/14/89 Time 14:10

Media Water Station 6

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 2 °C
pH 7.93 dissolved oxygen 13.6 mg/l
conductivity 183 umhos/cm turbidity 4.5 NTU @ 22:22
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 50 °F wind 3-5 MPH
precipitation NONE sunlight Clear/Sunny

Sampler (signature) Christopher J. Bailey Date 4/14/89
Supervisor (signature) [illegible] Date 4/28/89

Golder Associates

4/17/84 Alkalinity on Station #6 005-2146
CJP

Sample Taken: 14:10
" Tested: 23:28

No Pink P. Alk = 0

Bl.-Gy @ pH = 5.07 476 × 0.1 = 47.6 mg/L $CaCO_3$

T. Alk = 47.6

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-12-89-6

Sampling Location Moose Creek
E 250 Ft above confluence w/ Bof & Ck.

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 5/12/89 Time 11:31

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples across channel at depths 0 to 2 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 12 °C
@16:45 pH 7.25 dissolved oxygen 10 mg/l
conductivity 127 umhos/cm turbidity 9.0 NTU
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 45°F wind 1-2 MPH
precipitation NONE sunlight Overcast
On and off rain for the past 48 hours up till 6AM 5/13/89

Sampler (signature) Christopher A Paulos Date 5/12/89

Supervisor (signature) [illegible] Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT Supplemental Water Quality Samples		
Job No. 883-2146	Made by M. WEROERDER	Date 5/12/89
Ref.	Checked	Sheet 1 of 2
	Reviewed	

ALKALINITY

Station # 6

Sample Taken = 11:31

Sample Tested = 17:14

Titration Cartridge 0.16 N

P. ALK -

Color Description - Clear

P. ALK. = 0 mg/l

T. ALK -

Color Description - LT. GREENISH BLUE GRAY

#Units x Multiplier = 33.4 x 0.2 = 33.4 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-16-89-6

Sampling Location Moose Creek

1/125 Ft upstream of Confluence w/ B. Ck

Technical Procedure Reference(s) Sampling & H. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 5/16/89 Time 15:45

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 6 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 8.0 °C

pH 7.55 dissolved oxygen 11.2 mg/l

conductivity 124 umhos/cm turbidity 4.5 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 50°F wind 1-3 MPH

precipitation None sunlight Clear Sunny

Sampler (signature) Christopher J Pauley Date 5/17/89

Supervisor (signature) [illegible] Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT May Water Quality Run		
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 6 of 7
	Reviewed	

ALKALINITY

Station # 6

Sample Taken = 15:45 5/17

Sample Tested = 16:54 5/17

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl-Gy

#Units x Multiplier = 400 x .1 = 40.1 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-6

Sampling Location Moose Creek

½ 50 Ft. upstream Buffalo Creek Confluence

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. Ø

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 12:30

Media Water Station 6

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 4 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 8 °C

pH 7.17 dissolved oxygen 12.6 mg/l

conductivity 68 umhos/cm turbidity 2.7 NTU @ 12:44 6/19

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container		Preservation/Amount
half gal.		plastic bottle	✓	none
500 ml		plastic bottle	N/A	sulfuric acid
250 ml		plastic bottle	N/A	nitric acid
250 ml	filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 68°F wind 5 mph

precipitation NONE sunlight Clear & Sunny

Sampler (signature) Christopher J. Pauley Date June 20, 1989

Supervisor (signature) JV Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT	JUNE Water Quality Run	
Job No. 883-2146	Made by	Date 6/20/89
Ref.	Checked	Sheet 6 of 7
	Reviewed	

ALKALINITY

Station # 6

Sample Taken = 12:30 6/1

Sample Tested = 13:56

Titration Cartridge .6N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description - Bl - Gy

#Units x Multiplier = 207 x Ø.1 = 20.7 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146-C02

Site Location WISHBONE HILLS Sample ID 883-2146-7-30-89-6

Sampling Location Moose Creek

~ 1500 ft up-stream of Beck Confluence

Technical Procedure Reference(s) See also Q.A. Plan Rev. -0-

Type of Sampler Plastic Bottle Water Sampler

Date 7/20/89 Time 12:12

Media Water Station 6

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 6 subsamples across channel at depths 0 to 1.5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 7 °C

pH 7.37 dissolved oxygen 12.2 mg/l

conductivity 60 umhos/cm turbidity 2.4 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 60's wind none

precipitation 0 sunlight

Sampler (signature) Christopher H. Parker Date July 21, 1989

Supervisor (signature) JV Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality

Job No. 883-2146-002 | Made by CJP | Date 7/21/89

Ref. McKinley Mining | Checked | Sheet 6 of 7

Reviewed

ALKALINITY

Station # 6

Sample Taken = 18:12 7/2

Sample Tested = 14:27 7/2

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/L

T. ALK -

Color Description - Bl/Gy

#Units x Multiplier = 231 x 0.1 = 23.1 mg/L = T. ALK

SURFACE WATER SAMPLING
STATION #7

MOOSE CREEK

Sample Site: 883-2146-83188-7
Lab No: 886867
Date Sampled: 08/31/88 @ 1400
Date Received: 09/02/88

Total Suspended Solids, mg/l.....	2
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	42

Sample Site: 883-2146-92388-7
Lab No: 886978
Date Sampled: 09/23/88 @ 1729
Date Received: 09/28/88

Total Suspended Solids, mg/l.....	3
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	74

Sample Site: 883-2146-102288-7
Lab No: 887117
Date Sampled: 10/22/88 @ 1014
Date Received: 10/26/88

Total Suspended Solids, mg/l.....	2
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	66

Sample Site: 883-2146-111888-7
Lab No: 887227
Date Sampled: 11/18/88 @ 1550
Date Received: 11/23/88

Total Suspended Solids, mg/l.....	2
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	102

Sample Site: 883-2146-12-19-88-7
Lab No: 887415
Date Sampled: 12/19/88 @ 1600
Date Received: 12/22/88

Total Dissolved Solids (180), mg/l.....	54
Total Suspended Solids, mg/l.....	<1
Settleable Solids, ml/l.....	<0.1

Sample Site: 883-2146-2-25-89-7
Lab No: 897647
Date Sampled: 02/25/89 @ 1500
Date Received: 02/28/89

Total Suspended Solids, mg/l.....	4
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	52

Sample Site: 883-2146-3-20-89-7
Lab No: 897703
Date Sampled: 03/20/89 @ 1835
Date Received: 03/23/89

Total Suspended Solids, mg/l.....	<1
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	70

Sample Site: 883-2146-041489-7
Lab No: 897898
Date Sampled: 04/14/89 @ 1640
Date Received: 04/18/89

Total Suspended Solids, mg/l.....	4
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	70

Sample Site: 883-2146-5-16-89-7
Lab No: 898015
Date Sampled: 05/16/89 @ 1545
Date Received: 05/19/89

Total Suspended Solids, mg/l.....	7.0
Settleable Solids, ml/l.....	<0.1
Total Dissolved Solids (180), mg/l.....	90

Sample Site: 883-2146-06-19-89-7
Lab No: 898300
Date Sampled: 06/19/89 @ 1730
Date Received: 06/21/89

Total Dissolved Solids (180), mg/l.....	48
Total Suspended Solids, mg/l.....	4
Total Settleable Solids, ml/l.....	<1 <0.1

SAMPLE INTEGRITY DATA SHEET

Plant/Site Wishbone Hills Project No. 883-2146

Site Location Moose Ck Sample ID 883-2146-8-31-88-7

Sampling Location Moose Ck ≈ 1.5 mile down stream from Mine Bridge

Technical Procedure Reference(s) None

Type of Sampler Grab w/ Distilled Water Jug

Date 8/31/88 Time 1:50

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurments (depth, volume of static well water and purged water, etc.) 1 Ft deep across stream

Sample Description Base line water quality Moose Ck

Cloudy, light Sprinkles, ≈ 40°F

Field Measurements on Sample (pH, conductivity, etc.)

Temp. 7.5°C pH 6.35

D.O. 11.8 mg/l Conductivity 90 um

Turbidity 1.0

Aliquot Amount	Container	Preservative/Amount
1/2 gal	Plastic Jug	None

Sampler (signature) Christopher J Parker Date 8/31/88

Supervisor (signature) [illegible] Date 9-1-88

Golder Associates

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-9-23-88-7

Sampling Location Moose Creek ≈ 1400 Ft downstream of Premier Creek Bridge, @ confluence of two forks

Technical Procedure Reference(s) G.L. Mann date 9/21/88

Type of Sampler Distilled water Jug

Date 9/23/88 Time 5:29 pm

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples Halfway across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Moose Creek
Water Light Green/Yellow in color

Field Measurements on Sample (pH, conductivity, etc.) temperature 7 °C
pH 7.11 dissolved oxygen 10.9 mg/l
conductivity 110 umhos/cm turbidity 3.4 NTU
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 49° F wind NONE
precipitation NONE sunlight Station in Shade
Clear/Sunny Day

Sampler (signature) Christopher A Dunlap Date 9/24/88

Supervisor (signature) [signature] Date 27 Sept 1988

Golder Associates

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-10-22-88-7

Sampling Location Moose Creek
≈ 1.5 Miles downstream from Mine Bridge

Technical Procedure Reference(s) G.L. Memo Dated 9/2/88

Type of Sampler Plastic Distilled Water Jug

Date 10/22/88 Time 10:14

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples across channel at depths 0 to 1.0 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0.0°C
pH 6.20 dissolved oxygen 14.3 mg/l
conductivity 108 umhos/cm turbidity .58 NTU @ 13:18
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 26°F wind 10-20 MPH
precipitation None sunlight Clear
Station in Shade

Sampler (signature) Christopher L Paulsen Date 10/23/88

Supervisor (signature) J. Laird Date 10-27-88

Golder Associates

Golder Associates	SUBJECT Wishbone Hydrology		
	Job No. 883-2146 Ref.	Made by M. Musial Checked Reviewed	Date 10-24-88 Sheet 1 of 1

ALKALINITY TEST

SAMPLE SITE: 883-2146-10-22-88-7

DATE SAMPLED: 10/22/88 TIME SAMPLED: 10:14

NOTE - Alkalinity Measurements performed in lab 124+ hrs after sampled.

DATE TESTED: 10/24/88 TIME TESTED: 1137

Warmed 15 min @ 65°F Room Temp.

No Thermometer to Measure Temps.

P Alkalinity

Color = Clear

Titrate = 0 P Alkalinity = 0

Bromocresol Green Methyl Red

Color	Titrate
Light Green	0
Light Greenish Blue Gray	390 ✓
Light Pink	486

Scale Factor = 0.1

GREG: Pls Note we need to check this Against Manual

∴ Total Alkalinity = (0.1)(390)

= 39.0 mg/l as $CaCO_3$

SAMPLE INTEGRITY DATA SHEET

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-11-18-88-7

Sampling Location Moose Creek ≈ 1.5 mile downstream from site bridge ≈ 1000 Ft below station #7

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 11/18/88 Time 15:50

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Time ~~Spatial~~ composite of 5 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 3 °C

pH 7.26 dissolved oxygen 10.4 mg/l

conductivity 128 umhos/cm turbidity .3 NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

Field Parameters measured in car at 16:30

WEATHER temperature Not Taken wind 1-2 MPH

precipitation NONE sunlight Clear

Sampler (signature) Christopher J Pudey Date 11/20/88

Supervisor (signature) JD Date 12/9/88

Golder Associates

Golder Associates	SUBJECT Wishbone		
	Job No. 883-2146 Ref.	Made by MWSIAC Checked Reviewed	Date 11-22-88 Sheet 1 of 1

11-22-88
1100 hrs

ALKALINITY TEST STA 7

Titration Cartridge 0.16 NH_2SO_4

P Alk

Clear P Alk = ϕ

T Alk

Lt grnish Blu Gry = 438 units

T Alk = 438 x 0.1 = 43.8 mg/l

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-19-88-7

Sampling Location Moose Creek 1.5 miles downstream of site bridge

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 12/19/88 Time 1600

Media Water Station 7

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 4 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 0 °C

pH 7.40 dissolved oxygen 13.2 mg/l

conductivity 146 umhos/cm turbidity .3 NTU 6:13 12/22

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	✓ none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 30°F wind 5-10 MPH

precipitation NONE sunlight None Dark & Cloudy

Sampler (signature) Christopher J. Pauley Date 12/21/88

Supervisor (signature) [illegible] Date [illegible]

Golder Associates

ALKALINITY

STATION # 7 TESTED 12-19-88

TITRATION CARTRIDGE - 1.600 NH_2SO_4

P. ALK

COLOR → P. ALK = 0

CLEAR

T. ALK

LIGHT GREENISH BLU GRAY 107

T ALK = 107 X 1.0 = 107.0 mg/L as $CaCO_3$

LT. VIOLET GRAY 110

TO LT. PINK 113

T. ALK = 113 X 1.0 = 113.0 mg/L

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-2-25-89-7

Sampling Location Moose Creek ≈ 1.5 miles downstream of Site bridge @ Sta. #7 Location

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 2/25/89 Time 15:05

Media Water Station 7

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Grab ~~Spatial~~ composite of 2 subsamples across channel at depths 0 to -4 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature / °C

@ 16:20 pH 6.75 dissolved oxygen 14 mg/l

conductivity 165 umhos/cm turbidity NOT measured NTU

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container	Preservation/Amount
half gal.		plastic bottle	✓ none
500 ml		plastic bottle	N/A sulfuric acid
250 ml		plastic bottle	N/A nitric acid
250 ml	filtered	plastic bottle	N/A nitric acid

WEATHER temperature +34°F wind NONE

precipitation Heavy Mist/Lt. Rain Continuously sunlight NONE Cloudy

Sampler (signature) Christopher M. Faulk Date 2/27/89

Supervisor (signature) [illegible] Date 3/15/89

Golder Associates

Golder Associates	SUBJECT February Wl. Q. Run		
	Job No. 893-2146 Ref.	Made by MW Checked Reviewed	Date 2/28/89 Sheet 6 of 6

ALKALINITY

STATION: No. 7

STATION I.D:

TITRATION CARTRIDGE = 1.600N

Sample Taken =
Sample Tested = 12:29
2-26-89

P. ALK -

color - Clear P. ALK = 0

T. ALK -

LT. GREENISH BLUE GRAY = 29 UNITS

T. ALK = 29 x 1.0 = 29.0 mg/L

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-3-20-89-7

Sampling Location Moose Creek downstream of site bridge ≈ 2500 ft

Technical Procedure Reference(s) Sampling Q.A. Plan Rev-0-

Type of Sampler Plastic Distilled Water Jug

Date 3/20/89 Time 18:35

Media Water Station 7

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 2 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1.0 °C

pH 7.08 dissolved oxygen 13.2 mg/l

conductivity 151 umhos/cm turbidity 0.7 NTU 22:08

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 32 °F wind 2-3 MPH Gusts 7 MPH

precipitation NONE sunlight High Clouds

Sampler (signature) Christopher J Pouliot Date 3/23/89

Supervisor (signature) [illegible] Date 4/5/89

Golder Associates

Golder Associates	SUBJECT Wishbone Hills - Hydrology		
	Job No. 883-2146 Ref.	Made by Checked Reviewed	Date 5/20/89 Sheet of

ALKALINITY

STATION: #7

STATION I.D. = 8832146-3-20-89-7

Sample Taken: 18:35

TITRATION CARTRIDGE: 1.600 N_2SO_4

Sample Tested: 10:19 3-20-89

P. ALK

COLOR - CLEAR - P. ALK = 0

T. ALK

LT. GREENISH BLUE GRAY = 39 UNITS

T. ALK = 39 X 1.0 = 39.0 mg/L AS $CaCO_3$

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-4-14-89-7

Sampling Location Moose Creek

2400 ft downstream of bridge

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 4/14/89 Time 16:40

Media Water Station 7

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 1 subsamples across channel at depths 0 to .5 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 1 °C

pH 7.8 dissolved oxygen 14.6 mg/l

conductivity 167 umhos/cm turbidity 7.5 NTU @ 22:24

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container	Preservation/Amount
half gal.	plastic bottle	none
500 ml	plastic bottle	N/A sulfuric acid
250 ml	plastic bottle	N/A nitric acid
250 ml filtered	plastic bottle	N/A nitric acid

WEATHER temperature 46°F wind 5 mph

precipitation None sunlight Clear/Sunny

Sampler (signature) Christopher J. Paulos Date 4/16/89

Supervisor (signature) [illegible] Date 4/28/89

Golder Associates

4/14/89 Alkalinity on Station #7 CJP

Sample Taken: 16:40
" Tested: 23:00

No Pink Color P. Alk. = Ø

Add Bromcresol Green-Methyl Red and solution turns a medium Green.

Lt. Gr / Bl.-Gy w/ pH = 5.09-5.1 445 × 0.1 = 44.5 mg/L $CaCO_3$
T. Alk.

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-12-5-89-7

Sampling Location Moose Creek
≈ 1.5 miles downstream of site bridge

Technical Procedure Reference(s) Sampling Q.H. Plan, Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 5/12/89 Time 12:27

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 6 subsamples across channel at depths 0 to 2 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 11 °C
@ 12:15 pH 7.23 dissolved oxygen 10.3 mg/l
conductivity 123 umhos/cm turbidity 8.5 NTU
water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 45° wind 1-2 mph
precipitation None sunlight Overcast
Only rain in the past 48 hours was 4.6 at 6 AM 5/12/89

Sampler (signature) Christopher L Paulos Date 5/12/89

Supervisor (signature) [illegible] Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT Supplemental Water Quality Samples		
Job No. 883-2146	Made by M WEEDOLDER	Date 5/12/89
Ref.	Checked	Sheet 2 of 2
	Reviewed	

ALKALINITY

Station # 7

Sample Taken = 5-12-89 11:30

Sample Tested = 5-12-89 4:51

Titration Cartridge 1.6 N

P. ALK -

Color Description - CLEAR

P. ALK. = 0 mg/l

T. ALK -

Color Description - LT. GREENISH BLUEGRAY

#Units x Multiplier = 42 x 1.0 = 42.0 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-5-16-89-7

Sampling Location Moose Creek

≈ 500 Ft below Station #7

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. -0-

Type of Sampler Plastic Distilled Water Jug

Date 5/16/89 Time 17:45

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 4 subsamples across channel at depths 0 to .4 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 9.0 °C

pH 7.79 dissolved oxygen 11.2 mg/l

conductivity 120 umhos/cm turbidity 3.9 NTU [illegible] 5/18/89 Parameter measured in the field

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container		Preservation/Amount
half gal.		plastic bottle	✓	none
500 ml		plastic bottle	N/A	sulfuric acid
250 ml		plastic bottle	N/A	nitric acid
250 ml	filtered	plastic bottle	N/A	nitric acid

WEATHER temperature ~52°F wind 1-2 MPH

precipitation NONE sunlight Clear Sunny

Lt. Rain during last 24 hrs

Sampler (signature) Christopher J. Paulsen Date 5/18/89

Supervisor (signature) [illegible] Date 5/31/89

Golder Associates

Golder Associates Inc.

SUBJECT May Water Quality Run		
Job No. 883-2146	Made by CJP	Date 5/17/89
Ref.	Checked	Sheet 7 of 7
	Reviewed	

ALKALINITY

Station # 7

Sample Taken = 17:45 5/17

Sample Tested = 17:03 5/17

Titration Cartridge .5 N

P. ALK -

Color Description - Clear

P. ALK. = ϕ mg/l

T. ALK -

Color Description - Bl.-Gy

#Units x Multiplier = 397 x .1 = 39.7 mg/L = T. ALK

Plant/Site WISHBONE HILLS Project No. 883-2146

Site Location WISHBONE HILLS Sample ID 883-2146-6-19-89-7

Sampling Location Moose Creek ≈ 2000ft downstream of station #7

Technical Procedure Reference(s) Sampling Q.A. Plan Rev. 0

Type of Sampler Plastic Water Jug

Date 6/19/89 Time 17:30

Media Water Station 7

Sample Type: (grab) time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)
Spatial composite of 3 subsamples across channel at depths 0 to 1 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 9.5 °C

pH 7.39 dissolved oxygen 13.1 mg/l

conductivity 65 umhos/cm turbidity 2.5 NTU @ 13:02 6/20

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount		Container	✓	Preservation/Amount
half gal.		plastic bottle		none
500 ml		plastic bottle	N/A	sulfuric acid
250 ml		plastic bottle	N/A	nitric acid
250 ml	filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 73°F wind NONE

precipitation NONE sunlight clear & Sunny

Sampler (signature) Christopher J. Powles Date June 20, 1989

Supervisor (signature) [illegible] Date 7/7/89

Golder Associates

Golder Associates Inc.

SUBJECT	JUNE Water Quality RUN	
Job No. 883-2146	Made by CJP	Date 6/20/89
Ref.	Checked	Sheet 7 of 7
	Reviewed	

ALKALINITY

Station # 2

Sample Taken = 17:30 6/1

Sample Tested = 14:00

Titration Cartridge 0.6N

P. ALK -

Color Description - Ø

P. ALK. = Ø mg/l

T. ALK -

Color Description - El - Gy

#Units x Multiplier = 215 x 0.1 = 21.5 mg/L = T. ALK

..ant/Site WISHBONE HILLS Project No. 883-2146-002

Site Location WISHBONE HILLS Sample ID 883-2146-7-20-89-7

Sampling Location Moose Creek @ confluence of Drift Creek

Technical Procedure Reference(s) Sampling Q.A. Plan Rev-0-

Type of Sampler Plastic Distille. Water Jug

Date 7/20/89 Time 16:40

Media Water Station 7

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Spatial composite of 7 subsamples across channel at depths 0 to 2 feet below water surface

Sample Description Baseline water quality of Moose Creek

Field Measurements on Sample (pH, conductivity, etc.) temperature 7.5 °C

pH 7.07 dissolved oxygen 11.2 mg/l

conductivity 62 umhos/cm turbidity 2.5 NTU @ 19:52

water level - held staff N/A staff gage N/A Datapod N/A

Aliquot Amount	Container		Preservation/Amount
half gal.	plastic bottle	✓	none
500 ml	plastic bottle	N/A	sulfuric acid
250 ml	plastic bottle	N/A	nitric acid
250 ml filtered	plastic bottle	N/A	nitric acid

WEATHER temperature 60°F wind NONE

precipitation Light Rain sunlight Cloud.

Sampler (signature) Christopher J. Pardey Date July 21, 1989

Supervisor (signature) JV Date 8/23/89

Golder Associates

Golder Associates Inc.

SUBJECT July 1989 Water Quality		
Job No. 883-2146-002	Made by CJP	Date 7/21/89
Ref. McKinley Mining	Checked	Sheet 7 of 7
	Reviewed	

ALKALINITY

Station # 7

Sample Taken = 16:40 7/2

Sample Tested = 14:45 7/2

Titration Cartridge .6N

P. ALK -

Color Description - Clear

P. ALK. = Ø mg/L

T. ALK -

Color Description - Bl/Gy

#Units x Multiplier = 250 X .1 = 25.0 mg/L = T. ALK

ANALYTICAL DATA FOR TOTAL PHOSPHOROUS
AND DISSOLVED CHROMIUM, IRON,
AND MANGANESE

GOLDER ASSOCIATES

Wishbone Hills Project

Trace Metal Analysis
Dissolved Concentrations (mg/l)

Lab No.:	Sample Identification:	Chromium	Iron	Manganese
886643	883-2146-7-30-88-1	<0.02	<0.05	<0.02
886644	883-2146-7-30-88-2	<0.02	<0.05	<0.02
886445	883-2146-7-30-88-3	<0.02	0.16	<0.02
886446	883-2146-7-30-88-4	<0.02	<0.05	<0.02
886447	883-2146-7-30-88-5	<0.02	<0.05	<0.02
886448QC	883-2146-7-30-88-3	<0.02	<0.05	<0.02
886861	883-2146-83188-1	<0.02	<0.05	<0.02
886862	883-2146-83188-2	<0.02	<0.05	<0.02
886863	883-2146-83188-3	<0.02	0.12	0.03
886864	883-2146-83188-4	<0.02	0.24	<0.02
886865	883-2146-83188-5	<0.02	0.05	<0.02
886868QC	883-2146-83188-3	<0.02	0.12	0.03
886973	883-2146-92388-1	<0.02	<0.05	<0.02
886974	883-2146-92388-2	<0.02	0.05	<0.02
886975	883-2146-92388-4	<0.02	0.06	<0.02
886976	883-2146-92388-5	<0.02	<0.05	<0.02
886979QC	883-2146-92388-5	<0.02	<0.05	<0.02
887119	883-2146-102188-5	<0.02	<0.05	<0.02
887120	883-2146-102188-3	<0.02	0.06	<0.02
887121	883-2146-102188-2	<0.02	<0.05	<0.02
887122	883-2146-102188-4	<0.02	<0.05	<0.02
887123	883-2146-102188-1	<0.02	<0.05	<0.02
887124QC	883-2146-102188-5	<0.02	<0.05	<0.02
887181	883-2145-H88-21	<0.02	0.67	0.04
887182	883-2145-H88-22	<0.02	4.34	0.70
887183	883-2145-H88-23	<0.02	0.18	0.21
887184	883-2145-H88-24A	<0.02	0.09	4.58
887185	883-2145-H88-25	<0.02	<0.05	<0.02
887186QC	883-2145-H88-23	<0.02	0.19	0.21
887194	883-2145-H88-17	<0.02	0.11	0.08
887195	883-2145-H88-19	<0.02	0.24	0.18
887196	883-2145-H88-27	<0.02	0.22	0.05
887197	883-2145-H88-28	<0.02	0.17	0.02

GOLDER ASSOCIATES

Wishbone Hills Project

Trace Metal Analysis
Dissolved Concentrations (mg/l)

Lab No.:	Sample Identification:	Chromium	Iron	Manganese
887221	883-2146-111888-1	<0.02	<0.05	<0.02
887222	883-2146-111888-2	<0.02	<0.05	<0.02
887223	883-2146-111988-3	<0.02	0.10	<0.02
887224	883-2146-111988-4	<0.02	0.08	<0.02
887225	883-2146-111988-5	<0.02	<0.05	<0.02
887228QC	883-2146-111988-4	<0.02	0.08	<0.02
887234	883-2145-H88-10MW	<0.02	0.08	<0.02
887235	883-2145-H88-11MW	<0.02	0.08	<0.02
887236	883-2145-H88-12MW	<0.02	0.18	<0.02
887237	883-2145-H88-13MW	<0.02	0.11	<0.02
887238	883-2145-H88-14AMW	<0.02	<0.05	<0.02
887239	883-2145-H88-15	<0.02	<0.05	<0.02
887240	883-2145-H88-16MW	<0.02	0.20	<0.02
887241QC	883-2145-H88-14AMW	<0.02	<0.05	<0.02
887409	883-2146-12-20-88-1	<0.02	<0.05	<0.02
887410	883-2146-12-20-88-2	<0.02	<0.05	<0.02
887411	883-2146-12-20-88-3	<0.02	0.05	<0.02
887412	883-2146-12-20-88-4	<0.02	0.12	<0.02
887413	883-2146-12-20-88-5	<0.02	<0.05	<0.02
887416QC	883-2146-12-20-88-3	<0.02	0.05	<0.02

Inter·Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

1714 Phillips Circle
Gillette, Wyoming 82716
Tel. (307) 682-8945

Sample Site:	Lab No:	Total Phosphorus as P (mg/l)
883-2146-73088-1	886643	0.008
883-2146-73088-2	886644	0.014
883-2146-73088-3	886645	0.137
883-2146-73088-4	886646	0.011
883-2146-73088-5	886647	0.009
883-2146-73088-3 (DUP)	886648	0.153

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

1714 Phillips Circle
Gillette, Wyoming 82716
Tel. (307) 682-8945

Sample Site:	Lab No:	Total Phosphorus as P (mg/l)
883-2146-83188-1	886861	0.007
883-2146-83188-2	886862	0.011
883-2146-83188-3	886863	0.049
883-2146-83188-4	886864	0.023
883-2146-83188-5	886865	0.010
883-2146-83188-3 (DUP)	886868	0.050

LABORATORY QA/QC
ANALYTICAL METHODS

LABORATORY DETECTION LIMITS

Golder Associates

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

1714 Phillips Circle
Gillette, Wyoming 82716
Tel. (307) 682-8945

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378
(Analyzed concurrently with Golder Associates samples)
Analyzed: August 4 - 22, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	29.0	25.0	19.0-30.1
Cadmium, ug/l.....	2.6	2.7	1.8-3.4
Lead, ug/l.....	66.4	63.0	52.7-72.6
Mercury, ug/l.....	1.1	1.6	1.1-2.1
Selenium, ug/l.....	9.6	9.3	5.8-11.6

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: August 4 - 22, 1988

Parameter	Result	True Value	% Recovery
Chromium, ug/l.....	91.3	103	88.6
Iron, ug/l.....	92.8	102	91.0
Manganese, ug/l.....	107	102	105
Zinc, ug/l.....	96.8	101	95.8

NUTRIENT ANALYSIS

Identification: EPA QC WP284, WP486
(Analyzed concurrently with Golder Associates samples)
Analyzed: August 4 - 12, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	1.66	1.52	1.34-1.72
Nitrate as N, mg/l.....	0.18	0.18	0.14-0.22
Total Kjeldahl as N, mg/l.....	0.4	0.40	0.27-0.55
Orthophosphate as P, mg/l.....	0.27	0.27	0.25-0.29
Total Phosphate as P, mg/l.....	0.12	0.13	0.04-0.24

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378
(Analyzed concurrently with Golder Associates samples)
Analyzed: September 2 - 20, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	29.0	25.0	19.0-30.1
Cadmium, ug/l.....	6.1	2.7	1.8-3.4
Lead, ug/l.....	62.0	63.0	52.7-72.6
Mercury, ug/l.....	1.9	1.6	1.1-2.1
Selenium, ug/l.....	9.1	9.3	5.8-11.6

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: September 20, 1988

Parameter	Result	True Value	% Recovery
Chromium, ug/l.....	96.0	103	93.2
Iron, ug/l.....	101.7	102	99.7
Manganese, ug/l.....	99.3	102	97
Zinc, ug/l.....	96.9	101	95.9

NUTRIENT ANALYSIS

Identification: EPA QC WP284, WP486
(Analyzed concurrently with Golder Associates samples)
Analyzed: September 5 - 15, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.12	0.15	0.11-0.19
Nitrate as N, mg/l.....	0.18	0.18	0.14-0.22
Total Kjeldahl as N, mg/l.....	0.51	0.40	0.27-0.55
Orthophosphate as P, mg/l.....	0.270	0.27	0.25-0.29
Total Phosphate as P, mg/l.....	0.112	0.13	0.04-0.24

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378
(Analyzed concurrently with Golder Associates samples)
Analyzed: October 4 - 10, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	19.4	20.0	16.0-23.6
Cadmium, ug/l.....	13.0	14.0	10.6-17.6
Lead, ug/l.....	100.0	100.0	85.1-115.0
Mercury, ug/l.....	1.2	1.6	1.1-2.1
Selenium, ug/l.....	16.0	18.6	11.6-23.2

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: October 5, 1988

Parameter	Result	True Value	% Recovery
Chromium, ug/l.....	90.4	103	87.8
Iron, ug/l.....	91.5	102	89.7
Manganese, ug/l.....	98.1	102	96.2
Zinc, ug/l.....	102.6	101	101.6

NUTRIENT ANALYSIS

Identification: EPA QC WP284, WP486
(Analyzed concurrently with Golder Associates samples)
Analyzed: October 4 - 10, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.16	0.15	0.11-0.19
Nitrate as N, mg/l.....	0.17	0.18	0.14-0.22
Total Kjeldahl as N, mg/l.....	0.30	0.40	0.27-0.55
Orthophosphate as P, mg/l.....	0.258	0.27	0.25-0.29
Total Phosphate as P, mg/l.....	0.100	0.13	0.04-0.24

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WP481-1, WP481-2
(Analyzed concurrently with Golder Associates samples)
Analyzed: October 27 - November 2, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	85.0	100.0	80.0-118.0
Cadmium, ug/l.....	7.0	9.1	6.7-10.8
Lead, ug/l.....	43.0	43.0	34.0-54.0
Mercury, ug/l.....	1.9	2.0	1.5-2.5
Selenium, ug/l.....	31.4	50.0	31.3-62.1

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083, ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: October 31, 1988

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	980	970	101.0
Barium, ug/l.....	1030	970	106.2
Chromium, ug/l.....	98	103	95.1
Copper, ug/l.....	97	103	94.2
Iron, ug/l.....	90	102	88.2
Manganese, ug/l.....	100	102	98.0
Zinc, ug/l.....	101	101	100.0

NUTRIENT ANALYSIS

Identification: EPA QC WP284, WP486-1,4,6
(Analyzed concurrently with Golder Associates samples)
Analyzed: October 27 - November 19, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.16	0.15	0.11-0.19
Nitrate as N, mg/l.....	0.15	0.18	0.14-0.22
Total Kjeldahl as N, mg/l.....	0.46	0.40	0.27-0.55
Orthophosphate as P, mg/l.....	0.03	0.04	0.02-0.06

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WP1178-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: November 28 - December 9, 1988

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	22.4	27.0	19.8-34.2
Cadmium, ug/l.....	8.0	9.1	6.7-10.8
Lead, ug/l.....	51.0	43.0	34.0-54.0
Mercury, ug/l.....	0.6	0.7	0.3-1.1
Selenium, ug/l.....	26.5	25.0	17.4-28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083, ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: December 3, 1988

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	105	97	108.2
Barium, ug/l.....	104	99	105.1
Chromium, ug/l.....	98	103	95.1
Copper, ug/l.....	100	100	100.0
Iron, ug/l.....	109	102	106.9
Manganese, ug/l.....	101	102	99.0
Zinc, ug/l.....	100	101	99.0

NUTRIENT ANALYSIS

Identification: EPA QC WP284-1,5,6
(Analyzed concurrently with Golder Associates samples)
Analyzed: November 23 - December 1, 1988

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.18	0.15	0.11-0.19
Nitrate as N, mg/l.....	0.18	0.18	0.14-0.22
Total Kjeldahl as N, mg/l.....	0.38	0.40	0.27-0.55
Orthophosphate as P, mg/l.....	0.95	1.03	0.94-1.18

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378, WP287
(Analyzed concurrently with Golder Associates samples)
Analyzed: December 29, 1988 - January 11, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	63.5	62.0	48.1-73.2
Cadmium, ug/l.....	8.0	7.4	5.3-8.8
Lead, ug/l.....	54.0	63.0	52.7-72.6
Mercury, ug/l.....	5.9	5.0	3.85-6.25
Selenium, ug/l.....	24.2	25.0	17.4-28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: December 28, 1988

Parameter	Result	True Value	% Recovery
Chromium, ug/l.....	99.4	103	96.5
Iron, ug/l.....	117.0	102	114.7
Manganese, ug/l.....	105.4	102	103.3
Zinc, ug/l.....	109.1	101	108.0

NUTRIENT ANALYSIS

Identification: EPA QC WP284, WP486, WS378
(Analyzed concurrently with Golder Associates samples)
Analyzed: December 22, 1988 - January 7, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	3.00	3.00	2.71-3.23
Nitrate as N, mg/l.....	0.85	0.82	0.74-0.90
Total Kjeldahl as N, mg/l.....	4.73	4.78	4.32-5.44
Orthophosphate as P, mg/l.....	0.500	0.50	0.46-0.54
Total Phosphate as P, mg/l.....	0.938	1.03	0.94-1.18

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378-5,12,18, WP287-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: January 31 - February 3, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	52.8	51.0	41.6-58.7
Cadmium, ug/l.....	8.0	7.4	5.3-8.8
Lead, ug/l.....	31.0	34.0	27.6-39.8
Mercury, ug/l.....	2.2	3.0	2.16-3.85
Selenium, ug/l.....	22.4	25.0	17.4-28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: February 2, 1989

Parameter	Result	True Value	% Recovery
Chromium, ug/l.....	96.9	103	94.1
Iron, ug/l.....	95.4	102	93.5
Manganese, ug/l.....	98.6	102	96.7
Zinc, ug/l.....	92.6	101	91.7

NUTRIENT ANALYSIS

Identification: EPA QC WP284, WP486, WS378
(Analyzed concurrently with Golder Associates samples)
Analyzed: February 2 - 9, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	2.09	2.00	1.78 - 2.18
Nitrate as N, mg/l.....	0.09	0.10	0.06 - 0.16
Total Kjeldahl as N, mg/l.....	0.54	0.50	0.31 - 0.70
Orthophosphate as P, mg/l.....	0.497	0.50	0.46 - 0.54

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WS378 #18, #12, & #5
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 8 - 9, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	31.8	31.0	25.1 - 36.2
Cadmium, ug/l.....	7.0	7.4	5.3 - 8.8
Lead, ug/l.....	37.0	34.0	27.6 - 39.8
Mercury, ug/l.....	1.9	2.6	1.85 - 3.29
Selenium, ug/l.....	20.0	25.0	17.4 - 28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 7, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	121	97	124.7
Barium, ug/l.....	99	99	100.0
Chromium, ug/l.....	94	103	91.3
Copper, ug/l.....	105	100	105.0
Iron, ug/l.....	98	102	96.1
Manganese, ug/l.....	97	102	95.1
Zinc, ug/l.....	105	101	104.0

NUTRIENT ANALYSIS

Identification: EPA QC WS 378, WP 284
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 3 - March 19, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.46	0.50	0.42 - 0.57
Nitrate as N, mg/l.....	0.18	0.18	0.14 - 0.22
Total Kjeldahl as N, mg/l.....	0.46	0.50	0.42 - 0.57
Orthophosphate as P, mg/l.....	0.05	0.04	0.02 - 0.06

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP1178 #1, WS378 #18, #5
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 27 - 31, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	33.3	31.0	25.1 - 36.2
Cadmium, ug/l.....	4.8	4.9	3.7 - 5.3
Lead, ug/l.....	34.0	34.0	27.6 - 39.8
Mercury, ug/l.....	3.0	3.0	2.16 - 3.78
Selenium, ug/l.....	10.6	11.0	6.5 - 14.1

ICAP TRACE METAL ANALYSIS

Identification: EPA QC ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 28, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	113	97	116.5
Barium, ug/l.....	100	97	103.1
Chromium, ug/l.....	93	103	90.3
Copper, ug/l.....	95	103	92.2
Iron, ug/l.....	97	102	95.1
Manganese, ug/l.....	96	102	94.1
Zinc, ug/l.....	97	101	96.0

NUTRIENT ANALYSIS

Identification: EPA QC WP 284, WS 378
(Analyzed concurrently with Golder Associates samples)
Analyzed: March 24 - April 17, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.14	0.15	0.11 - 0.19
Nitrate as N, mg/l.....	0.08	0.10	0.06 - 0.16
Total Kjeldahl as N, mg/l.....	4.90	4.78	4.32 - 5.44
Orthophosphate as P, mg/l.....	0.04	0.04	0.02 - 0.06

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP1178 #1, WS378 #18, #5, #12
(Analyzed concurrently with Golder Associates samples)
Analyzed: April 21 - 26, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	49.0	51.0	41.6 - 58.7
Cadmium, ug/l.....	7.0	7.4	5.3 - 8.8
Lead, ug/l.....	46.0	43.0	34.0 - 54.0
Mercury, ug/l.....	2.1	2.6	1.85 - 3.29
Selenium, ug/l.....	8.0	8.0	5.78 - 10.2

ICAP TRACE METAL ANALYSIS

Identification: EPA QC ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: April 20, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	106	105	101.0
Barium, ug/l.....	100	100	100.0
Chromium, ug/l.....	94	96	97.9
Copper, ug/l.....	98	101	97.0
Iron, ug/l.....	93	100	93.0
Manganese, ug/l.....	98	96	102.1
Zinc, ug/l.....	95	103	92.2

NUTRIENT ANALYSIS

Identification: EPA QC WP 284, WS 378
(Analyzed concurrently with Golder Associates samples)
Analyzed: April 19 - 26, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	0.18	0.15	0.11 - 0.19
Nitrate as N, mg/l.....	0.16	0.15	0.11 - 0.19
Orthophosphate as P, mg/l.....	0.04	0.04	0.02 - 0.06

GOLDER ASSOCIATES, INC. QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WP287, WS378 #18, #5
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 1 - 9, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	51.9	51.0	41.6 - 58.7
Cadmium, ug/l.....	5.0	4.8	3.68 - 5.34
Lead, ug/l.....	38.0	34.0	27.6 - 39.8
Mercury, ug/l.....	4.0	5.0	3.85 - 6.25
Selenium, ug/l.....	8.5	8.1	5.78 - 10.2

ICAP TRACE METAL ANALYSIS

Identification: EPA QC ICAP-19, ICAP-7
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 1, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	100	105	95.2
Barium, ug/l.....	97	100	97.0
Chromium, ug/l.....	104	96	108
Copper, ug/l.....	103	101	102
Iron, ug/l.....	104	100	104
Manganese, ug/l.....	105	96	109
Zinc, ug/l.....	109	103	106

NUTRIENT ANALYSIS

Identification: EPA WP 284 #1, #2, #6
(Analyzed concurrently with Golder Associates samples)
Analyzed: May 18 - June 6, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	1.53	1.52	1.34 - 1.70
Total Kjeldahl as N, mg/l.....	4.87	4.78	4.32 - 5.44
Nitrate as N, mg/l.....	0.16	0.18	0.14 - 0.22
Orthophosphate as P, mg/l.....	0.04	0.04	0.02 - 0.06
Total phosphorus as P, mg/l.....	0.94	1.03	0.94 - 1.18

QUALITY ASSURANCE

ATOMIC ABSORPTION TRACE METAL ANALYSIS

Identification: EPA QC WS378-4,12 WP287-1
(Analyzed concurrently with Golder Associates samples)
Analyzed: July 19 - 20, 1989

Parameter	Result	True Value	95% Confidence Interval
Arsenic, ug/l.....	30.5	31.0	25.1 - 36.2
Cadmium, ug/l.....	3.0	2.7	1.8 - 3.4
Lead, ug/l.....	27.0	26.0	19.4 - 33.4
Mercury, ug/l.....	1.2	1.6	1.1 - 2.1
Selenium, ug/l.....	21.9	25.0	17.4 - 28.3

ICAP TRACE METAL ANALYSIS

Identification: EPA QC WP1083 ICAP-19
(Analyzed concurrently with Golder Associates samples)
Analyzed: July 19, 1989

Parameter	Result	True Value	% Recovery
Aluminum, ug/l.....	107	97	110.3
Barium, ug/l.....	101	97	104.1
Chromium, ug/l.....	102	103	99.0
Copper, ug/l.....	105	103	101.9
Iron, ug/l.....	105	102	102.9
Manganese, ug/l.....	100	102	98.0
Zinc, ug/l.....	109	101	107.9

NUTRIENT ANALYSIS

Identification: EPA QC WP284
(Analyzed concurrently with Golder Associates samples)
Analyzed: June 22 - July 4, 1989

Parameter	Result	True Value	95% Confidence Interval
Ammonia as N, mg/l.....	1.23	1.52	1.34 - 1.70
Nitrate as N, mg/l.....	1.54	1.60	1.44 - 1.76
Total Kjeldahl as N, mg/l.....	5.32	4.78	4.32 - 5.44
Orthophosphate as P, mg/l.....	0.265	0.27	0.25 - 0.29

CONSTITUENT	STANDARD DETECTION LIMIT	METHOD REFERENCE	
Acidity	1	EPA 305.1	Titrimetric, 8.3
Alkalinity	1	EPA 310.1	Titrimetric, 4.5
Aluminum	0.1	EPA 200.7	ICP
Ammonia Nitrogen	0.01	EPA 350.1	Colorimetric, Automated Phenate
Arsenic	0.005	EPA 206.2	AA, Furnace Technique
Barium	0.5	EPA 200.7	ICP
Bicarbonate	1	EPA 310.1	Titrimetric, 4.5
Boron	0.01	EPA 200.7	ICP
Cadmium	0.002	EPA 213.2	AA, Furnace Technique
Calcium	1	EPA 215.2	Titrimetric, EDTA
Carbonate	1	EPA 310.1	Titrimetric, 8.3
Chloride	1	EPA 325.3	Titrimetric, Mercuric Nitrate
Chromium	0.02	EPA 200.7	ICP
Color	1	SM 204.A	Visual Comparison Method
Cobalt	0.01	EPA 200.7	ICP
Conductivity	10	EPA 120.1	Specific Conductance, umhos-25C
Copper	0.01	EPA 200.7	ICP
Cyanide	0.005	EPA 335.3	Colorimetric, Automated UV
Dissolved Solids	1	EPA 160.1	Gravimetric, 180C
Fluoride	0.05	EPA 340.2	Potentiometric, ISE
Hardness	1	EPA 130.2	Titrimetric, EDTA
Hydroxide	1	EPA 310.1	Titrimetric
Iron	0.05	EPA 200.7	ICP
Kjeldahl Nitrogen	0.1	EPA 351.1	Colorimetric, Automated Phenate
Lead	0.002	EPA 239.2	AA Furnace Technique
Magnesium	0.1	EPA 200.7	ICP
Manganese	0.02	EPA 200.7	ICP
Mercury	0.001	EPA 245.1	Manual Cold Vapor Technique
Molybdenum	0.02	EPA 200.7	ICP
Nickel	0.01	EPA 200.7	ICP
Nitrate Nitrogen	0.01	EPA 353.2	Color, Auto, Cadmium Reduction
Nitrite Nitrogen	0.01	EPA 353.2	Colorimetric, Automated
pH	0.1	EPA 150.1	Electrometric
Phenols	0.005	EPA 420.2	Color, Auto with Distillation
Phosphorus	0.005	EPA 365.2	Colorimetric, Ascorbic Acid
Potassium	0.5	SM 322.B	Flame Photometer
Selenium	0.005	EPA 270.2	AA, Furnace Technique
Settleable Solids	0.1	EPA 160.2	Volumetric, Imhoff Cone
Silica	0.1	EPA 200.7	ICP
Silver	0.01	EPA 200.7	ICP
Sodium	0.5	SM 325.B	Flame Photometer
Sulfate	1	EPA 375.3	Gravimetric
Sulfide	0.04	EPA 376.1	Titrimetric, Iodine
Suspended Solids	1	EPA 160.2	Gravimetric, 103-105C
Thallium	0.1	EPA 200.7	ICP
Turbidity	0.05	EPA 180.1	Nephelometric
Vanadium	0.1	EPA 200.7	ICP
Zinc	0.01	EPA 200.7	ICP

SM = Standard Methods, 16th Ed., 1985.
EPA = EPA Methods Manual, EPA-600/4-79-020, 1983.

APPENDIX D

FLOOD PLAIN CALCULATIONS

```
1*****************************************************
 *  WATER SURFACE PROFILES                          *
 *  VERSION OF NOVEMBER 1976                        *
 *  UPDATED MAY 1984                                *
 *  IBM-PC-XT VERSION AUGUST 1985                   *
 *  RUN DATE  03-02-89   TIME  10:39:45               *
 *****************************************************
```

```
****************************************
 *  U.S. ARMY CORPS OF ENGINEERS        *
 *  THE HYDROLOGIC ENGINEERING CENTER   *
 *  609 SECOND STREET, SUITE D          *
 *  DAVIS, CALIFORNIA 95616             *
  *  (916) 440-2105 (FTS) 448-2105       *
****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

1

THIS RUN EXECUTED 03-02-89

```
**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
  IBM-PC-XT VERSION AUGUST 1985
**************************************************
```

```
C
T1 Wishbone Hills Hydrology
T2 Flood Analysis Supercritical
T3 Moose Creek 100-yr 6080 cfs.

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

      0.       5.       0.       1. -1.000000      .00      5.0      0.  1133.000    .000

J2  NPROF    IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    -1.000     .000  -10.000     .000     .000     .000     .000     .000     .000     .000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38.000    1.000    8.000    4.000   53.000   54.000     .000     .000     .000     .000

NC      .100     .100     .050     .300     .500     .000     .000     .000     .000     .000
QT     4.000  912.000 1150.000 1520.000 6080.000     .000     .000     .000     .000     .000
X1    32.000   17.000   80.000  105.000 1000.000 1000.000 1000.000     .000     .000     .000
X3    10.000     .000     .000     .000     .000     .000     .000     .000     .000     .000
X4     3.000 1138.000  165.000 1137.000  205.000 1137.000  350.000     .000     .000     .000
GR  1150.000     .000 1145.000   10.000 1145.000   50.000 1145.000   60.000 1140.000   65.000
GR  1135.000   70.000 1132.500   80.000 1130.500   82.000 1130.500  103.000 1132.500  105.000
GR  1135.000  120.000 1135.000  285.000 1135.000  310.000 1135.000  410.000 1140.000  465.000
GR  1145.000  590.000 1150.000  605.000     .000     .000     .000     .000     .000     .000
```

X1	31.000	18.000	220.000	240.000	900.000	1000.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	5.000	1107.000	45.000	1108.000	65.000	1109.500	110.000	1101.000	135.000	1102.500
X4	190.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
GR	1125.000	.000	1120.000	10.000	1115.000	20.000	1110.000	35.000	1105.000	85.000
GR	1100.000	105.000	1100.000	125.000	1100.000	210.000	1099.000	220.000	1097.000	222.000
GR	1097.000	238.000	1099.000	240.000	1100.000	250.000	1105.000	265.000	1110.000	310.000
GR	1115.000	370.000	1120.000	420.000	1125.000	555.000	.000	.000	.000	.000
X1	30.000	22.000	280.000	310.000	1000.000	950.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	3.000	1084.000	105.000	1082.000	220.000	1081.000	345.000	.000	.000	.000
GR	1125.000	.000	1100.000	35.000	1085.000	75.000	1080.000	180.000	1080.000	260.000
GR	1075.000	270.000	1072.000	280.000	1070.000	282.000	1070.000	308.000	1072.000	310.000
GR	1075.000	315.000	1080.000	325.000	1080.000	365.000	1075.000	450.000	1075.000	470.000
GR	1080.000	480.000	1085.000	490.000	1085.000	540.000	1090.000	560.000	1095.000	580.000
GR	1100.000	600.000	1125.000	650.000	.000	.000	.000	.000	.000	.000

1

X1	29.000	20.000	250.000	300.000	1000.000	900.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	9.000	1051.000	60.000	1053.000	100.000	1045.500	135.000	1046.000	150.000	1046.000
X4	180.000	1050.500	220.000	1051.000	330.000	1048.500	390.000	1050.500	440.000	.000
GR	1075.000	.000	1055.000	40.000	1050.000	120.000	1050.000	210.000	1050.000	230.000
GR	1045.000	240.000	1044.000	250.000	1042.000	252.000	1042.000	298.000	1044.000	300.000
GR	1045.000	310.000	1050.000	315.000	1050.000	360.000	1050.000	435.000	1050.000	470.000
GR	1045.000	500.000	1045.000	540.000	1045.000	570.000	1050.000	605.000	1075.000	655.000
X1	28.000	21.000	285.000	315.000	800.000	850.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	8.000	1016.000	165.000	1019.000	235.000	1015.500	330.000	1014.000	360.000	1014.500
X4	375.000	1014.000	390.000	1020.500	470.000	1024.500	685.000	.000	.000	.000
GR	1050.000	.000	1025.000	60.000	1020.000	120.000	1015.000	230.000	1014.500	285.000
GR	1012.500	287.000	1012.500	313.000	1014.500	315.000	1015.000	320.000	1015.000	400.000
GR	1020.000	440.000	1020.000	500.000	1015.000	530.000	1015.000	610.000	1020.000	650.000
GR	1025.000	710.000	1030.000	740.000	1035.000	780.000	1040.000	890.000	1045.000	915.000
GR	1050.000	935.000	.000	.000	.000	.000	.000	.000	.000	.000

X1	27.500	17.000	367.000	398.000	400.000	500.000	500.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	6.000	1004.000	110.000	1005.500	150.000	1004.500	210.000	1002.000	325.000	1005.500
X4	435.000	1006.500	560.000	.000	.000	.000	.000	.000	.000	.000
GR	1025.000	.000	1020.000	10.000	1015.000	20.000	1010.000	35.000	1005.000	100.000
GR	1005.000	120.000	1000.000	270.000	1000.000	290.000	1003.000	365.000	1001.000	367.000
GR	1001.000	398.000	1003.000	400.000	1005.000	420.000	1005.500	455.000	1005.000	670.000
GR	1010.000	680.000	1020.000	700.000	1020.000	740.000	1025.000	840.000	.000	.000
X1	27.000	25.000	190.000	225.000	950.000	900.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	12.000	993.000	110.000	989.000	150.000	990.500	170.000	991.000	265.000	989.500
X4	290.000	993.000	325.000	991.000	365.000	992.500	410.000	995.500	460.000	996.000
X4	630.000	994.500	715.000	1012.000	850.000	.000	.000	.000	.000	.000
GR	1025.000	.000	1005.000	20.000	1000.000	45.000	995.000	80.000	990.000	150.000
GR	990.000	160.000	990.000	185.000	987.000	190.000	985.000	192.000	985.000	223.000
GR	987.000	225.000	990.000	240.000	995.000	430.000	995.000	480.000	990.000	495.000
GR	990.000	530.000	995.000	570.000	995.000	700.000	995.000	720.000	1000.000	730.000
GR	1005.000	740.000	1010.000	810.000	1015.000	900.000	1020.000	915.000	1025.000	930.000
X1	26.000	21.000	700.000	755.000	800.000	1000.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	9.000	963.500	110.000	967.000	160.000	964.000	200.000	969.000	470.000	962.500
X4	510.000	966.000	550.000	968.000	625.000	967.000	870.000	964.500	940.000	.000
GR	1000.000	.000	975.000	60.000	970.000	70.000	965.000	90.000	965.000	125.000
GR	965.000	190.000	965.000	220.000	965.000	500.000	965.000	530.000	965.000	575.000
GR	965.000	680.000	961.000	700.000	959.000	702.000	959.000	753.000	961.000	755.000
GR	965.000	785.000	965.000	930.000	965.000	950.000	970.000	1005.000	975.000	1020.000
GR	985.000	1030.000	.000	.000	.000	.000	.000	.000	.000	.000

1

X1	25.000	21.000	950.000	1005.000	1000.000	900.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	19.000	953.000	280.000	949.500	360.000	950.000	370.000	950.500	420.000	945.500
X4	480.000	948.000	540.000	946.000	570.000	947.000	600.000	944.000	650.000	948.000
X4	690.000	946.000	730.000	947.000	780.000	939.000	890.000	942.000	920.000	942.000
X4	1045.000	938.000	1075.000	957.000	1140.000	955.500	1200.000	960.500	1270.000	.000
GR	975.000	.000	955.000	50.000	950.000	350.000	950.000	440.000	945.000	640.000
GR	945.000	660.000	945.000	805.000	940.000	880.000	940.000	910.000	940.000	940.000
GR	937.000	950.000	935.000	952.000	935.000	1003.000	937.000	1005.000	940.000	1025.000
GR	940.000	1070.000	940.000	1100.000	945.000	1110.000	950.000	1120.000	955.000	1135.000
GR	960.000	1250.000	.000	.000	.000	.000	.000	.000	.000	.000

X1	24.000	21.000	550.000	575.000	800.000	1000.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	6.000	914.000	70.000	920.500	150.000	913.000	330.000	920.000	450.000	920.000
X4	700.000	921.000	825.000	.000	.000	.000	.000	.000	.000	.000
GR	950.000	.000	925.000	10.000	920.000	25.000	915.000	60.000	915.000	105.000
GR	920.000	120.000	920.000	200.000	915.000	295.000	915.000	380.000	915.000	520.000
GR	910.000	540.000	909.000	550.000	907.000	552.000	907.000	573.000	909.000	575.000
GR	910.000	585.000	915.000	600.000	915.000	750.000	920.000	805.000	925.000	850.000
GR	930.000	855.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	23.000	16.000	405.000	440.000	900.000	750.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	10.000	894.000	75.000	894.500	90.000	895.000	120.000	892.000	200.000	897.000
X4	240.000	891.000	350.000	891.000	470.000	890.000	500.000	893.000	530.000	894.500
X4	600.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
GR	925.000	.000	900.000	40.000	895.000	70.000	895.000	220.000	895.000	255.000
GR	890.000	325.000	890.000	370.000	886.000	405.000	884.000	407.000	884.000	438.000
GR	886.000	440.000	890.000	465.000	890.000	570.000	895.000	680.000	900.000	690.000
GR	910.000	700.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	22.000	18.000	165.000	200.000	975.000	950.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	9.000	869.000	45.000	871.000	80.000	872.000	250.000	870.500	275.000	873.000
X4	330.000	872.000	380.000	893.000	560.000	896.000	660.000	894.000	690.000	.000
GR	900.000	.000	875.000	25.000	870.000	40.000	870.000	50.000	870.000	140.000
GR	866.000	165.000	864.000	167.000	864.000	198.000	866.000	200.000	870.000	230.000
GR	873.000	325.000	875.000	420.000	885.000	440.000	890.000	490.000	895.000	635.000
GR	895.000	680.000	895.000	700.000	900.000	730.000	.000	.000	.000	.000
X1	21.000	17.000	220.000	240.000	950.000	1000.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	8.000	844.000	50.000	845.000	65.000	844.000	90.000	851.000	190.000	851.000
X4	280.000	850.500	300.000	852.000	330.000	849.000	360.000	.000	.000	.000
GR	875.000	.000	850.000	40.000	845.000	110.000	850.000	165.000	850.000	210.000
GR	845.000	215.000	843.000	220.000	841.000	222.000	841.000	238.000	843.000	240.000
GR	845.000	245.000	850.000	270.000	850.000	350.000	850.000	375.000	865.000	400.000
GR	870.000	410.000	875.000	515.000	.000	.000	.000	.000	.000	.000

1

X1	20.000	17.000	135.000	160.000	950.000	1000.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	4.000	827.000	220.000	826.000	260.000	827.000	300.000	819.500	345.000	.000
GR	850.000	.000	830.000	35.000	825.000	105.000	822.000	135.000	820.000	137.000
GR	820.000	158.000	822.000	160.000	825.000	175.000	825.000	330.000	820.000	340.000
GR	820.000	350.000	825.000	360.000	830.000	425.000	835.000	435.000	840.000	440.000
GR	845.000	515.000	850.000	660.000	.000	.000	.000	.000	.000	.000
X1	19.000	16.000	50.000	115.000	1000.000	950.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	3.000	798.000	75.000	803.000	250.000	797.000	370.000	.000	.000	.000
GR	825.000	.000	800.000	40.000	799.000	50.000	797.000	52.000	797.000	113.000
GR	799.000	115.000	800.000	135.000	800.000	305.000	799.000	360.000	799.000	370.000
GR	800.000	390.000	805.000	475.000	810.000	510.000	815.000	530.000	820.000	545.000
GR	825.000	630.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	18.000	14.000	60.000	80.000	1000.000	1100.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	1.000	781.000	180.000	.000	.000	.000	.000	.000	.000	.000
GR	800.000	.000	775.000	50.000	773.000	60.000	771.000	62.000	771.000	78.000
GR	773.000	80.000	775.000	90.000	780.000	160.000	780.000	220.000	780.000	370.000
GR	785.000	400.000	790.000	460.000	795.000	480.000	800.000	510.000	.000	.000
X1	17.000	20.000	350.000	400.000	900.000	950.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	11.000	754.500	135.000	758.000	230.000	755.500	430.000	760.500	560.000	760.000
X4	585.000	761.000	620.000	760.000	670.000	761.000	765.000	760.000	820.000	760.500
X4	850.000	758.000	910.000	.000	.000	.000	.000	.000	.000	.000
GR	775.000	.000	770.000	20.000	765.000	40.000	760.000	80.000	755.000	130.000
GR	755.000	150.000	755.000	335.000	753.000	350.000	751.000	352.000	751.000	398.000
GR	753.000	400.000	755.000	410.000	755.000	445.000	755.000	470.000	760.000	540.000
GR	760.000	860.000	760.000	950.000	765.000	990.000	770.000	1010.000	775.000	1025.000

X1	16.000	24.000	760.000	850.000	975.000	1000.000	1000.000	.000	.000	.000
X3	10.000	.000	.000	560.000	738.000	.000	.000	.000	.000	.000
X4	13.000	729.000	410.000	738.000	560.000	735.000	685.000	735.500	880.000	734.000
X4	1000.000	735.500	1055.000	729.000	1100.000	735.500	1180.000	734.000	1215.000	737.000
X4	1240.000	734.000	1265.000	737.000	1300.000	736.000	1350.000	.000	.000	.000
GR	750.000	.000	735.000	30.000	730.000	400.000	730.000	435.000	735.000	540.000
GR	735.000	615.000	730.000	760.000	728.000	762.000	728.000	790.000	728.000	848.000
GR	735.000	850.000	735.000	935.000	735.000	1045.000	735.000	1070.000	730.000	1090.000
GR	730.000	1120.000	735.000	1160.000	735.000	1220.000	735.000	1240.000	735.000	1270.000
GR	735.000	1280.000	740.000	1400.000	745.000	1440.000	750.000	1475.000	.000	.000
X1	15.000	24.000	480.000	560.000	4500.000	5000.000	5000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
X4	6.000	724.000	115.000	726.000	155.000	707.000	310.000	710.500	375.000	709.000
X4	400.000	710.500	430.000	.000	.000	.000	.000	.000	.000	.000
GR	750.000	.000	745.000	10.000	740.000	20.000	735.000	30.000	730.000	70.000
GR	725.000	90.000	725.000	130.000	725.000	180.000	720.000	195.000	715.000	210.000
GR	710.000	260.000	710.000	365.000	710.000	390.000	710.000	420.000	710.000	440.000
GR	707.000	480.000	706.000	482.000	705.000	530.000	703.000	558.000	704.000	560.000
GR	705.000	570.000	710.000	600.000	725.000	630.000	750.000	655.000	.000	.000

1

X1	10.000	11.000	95.000	120.000	4500.000	4750.000	5000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
GR	600.000	.000	595.000	15.000	590.000	30.000	585.000	50.000	582.000	95.000
GR	580.000	97.000	580.000	118.000	585.000	120.000	590.000	180.000	595.000	195.000
GR	600.000	200.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	5.000	15.000	85.000	150.000	5000.000	5000.000	5000.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
GR	525.000	.000	500.000	30.000	495.000	40.000	490.000	50.000	485.000	85.000
GR	483.000	87.000	483.000	148.000	485.000	150.000	485.000	180.000	490.000	370.000
GR	490.000	410.000	490.000	450.000	495.000	560.000	500.000	610.000	525.000	690.000
X1	.000	16.000	175.000	215.000	.000	.000	.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
GR	410.000	.000	405.000	30.000	400.000	40.000	395.000	90.000	390.000	100.000
GR	385.000	110.000	385.000	160.000	385.000	175.000	383.000	177.000	383.000	205.000
GR	383.000	213.000	390.000	215.000	395.000	400.000	400.000	640.000	405.000	760.000
GR	410.000	940.000	.000	.000	.000	.000	.000	.000	.000	.000
EJ	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

1

```
   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG.       HV        HL        OLOSS    BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 *PROF 1


 CCHV=    .300 CEHV=    .500
 *SECNO 32.000
 3720 CRITICAL DEPTH ASSUMED
    32.00     8.27  1138.77  1138.77  1133.00  1140.13     1.36      .00      .00  1132.50
    6080.     265.    2721.    3093.      57.     203.     898.       0.       0.  1132.50
      .00     4.63    13.43     3.44     .100     .050     .100     .000  1130.50    66.23
  .013651       0.       0.       0.        0       19        0      .00   385.21   451.44
0
 *SECNO 31.000

 1645 INT SEC ADDED BY RAISING SEC     31.00,  16.750FT AND MULTIPLYING BY   1.128


 3265 DIVIDED FLOW

     1.01     6.63  1120.38  1122.19      .00  1126.15     5.77    12.65     1.32  1115.75
    6080.    1963.    3555.     562.     297.     145.      69.      10.       3.  1115.75
      .01     6.60    24.52     8.16     .100     .050     .100     .000  1113.75   102.08
  .062093     500.     500.     500.        7        5        0      .00   178.27   294.30
0

 1645 INT SEC ADDED BY RAISING SEC      1.01, -16.750FT AND MULTIPLYING BY    .886


 3265 DIVIDED FLOW

    31.00     8.53  1105.53  1105.75      .00  1107.75     2.22    16.62     1.78  1099.00
    6080.    2680.    2777.     624.     498.     167.     107.      17.       5.  1099.00
      .02     5.38    16.66     5.82     .100     .050     .100     .000  1097.00    81.44
  .020669     500.     500.     500.        9       11        0      .00   180.02   269.81
0
```

*SECNO 30.000

3265 DIVIDED FLOW

30.00	8.25	1078.25	1080.05	.00	1083.15	4.91	23.79	.81	1072.00
6080.	365.	4818.	897.	58.	243.	199.	31.	9.	1072.00
.04	6.30	19.80	4.51	.100	.050	.100	.000	1070.00	263.51
.029253	900.	1000.	1000.	4	11	0	.00	139.62	476.49

0

1

03-02-89 10:39:46

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 29.000

3265 DIVIDED FLOW

29.00	5.44	1047.44	1048.41	.00	1050.68	3.24	31.64	.83	1044.00
6080.	470.	4457.	1153.	118.	268.	241.	44.	13.	1044.00
.06	3.99	16.64	4.78	.100	.050	.100	.000	1042.00	128.55
.034951	1000.	1000.	950.	5	15	0	.00	241.20	587.05

0

*SECNO 28.000

3265 DIVIDED FLOW

28.00	5.31	1017.81	1018.03	.00	1019.25	1.43	30.52	.90	1014.50
6080.	929.	2255.	2895.	234.	155.	584.	61.	20.	1014.50
.09	3.97	14.53	4.96	.100	.050	.100	.000	1012.50	144.65
.028666	1000.	1000.	900.	3	5	0	.00	382.42	632.47

0

```
 *SECNO 27.500

 3265 DIVIDED FLOW

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
     27.50     5.60  1005.60  1005.60      .00  1006.91     1.31    25.10    13.33  1001.00
     6080.    3945.    1970.     165.     676.     143.      61.      79.      27.  1001.00
       .12     5.83    13.82     2.73     .100     .050     .100     .000  1000.00    92.20
   .028242     800.    1000.     850.       20        8        0      .00   418.51   671.20
0
 *SECNO 27.000

 3265 DIVIDED FLOW

     27.00     7.54   992.54   993.42      .00   995.27     2.73    11.21      .43   987.00
     6080.     550.    4130.    1400.     151.     260.     398.      88.      31.   987.00
       .13     3.65    15.89     3.51     .100     .050     .100     .000   985.00   116.15
   .021000     400.     500.     500.        8       11        0      .00   343.24   550.31
0
1
  03-02-89     10:39:46                                                                  PAGE     8


    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


 *SECNO 26.000

 3265 DIVIDED FLOW

     26.00     5.88   964.88   966.58      .00   969.09     4.21    25.73      .44   961.00
     6080.     327.    5512.     241.     106.     320.      59.     102.      37.   961.00
       .15     3.09    17.25     4.05     .100     .050     .100     .000   959.00    91.55
   .033541     950.    1000.     900.        5        5        0      .00   206.26   947.67
0
```

*SECNO 25.000

3265 DIVIDED FLOW

25.00	6.64	941.64	942.19	.00	944.16	2.52	24.09	.84	937.00
6080.	420.	5028.	633.	136.	361.	175.	115.	42.	937.00
.17	3.08	13.91	3.61	.100	.050	.100	.000	935.00	855.35
.018525	800.	1000.	1000.	7	11	0	.00	234.54	1103.29

0

*SECNO 24.000

3265 DIVIDED FLOW

24.00	8.28	915.28	916.96	.00	919.93	4.65	23.59	.64	909.00
6080.	1202.	4172.	706.	260.	203.	101.	129.	47.	909.00
.19	4.62	20.54	6.97	.100	.050	.100	.000	907.00	58.01
.031850	1000.	1000.	900.	7	11	0	.00	237.90	753.13

0

*SECNO 23.000

3265 DIVIDED FLOW

23.00	7.91	891.91	892.84	.00	894.89	2.99	24.21	.83	886.00
6080.	934.	4397.	749.	225.	273.	201.	142.	52.	886.00
.21	4.14	16.13	3.72	.100	.050	.100	.000	884.00	298.33
.020273	800.	1000.	1000.	4	8	0	.00	258.82	582.70

0

*SECNO 22.000

1

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3265 DIVIDED FLOW

22.00	7.84	871.84	872.91	.00	874.99	3.15	19.86	.05	866.00
6080.	926.	4453.	701.	246.	271.	165.	156.	57.	866.00
.23	3.77	16.46	4.23	.100	.050	.100	.000	864.00	34.47
.021335	900.	1000.	750.	4	8	0	.00	263.28	301.89

```
0
 *SECNO 21.000

 3265 DIVIDED FLOW

     21.00     8.42   849.42   850.12      .00   852.15     2.73    22.63      .21   843.00
     6080.    2735.    2966.     379.     464.     164.      78.     172.      62.   843.00
       .25     5.89    18.03     4.84     .100     .050     .100     .000   841.00    40.96
   .024661     975.    1000.     950.        5       11        0      .00   184.81   366.35
0
 *SECNO 20.000
     20.00     8.17   827.67   828.12      .00   829.67     2.00    22.12      .36   822.00
     6080.     815.    2935.    2330.     175.     188.     510.     190.      68.   822.00
       .28     4.66    15.64     4.57     .100     .050     .100     .000   819.50    67.66
   .020513     950.    1000.    1000.        4        5        0      .00   327.01   394.67
0
 *SECNO 19.000

 3265 DIVIDED FLOW

     19.00     4.97   801.97   802.59      .00   804.19     2.22    25.41      .07   799.00
     6080.     128.    4106.    1846.      28.     288.     427.     208.      76.   799.00
       .30     4.60    14.24     4.33     .100     .050     .100     .000   797.00    36.85
   .032577     950.    1000.    1000.        4       16        0      .00   328.09   423.45
0
 *SECNO 18.000
     18.00    10.34   781.34   781.75      .00   783.57     2.24    20.62      .00   773.00
     6080.     637.    3239.    2204.     114.     203.     600.     227.      83.   773.00
       .33     5.60    15.97     3.67     .100     .050     .100     .000   771.00    37.31
   .014613    1000.    1000.     950.        9       14        0      .00   340.74   378.06
0
1
 03-02-89     10:39:46
```



```
   SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
   Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA      LEFT/RIGHT
   TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN    SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID   ENDST
```

```
 *SECNO 17.000

 3265 DIVIDED FLOW

     17.00     5.66   756.66   758.07      .00   760.57     3.91    22.50      .50   753.00
     6080.     636.    4906.     538.     178.     279.     137.     245.      91.   753.00
       .35     3.58    17.57     3.92     .100     .050     .100     .000   751.00   113.35
   .036827    1000.    1000.    1100.        6       19        0      .00   297.62   493.31
0
 *SECNO 16.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3470 ENCROACHMENT STATIONS=     560.0    1475.0  TYPE=     1  TARGET=    -560.000
  ELENCL=    738.00  ELENCR= 100000.00

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      730.00 ELREA=      735.00

     16.00     5.32   733.32   733.32      .00   735.62     2.30    26.65     1.02   730.00
     6080.     246.    5834.       0.      83.     470.       0.     257.      95.   735.00
       .37     2.98    12.41      .00     .100     .050     .100     .000   728.00   710.24
   .020510     900.    1000.     950.       20       11        0      .00   139.28   849.52
0
 *SECNO 15.000

 3265 DIVIDED FLOW

     15.00     6.54   709.54   710.27      .00   711.96     2.41    23.63      .03   707.00
     6080.     458.    4995.     627.     161.     368.     112.     271.     100.   704.00
       .40     2.84    13.59     5.58     .100     .050     .100     .000   703.00   267.57
   .027599     975.    1000.    1000.        8       11        0      .00   256.67   597.27
0
 *SECNO 10.000

 3301 HV CHANGED MORE THAN HVINS

1
```

```
    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

     10.00      9.20    589.20    589.62       .00    592.21      3.01    119.57       .18    582.00
     6080.     1914.     3787.      379.      292.      223.      106.      341.      121.    585.00
       .50      6.56     16.98      3.58      .100      .050      .100      .000    580.00     33.20
   .021709     4500.     5000.     5000.         8        14         0       .00    137.21    170.41
0
 *SECNO 5.000

 3301 HV CHANGED MORE THAN HVINS

      5.00      5.61    488.61    488.82       .00    490.62      2.01    101.09       .50    485.00
     6080.      140.     4642.     1297.       46.      360.      355.      417.      143.    485.00
       .63      3.08     12.88      3.65      .100      .050      .100      .000    483.00     59.75
   .019780     4500.     5000.     4750.         3        14         0       .00    257.33    317.08
0
 *SECNO  .000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      385.00 ELREA=      390.00

       .00      6.76    389.76    389.76       .00    392.26      2.50    111.01     37.65    385.00
     6080.     2151.     3929.        0.      332.      261.        0.      495.      164.    390.00
       .74      6.47     15.03       .00      .100      .050      .100      .000    383.00    100.48
   .025098     5000.     5000.     5000.        20        11         0       .00    114.46    214.93
0
1
```

THIS RUN EXECUTED 03-02-89

```
**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
  IBM-PC-XT VERSION AUGUST 1985
**************************************************
```

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

Creek 100-yr 6080 cfs.

SUMMARY PRINTOUT

	SECNO	CWSEL	DEPTH	TOPWID	SSTA	ENDST
*	32.000	1138.77	8.27	385.21	66.23	451.44
*	31.000	1105.53	8.53	180.02	81.44	269.81
	30.000	1078.25	8.25	139.62	263.51	476.49
	29.000	1047.44	5.44	241.20	128.55	587.05
	28.000	1017.81	5.31	382.42	144.65	632.47
*	27.500	1005.60	5.60	418.51	92.20	671.20
	27.000	992.54	7.54	343.24	116.15	550.31
	26.000	964.88	5.88	206.26	91.55	947.67
	25.000	941.64	6.64	234.54	855.35	1103.29
	24.000	915.28	8.28	237.90	58.01	753.13
	23.000	891.91	7.91	258.82	298.33	582.70

22.000	871.84	7.84	263.28	34.47	301.89
21.000	849.42	8.42	184.81	40.96	366.35
20.000	827.67	8.17	327.01	67.66	394.67
19.000	801.97	4.97	328.09	36.85	423.45
18.000	781.34	10.34	340.74	37.31	378.06
17.000	756.66	5.66	297.62	113.35	493.31

1

	SECNO	CWSEL	DEPTH	TOPWID	SSTA	ENDST
*	16.000	733.32	5.32	139.28	710.24	849.52
	15.000	709.54	6.54	256.67	267.57	597.27
	10.000	589.20	9.20	137.21	33.20	170.41
	5.000	488.61	5.61	257.33	59.75	317.08
*	.000	389.76	6.76	114.46	100.48	214.93

1

SUMMARY OF ERRORS AND SPECIAL NOTES

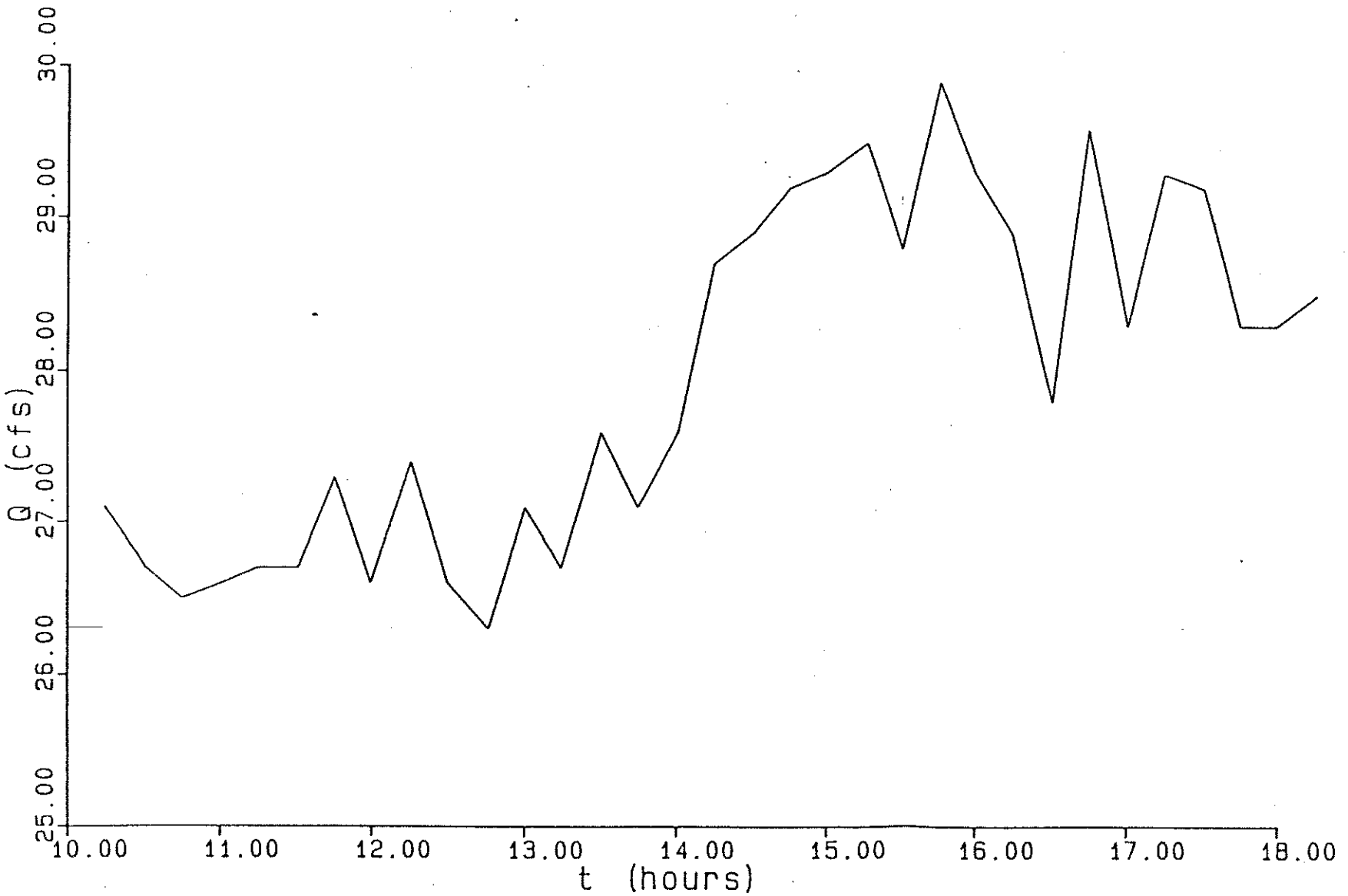
```
CAUTION  SECNO=   32.000  PROFILE= 1  CRITICAL DEPTH ASSUMED

CAUTION  SECNO=   31.000  PROFILE= 1  INTERPOLATED XSECTIONS USED

CAUTION  SECNO=   27.500  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   27.500  PROFILE= 1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   27.500  PROFILE= 1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION  SECNO=   16.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   16.000  PROFILE= 1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   16.000  PROFILE= 1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION  SECNO=     .000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=     .000  PROFILE= 1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=     .000  PROFILE= 1  20 TRIALS ATTEMPTED TO BALANCE WSEL
```



Discharge at Mo
Station 1 on 11-
(During seepage
$\Delta Q \approx 3.6$ cfs

2 YR 24 hr 2 inch PPT

1

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

Buffalo Cr

Q_2 = 18 cfs

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1 HEC-1 INPUT PAGE 1

```
      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID   WISHBONE HILLS, PALMER, AK  (McKinley Mining 883-2146)
        2           ID   BUFFALO CREEK   2 YR, 24 HR STORM - 2.0 INCH PPT.
        3           IT       6 28FEB89    1200     300
        4           IN       6 28FEB89    1206
        5           IO       5       1
*** FREE ***

        6           KK    SUB1
        7           KM    WISHBONE LAKE SUB-BASIN
        8           BA   0.250
        9           BF       0
       10           PB     2.0
       11           PC   0.002   0.004   0.006   0.008   0.010   0.012   0.014   0.016   0.018   0.020
       12           PC   0.022   0.024   0.026   0.028   0.030   0.032   0.034   0.036   0.038   0.040
       13           PC   0.042   0.044   0.046   0.048   0.050   0.052   0.054   0.056   0.058   0.060
       14           PC   0.062   0.064   0.066   0.068   0.070   0.072   0.074   0.076   0.078   0.080
       15           PC   0.082   0.084   0.086   0.088   0.090   0.092   0.094   0.096   0.098   0.100
       16           PC   0.103   0.105   0.107   0.110   0.112   0.115   0.117   0.120   0.122   0.125
       17           PC   0.128   0.131   0.134   0.137   0.140   0.143   0.146   0.149   0.152   0.155
       18           PC   0.159   0.163   0.167   0.171   0.175   0.179   0.183   0.187   0.191   0.195
```

```
 19          PC   0.201   0.207   0.213   0.219   0.225   0.231   0.237   0.243   0.249   0.255
 20          PC   0.265   0.275   0.285   0.295   0.310   0.325   0.350   0.400   0.450   0.510
 21          PC   0.530   0.545   0.560   0.575   0.585   0.592   0.600   0.610   0.615   0.625
 22          PC   0.631   0.637   0.643   0.649   0.655   0.661   0.667   0.673   0.679   0.685
 23          PC   0.690   0.694   0.699   0.703   0.708   0.712   0.717   0.721   0.725   0.730
 24          PC   0.734   0.737   0.741   0.744   0.748   0.751   0.755   0.758   0.761   0.765
 25          PC   0.768   0.771   0.774   0.777   0.780   0.783   0.786   0.789   0.792   0.795
 26          PC   0.798   0.801   0.804   0.807   0.810   0.813   0.816   0.819   0.822   0.825
 27          PC   0.828   0.831   0.834   0.837   0.840   0.843   0.846   0.849   0.852   0.855
 28          PC   0.858   0.860   0.863   0.865   0.868   0.870   0.873   0.875   0.878   0.880
 29          PC   0.882   0.884   0.886   0.888   0.890   0.892   0.894   0.896   0.898   0.900
 30          PC   0.903   0.905   0.908   0.910   0.913   0.915   0.918   0.920   0.923   0.925
 31          PC   0.927   0.928   0.930   0.931   0.933   0.934   0.936   0.937   0.939   0.940
 32          PC   0.942   0.944   0.946   0.948   0.950   0.952   0.954   0.956   0.958   0.960
 33          PC   0.962   0.964   0.966   0.968   0.970   0.972   0.974   0.976   0.978   0.980
 34          PC   0.982   0.984   0.986   0.988   0.990   0.992   0.994   0.996   0.998   1.000
 35          LS       0      74    11.3
 36          UD   0.154

 37          KK   LAKE1
 38          KM    WISHBONE LAKE (RESERVOIR W/ WEIR)
 39          RS       1    ELEV  1515.5       0
 40          SA       0      38      41
 41          SE    1510    1515    1520
 42          SS    1515      10   3.087     1.5

 43          KK    SUB2
 44          KM   WISHBONE DRY ARM SUB-BASIN
 45          BA   0.133
 46          BF       0
 47          LS       0      74
 48          UD   0.278
 49          UK     575   0.383    0.45     100
 50          RK    4600   0.038   0.035   0.133    TRAP       2       2     YES
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
51          KK    SUB3
52          KM    BUFFALO CREEK SUB-BASIN
53          BA   0.524
54          BF       0
55          LS       0      74
56          UD   0.406
57          UK    1575   0.140    0.45     100
58          RK    9275   0.063   0.035   0.524    TRAP       2       2     YES
59          ZZ                                    ****
1                    FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
        U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                                  ****


                WISHBONE HILLS, PALMER, AK  (McKinley Mining 883-2146)
                BUFFALO CREEK   2 YR, 24 HR STORM - 2.0 INCH PPT.

5 10        OUTPUT CONTROL VARIABLES
                IPRNT          5  PRINT CONTROL
                IPLOT          1  PLOT CONTROL
                QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT        HYDROGRAPH TIME DATA
                NMIN           6  MINUTES IN COMPUTATION INTERVAL
               IDATE     28FEB89  STARTING DATE
               ITIME        1200  STARTING TIME
                  NQ         300  NUMBER OF HYDROGRAPH ORDINATES
              NDDATE      1MAR89  ENDING DATE
              NDTIME        1754  ENDING TIME

          COMPUTATION INTERVAL     .10 HOURS
               TOTAL TIME BASE   29.90 HOURS

      ENGLISH UNITS

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
```

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	SUB1	30.	10.10	8.	4.	3.	.25		
+	ROUTED TO	LAKE1	11.	.10	9.	7.	7.	.25		
+									1515.50	.00
+	HYDROGRAPH AT	SUB2	11.	.30	9.	8.	8.	.38		
+	HYDROGRAPH AT	SUB3	18.	14.90	17.	12.	11.	.91		

*** NORMAL END OF HEC-1 ***

1

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1

HEC-1 INPUT


```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   WISHBONE HILLS, PALMER, AK  (McKinley Mining 883-2146)
  2           ID   BUFFALO CREEK 100 YR, 24 HR STORM - 4.0 INCH PPT.
  3           IT       6 28FEB89    1200     300
  4           IN       6 28FEB89    1206
  5           IO       5       1
*** FREE ***

  6           KK    SUB1
  7           KM    WISHBONE LAKE SUB-BASIN
  8           BA   0.250
  9           BF       0
 10           PB     4.0
 11           PC   0.002   0.004   0.006   0.008   0.010   0.012   0.014   0.016   0.018   0.020
 12           PC   0.022   0.024   0.026   0.028   0.030   0.032   0.034   0.036   0.038   0.040
 13           PC   0.042   0.044   0.046   0.048   0.050   0.052   0.054   0.056   0.058   0.060
 14           PC   0.062   0.064   0.066   0.068   0.070   0.072   0.074   0.076   0.078   0.080
 15           PC   0.082   0.084   0.086   0.088   0.090   0.092   0.094   0.096   0.098   0.100
 16           PC   0.103   0.105   0.107   0.110   0.112   0.115   0.117   0.120   0.122   0.125
 17           PC   0.128   0.131   0.134   0.137   0.140   0.143   0.146   0.149   0.152   0.155
 18           PC   0.159   0.163   0.167   0.171   0.175   0.179   0.183   0.187   0.191   0.195
```

Buffalo Cr

Q_{100} = 122 cfs

```
 19          PC   0.201   0.207   0.213   0.219   0.225   0.231   0.237   0.243   0.249   0.255
 20          PC   0.265   0.275   0.285   0.295   0.310   0.325   0.350   0.400   0.450   0.510
 21          PC   0.530   0.545   0.560   0.575   0.585   0.592   0.600   0.610   0.615   0.625
 22          PC   0.631   0.637   0.643   0.649   0.655   0.661   0.667   0.673   0.679   0.685
 23          PC   0.690   0.694   0.699   0.703   0.708   0.712   0.717   0.721   0.725   0.730
 24          PC   0.734   0.737   0.741   0.744   0.748   0.751   0.755   0.758   0.761   0.765
 25          PC   0.768   0.771   0.774   0.777   0.780   0.783   0.786   0.789   0.792   0.795
 26          PC   0.798   0.801   0.804   0.807   0.810   0.813   0.816   0.819   0.822   0.825
 27          PC   0.828   0.831   0.834   0.837   0.840   0.843   0.846   0.849   0.852   0.855
 28          PC   0.858   0.860   0.863   0.865   0.868   0.870   0.873   0.875   0.878   0.880
 29          PC   0.882   0.884   0.886   0.888   0.890   0.892   0.894   0.896   0.898   0.900
 30          PC   0.903   0.905   0.908   0.910   0.913   0.915   0.918   0.920   0.923   0.925
 31          PC   0.927   0.928   0.930   0.931   0.933   0.934   0.936   0.937   0.939   0.940
 32          PC   0.942   0.944   0.946   0.948   0.950   0.952   0.954   0.956   0.958   0.960
 33          PC   0.962   0.964   0.966   0.968   0.970   0.972   0.974   0.976   0.978   0.980
 34          PC   0.982   0.984   0.986   0.988   0.990   0.992   0.994   0.996   0.998   1.000
 35          LS       0      74    11.3
 36          UD   0.154

 37          KK   LAKE1
 38          KM    WISHBONE LAKE (RESERVOIR W/ WEIR)
 39          RS       1    ELEV  1515.5       0
 40          SA       0      38      41
 41          SE    1510    1515    1520
 42          SS    1515      10   3.087     1.5

 43          KK    SUB2
 44          KM   WISHBONE DRY ARM SUB-BASIN
 45          BA   0.133
 46          BF       0
 47          LS       0      74
 48          UD   0.278
 49          UK     575   0.383    0.45     100
 50          RK    4600   0.038   0.035   0.133    TRAP       2       2     YES
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
51          KK    SUB3
52          KM    BUFFALO CREEK SUB-BASIN
53          BA   0.524
54          BF       0
55          LS       0      74
56          UD   0.406
57          UK    1575   0.140    0.45     100
58          RK    9275   0.063   0.035   0.524    TRAP       2       2     YES
59          ZZ
1                                                   ****
                    FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
     U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                                    ****



                WISHBONE HILLS, PALMER, AK  (McKinley Mining 883-2146)
                BUFFALO CREEK 100 YR, 24 HR STORM - 4.0 INCH PPT.

  5 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          1  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT         HYDROGRAPH TIME DATA
                     NMIN          6  MINUTES IN COMPUTATION INTERVAL
                    IDATE     28FEB89  STARTING DATE
                    ITIME       1200  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      1MAR89  ENDING DATE
                   NDTIME       1754  ENDING TIME

             COMPUTATION INTERVAL     .10 HOURS
                  TOTAL TIME BASE   29.90 HOURS

        ENGLISH UNITS

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
```

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	SUB1	142.	10.10	30.	13.	10.	.25		
+	ROUTED TO	LAKE1	15.	14.20	14.	12.	11.	.25		
+									1515.60	14.10
+	HYDROGRAPH AT	SUB2	54.	10.40	27.	17.	16.	.38		
+	HYDROGRAPH AT	SUB3	122.	10.80	77.	39.	34.	.91		

*** NORMAL END OF HEC-1 ***

APPENDIX E

REGIONAL WATERSHED DATA

TABLE 5.—FLOOD FREQUENCY (DATA THROUGH 1977 WATER YEAR).

Station number	Station name	Annual flood discharge, in ft³/s Recurrence interval, in years					Years of record
		2	5	10	25	50	
15239000	Bradley R nr Homer	2,730	4,010	5,010	6,470	7,700	20
15239500	Fritz C nr Homer	86.5	197	318	549	798	15
15239800	Diamond C nr Homer	58.6	88.9	113	150	181	15
15239900	Anchor R nr Anchor Point	1,240	1,590	1,840	2,170	2,440	10
15240000	Anchor R at Anchor Point	1,870	2,350	2,680	3,130	3,470	13
15240500	Cook Inlet tr nr Ninilchik	51.3	76.7	96.8	126	152	12
15241600	Ninilchik R at Ninilchik	598	899	1,140	1,490	1,800	15
15242000	Kasilof R nr Kasilof	7,980	9,850	11,100	12,800	14,100	26
15243950	Porcupine C nr Primrose	720	1,110	1,420	1,890	2,300	15
15244000	Ptarmigan C at Lawing	519	701	835	1,020	1,170	10
15246000	Grant C nr Moose Pass	960	1,350	1,650	2,080	2,430	10
15248000	Trail R nr Lawing	3,560	4,620	5,390	6,420	7,230	26
15250000	Falls C nr Lawing	261	474	669	994	1,300	10
15254000	Crescent C nr Cooper Landing	327	510	660	888	1,090	29
15258000	Kenai R at Cooper Landing	10,800	14,600	17,400	21,300	24,400	31
15260000	Cooper C nr Cooper Landing	293	406	491	610	707	11
15266300	Kenai R at Soldotna	20,000	26,300	30,800	37,000	41,900	13
15266500	Beaver C nr Kenai	130	272	418	684	959	10
15267900	Resurrection C nr Hope	1,250	1,970	2,560	3,460	4,260	10
15269500	Granite C nr Portage	928	1,500	1,970	2,710	3,370	11
15270400	Donaldson C nr Wibel	68.1	104	133	176	213	10
15271900	Cub C nr Sunrise	27.6	36.1	42.2	50.4	56.9	13
15272530	California C at Girdwood	210	410	605	944	1,280	11
15272550	Glacier C at Girdwood	2,410	4,640	6,790	10,500	14,100	13
15273900	SF Campbell C at canyon mouth nr Anchorage	214	299	362	452	526	11
15274000	SF Campbell C nr Anchorage	214	325	414	547	662	25
15274300	NF Campbell C nr Anchorage	62.5	85.4	102	126	145	11
15274600	Campbell C nr Spenard	250	344	414	513	593	12
15274800	SB SF Chester C nr Anchorage	23.1	38.1	50.9	71.0	89.1	10
15275000	Chester C at Anchorage	58.5	79.9	95.6	118	135	18
15275100	Chester C at Arctic Blvd at Anchorage	84.2	110	129	154	175	12
15276000	Ship C nr Anchorage	834	1,120	1,330	1,610	1,840	31
15277100	Eagle R at Eagle River	3,240	4,180	4,850	5,750	6,460	12
15277200	Meadow C at Eagle River	21.5	49.9	81.2	142	208	10
15281000	Knik R nr Palmer	32,500	38,400	42,300	47,200	50,900	12
15282000	Caribou C nr Sutton	4,620	6,010	6,990	8,330	9,380	23
15282400	Puritan C nr Sutton	24.6	49.5	74.3	118	162	14
15284000	Matanuska R at Palmer	23,900	29,000	32,500	36,900	40,300	25
15290000	Little Susitna R nr Palmer	1,970	3,030	3,890	5,190	6,320	29
15291000	Susitna R nr Denali	17,000	21,700	24,900	29,300	32,800	18
15291100	Raft C nr Denali	110	126	136	148	158	15
15291200	Maclaren R nr Paxson	5,600	6,960	7,900	9,130	10,100	20
15291500	Susitna R at Cantwell	31,800	43,700	52,500	64,900	74,900	12
15292000	Susitna R at Gold Creek	48,500	64,200	75,600	91,000	103,000	28
15292400	Chulitna R nr Talkeetna	38,200	45,900	51,100	57,800	62,900	18
15292700	Talkeetna R nr Talkeetna	28,500	40,000	48,800	61,200	71,500	14
15292800	Montana C nr Montana	3,160	4,440	5,400	6,770	7,890	10
15293000	Caswell C nr Caswell	89.0	143	188	258	321	15
15294300	Skwentna R nr Skwentna	31,900	39,100	44,000	50,400	55,200	18
15294500	Chakachatna R nr Tyonek	15,200	18,300	20,400	23,100	25,100	11

(Freethey & Scully, 1980)

Public-Data File 88-40

PRELIMINARY WATER RESOURCES ASSESSMENT OF THE PROPOSED HATCHER PASS ALPINE SKI AREA NEAR GOVERNMENT PEAK, SOUTHCENTRAL ALASKA

By
Stan Carrick, Mary Maurer, Danita Maynard, and Jim Munter [1]

Alaska Division of Geological and Geophysical Surveys

November 1988

THIS REPORT HAS NOT BEEN REVIEWED FOR TECHNICAL CONTENT (EXCEPT AS NOTED IN TEXT) OR FOR CONFORMITY TO THE EDITORIAL STANDARDS OF DGGS.

3700 Airport Way
Fairbanks, Alaska 99709

[1] ADGGS, P.O. Box 772116, Eagle River, Alaska 99577

Table 1. Streamflow data for Little Susitna River near Palmer, Alaska, 1949-1987. (Flow figures in cubic feet per second or cfs).

Average Flow: 211
Lowest Annual Flow: 96 (1969)
Highest Annual Flow: 316 (1949)

Monthly Average Flows:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
29.5	23.5	19.2	22.1	205.0	682.0	551.0	446.0	309.0	138.0	61.5	38.4

Lowest Monthly Flow: 10.0 (April 1955, March 1956)
Highest Monthly Flow: 1215 (June 1977)
Lowest Daily Flow: 8.0 (1956 and 1957)
Highest Daily Flow: 5040 (1971)

Estimated Streamflow Statistics (cfs):

	Mean	Recurrence Interval 10-Yr Flow	Recurrence Interval 50-Yr Flow	Recurrence Interval 100-Yr Flow
1-Day Low Value	16.3	10.9	7.8	6.8
7-Day Low Value	16.5	11.1	8.1	7.1
30-Day Low Value	18.0	12.2	9.0	8.0
7-Day High Value	1158.0	1698.1	2153.0	2332.6
30-Day High Value	783.0	1114.8	1352.8	1439.8

The above data was compiled from USGS computer printouts (Lamke, 1988).

Table 3. Compilation of records of quantity and quality of surface waters of Little Susitna River near Palmer, lat 61°41'40", long 149°13'40".[1] Chemical analyses in milligrams per liter (mg/L).

Date	Water temperature (°C)	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium[2] (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)
10-19-48	-	125	7.7	-	11	2.4	4.3		42	6.0	4.5
04-18-49	-	26	-	-	-	-	-		48	7.1	19
05-19-49	-	167	6.4	-	-	-	6.0		38	3.1	6.5
10-03-49	-	247	5.2	-	-	-	3.9		34	3.2	4.5
06-15-50	-	456	4.5	0.02	8.9	2.8	0.6		33	3.8	2.4
08-03-50	-	432	4.5	0.04	9.4	-	-		34	1.9	1.4
09-01-50	-	123	4.5	0.05	8.5	1.5	4.8		36	5.6	1.5
03-19-51	-	15	6.8	0.01	12	3.8	12		45	5.1	20
04-18-51	-	25	3.6	0.03	12	2.8	6.3		41	3.5	12
05-24-51	-	206	5.5	0.01	4.7	1.4	9.8		35	4.4	3.2
02-12-52	0.0	14	7.2	0.01	12	3.3	9.1		43	4.4	16
03-12-52	0.5	13	6.7	0.03	13	3.0	11.0		44	5.8	18
04-15-52	1.0	15	6.8	0.01	14	3.0	13.0		46	7.2	21
05-07-52	3.0	29	7.3	0.04	14	3.3	10.0		46	6.3	18
06-11-52	5.0	1230	5.8	0.02	5.9	1.3	3.8		24	4.0	2.8
07-16-52	-	506	4.1	0.02	6.8	1.6	1.1		25	2.8	1.5
08-26-52	6.0	709	6.4	0.10	9.0	1.8	-		34	4.8	0.5
10-27-67	-	66	5.5	0.08	10	2.0	3.9	.5	35	2.0	7.1
02-26-68	-	27	6.5	0.18	12	2.3	9.3	.9	43	.0	17
03-27-68	-	29	6.5	0.13	13	2.9	11	.8	44	1.8	19
03-25-71	-	19	6.3	0.08	14	3.0	12	1.0	44	5.6	-
04-26-71	-	19	5.5	0.05	15	3.1	12	1.0	47	5.6	-
04-25-72	0.5	19	7.7	0	33	4.6	3.7	1.7	103	20	5.2

Date	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation @ 180° C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (µmhos @ 25° C)	pH	Color	Carbonate, field (mg/L as CO_3)	Carbon dioxide, dissolved (mg/L as CO_2)	Alkalinity, field (mg/L as $CaCO_3$)
10-19-48	0.0	1.4	58	38	3	84	-	-	-	-	-
04-18-49	-	-	-	-	-	143	-	-	-	-	-
05-19-49	-	4.0	-	33	2	95	6.2	-	-	-	-
10-03-49	-	.8	-	30	0	75	7.1	-	-	-	-
06-15-50	0	.8	40	34	7	63.3	7.4	4	-	-	-
08-03-50	-	.5	-	-	-	69.6	7.4	5	-	-	-
09-01-50	-	.4	45	27	0	72.0	-	5	-	-	-
03-19-51	-	0.9	83	46	9	144	7.6	5	-	-	-
04-18-51	-	1.3	62	41	8	119	7.7	5	-	-	-
05-24-51	-	1.3	48	18	0	82.2	7.3	5	-	-	-
02-12-52	0.0	1.0	76	44	9	130	7.3	5	0	3.4	35
03-12-52	0.1	0.8	81	45	9	141	7.1	5	0	5.6	36
04-15-52	0.1	0.8	-	47	9	149	7.2	5	0	4.6	38
05-07-52	0.0	1.5	-	49	11	145	7.3	10	0	3.7	38
06-11-52	0.1	0.5	-	20	0	46	7.0	5	0	3.8	20
07-16-52	0.0	0.6	-	24	3	51	6.5	5	0	13	21
08-26-52	0.1	1.3	-	30	2	66	6.5	5	0	17	28
04-25-72	0.2	0.05	-	102	18	220	8.1	0	0	-	-

[1] U.S. Geological Survey data (USGS, unpublished 1952 WATSTORE data; 1957;1958;1968;1971;1972)
[2] Sodium and potassium values from 1967-1972 are listed separately.

APPENDIX F

FLOOD ANALYSIS FOR BUFFALO CREEK

August 1989

883-2146

1

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

```
      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID   McKinley /Hydrology/ AK  Buffalo Creek Peak Flow Estimation
        2           ID   883-2146.000  J. Velimesis  18 May 1989
        3           IT       6 18MAY89    1200     300
        4           IN       6 19MAY89    1206
        5           IO       5       1
*** FREE ***
                    *DIAGRAM

        6           KK   BasinAbove Wishbone Lake (Feeds Buffalo Creek)
        7           KM   2 yr, 24 hr storm; P = 2.0"; Type I Dist (24 hr)
        8           KM   SCS RUNOFF COMPUTATION, CN LOSS RATE
        9           BA   0.250
       10           BF       0
       11           PB     2.0
       12           PC  0.0018  0.0036  0.0054  0.0072  0.0090  0.0108  0.0126  0.0144  0.0162  0.0180
       13           PC  0.0198  0.0216  0.0234  0.0252  0.0270  0.0288  0.0306  0.0324  0.0342  0.0360
       14           PC  0.0380  0.0400  0.0420  0.0440  0.0460  0.0482  0.0504  0.0526  0.0548  0.0570
       15           PC  0.0592  0.0614  0.0636  0.0658  0.0680  0.0700  0.0720  0.0740  0.0760  0.0780
       16           PC  0.0802  0.0824  0.0846  0.0868  0.0890  0.0914  0.0938  0.0962  0.0986  0.1010
       17           PC  0.1034  0.1058  0.1082  0.1106  0.1130  0.1156  0.1182  0.1208  0.1234  0.1260
       18           PC  0.1288  0.1316  0.1344  0.1372  0.1400  0.1430  0.1460  0.1490  0.1520  0.1550
       19           PC  0.1592  0.1634  0.1676  0.1718  0.1760  0.1802  0.1844  0.1886  0.1928  0.1970
       20           PC  0.2020  0.2070  0.2115  0.2160  0.2220  0.2280  0.2345  0.2410  0.2485  0.2560
       21           PC  0.2660  0.2760  0.2860  0.2960  0.3115  0.3270  0.3590  0.4100  0.4620  0.5130
       22           PC  0.5330  0.5480  0.5610  0.5740  0.5835  0.5930  0.6015  0.6100  0.6170  0.6240
       23           PC  0.6310  0.6380  0.6445  0.6510  0.6565  0.6620  0.6670  0.6720  0.6765  0.6810
       24           PC  0.6860  0.6910  0.6960  0.7010  0.7060  0.7102  0.7144  0.7186  0.7228  0.7270
       25           PC  0.7310  0.7350  0.7390  0.7430  0.7470  0.7506  0.7542  0.7578  0.7614  0.7650
       26           PC  0.7684  0.7718  0.7752  0.7786  0.7820  0.7852  0.7884  0.7916  0.7948  0.7980
       27           PC  0.8010  0.8040  0.8070  0.8100  0.8130  0.8158  0.8186  0.8214  0.8242  0.8270
       28           PC  0.8298  0.8326  0.8354  0.8382  0.8410  0.8440  0.8470  0.8500  0.8530  0.8560
       29           PC  0.8584  0.8608  0.8632  0.8656  0.8680  0.8702  0.8724  0.8746  0.8768  0.8790
       30           PC  0.8812  0.8834  0.8856  0.8878  0.8900  0.8924  0.8948  0.8972  0.8996  0.9020
       31           PC  0.9042  0.9064  0.9086  0.9108  0.9130  0.9150  0.9170  0.9190  0.9210  0.9230
       32           PC  0.9252  0.9274  0.9296  0.9318  0.9340  0.9360  0.9380  0.9400  0.9420  0.9440
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  33          PC  0.9458  0.9476  0.9494  0.9512  0.9530  0.9550  0.9570  0.9590  0.9610  0.9630
  34          PC  0.9648  0.9666  0.9684  0.9702  0.9720  0.9738  0.9756  0.9774  0.9792  0.9810
  35          PC  0.9828  0.9846  0.9864  0.9882  0.9900  0.9920  0.9940  0.9960  0.9980  1.0000
  36          LS       0      74   23.75
  37          UD   0.154

  38          KK    LakeWishbone
  39          KM   STORAGE ROUTE THRU LAKE (RESERVOIR)
  40          RS       1    ELEV  1515.5       0
  41          SA       0      38      41
  42          SE    1510    1515    1520
  43          SS    1515      10   3.087     1.5

  44          KK  DryArmSub-Basin; Parallel to Wishbone Lake
  45          KM   KINEMATIC RUNOFF AND ROUTE THRU DRY ARM SUB-BASIN
  46          BA   0.133
  47          BF       0
  48          LS       0      74       0
  49          UK     575   0.383    0.45     100
  50          RK    4600   0.038   0.035   0.133    TRAP       2       2      NO

  51          KKJunction
  52          KM   COMBINE HYDROGRAPHS FROM LAKE AND DRY ARM
  53          HC       2       0

  54          KK BuffaloCreek Sub-Basin; Below Wishbone Lake & Dry Arm
  55          KM   KINEMATIC RUNOFF AND ROUTE THRU BUFFALO CREEK REACH
  56          BA   0.524
  57          BF       0
  58          LS       0      74       0
  59          UK    1575   0.140    0.45     100
  60          RK    8823   0.064   0.035   0.524    TRAP       2       2     YES
  61          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    6       Basin
                V
                V
   38        Lake
                .
                .
   44           .      DryArm
                .           .
                .           .
   51    Junction............
                V
                V
   54     Buffalo ***

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

McKinley /Hydrology/ AK Buffalo Creek Peak Flow Estimation

883-2146.000 J. Velimesis 18 May 1989

```
  5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          1  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
```

```
IT          HYDROGRAPH TIME DATA
                 NMIN          6  MINUTES IN COMPUTATION INTERVAL
                IDATE     18MAY89  STARTING DATE
                ITIME        1200  STARTING TIME
                   NQ         300  NUMBER OF HYDROGRAPH ORDINATES
               NDDATE     19MAY89  ENDING DATE
               NDTIME        1754  ENDING TIME

            COMPUTATION INTERVAL     .10 HOURS
                 TOTAL TIME BASE   29.90 HOURS

      ENGLISH UNITS

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	Basin	40.	29.90	19.	5.	4.	.25		
+	ROUTED TO	Lake	11.	.10	9.	6.	5.	.25		
+									1515.50	.00
+	HYDROGRAPH AT	DryArm	14.	29.90	3.	1.	1.	.13		
+	2 COMBINED AT	Junction	21.	29.90	9.	6.	6.	.38		
+	HYDROGRAPH AT	Buffalo	47.	29.90	10.	6.	7.	.91		

*** NORMAL END OF HEC-1 ***

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   McKinley /Hydrology/ AK  Buffalo Creek Peak Flow Estimation
  2           ID   883-2146.000  J. Velimesis  18 May 1989
  3           IT       6 18MAY89    1200     300
  4           IN       6 19MAY89    1206
  5           IO       5       1
*** FREE ***
              *DIAGRAM

  6           KK   BasinAbove Wishbone Lake (Feeds Buffalo Creek)
  7           KM   25 yr, 24 hr storm; P = 3.0"; Type I Dist (24 hr)
  8           KM   SCS RUNOFF COMPUTATION, CN LOSS RATE
  9           BA   0.250
 10           BF       0
 11           PB     3.0
 12           PC  0.0018  0.0036  0.0054  0.0072  0.0090  0.0108  0.0126  0.0144  0.0162  0.0180
 13           PC  0.0198  0.0216  0.0234  0.0252  0.0270  0.0288  0.0306  0.0324  0.0342  0.0360
 14           PC  0.0380  0.0400  0.0420  0.0440  0.0460  0.0482  0.0504  0.0526  0.0548  0.0570
 15           PC  0.0592  0.0614  0.0636  0.0658  0.0680  0.0700  0.0720  0.0740  0.0760  0.0780
 16           PC  0.0802  0.0824  0.0846  0.0868  0.0890  0.0914  0.0938  0.0962  0.0986  0.1010
 17           PC  0.1034  0.1058  0.1082  0.1106  0.1130  0.1156  0.1182  0.1208  0.1234  0.1260
 18           PC  0.1288  0.1316  0.1344  0.1372  0.1400  0.1430  0.1460  0.1490  0.1520  0.1550
 19           PC  0.1592  0.1634  0.1676  0.1718  0.1760  0.1802  0.1844  0.1886  0.1928  0.1970
 20           PC  0.2020  0.2070  0.2115  0.2160  0.2220  0.2280  0.2345  0.2410  0.2485  0.2560
 21           PC  0.2660  0.2760  0.2860  0.2960  0.3115  0.3270  0.3590  0.4100  0.4620  0.5130
 22           PC  0.5330  0.5480  0.5610  0.5740  0.5835  0.5930  0.6015  0.6100  0.6170  0.6240
 23           PC  0.6310  0.6380  0.6445  0.6510  0.6565  0.6620  0.6670  0.6720  0.6765  0.6810
 24           PC  0.6860  0.6910  0.6960  0.7010  0.7060  0.7102  0.7144  0.7186  0.7228  0.7270
 25           PC  0.7310  0.7350  0.7390  0.7430  0.7470  0.7506  0.7542  0.7578  0.7614  0.7650
 26           PC  0.7684  0.7718  0.7752  0.7786  0.7820  0.7852  0.7884  0.7916  0.7948  0.7980
 27           PC  0.8010  0.8040  0.8070  0.8100  0.8130  0.8158  0.8186  0.8214  0.8242  0.8270
 28           PC  0.8298  0.8326  0.8354  0.8382  0.8410  0.8440  0.8470  0.8500  0.8530  0.8560
 29           PC  0.8584  0.8608  0.8632  0.8656  0.8680  0.8702  0.8724  0.8746  0.8768  0.8790
 30           PC  0.8812  0.8834  0.8856  0.8878  0.8900  0.8924  0.8948  0.8972  0.8996  0.9020
 31           PC  0.9042  0.9064  0.9086  0.9108  0.9130  0.9150  0.9170  0.9190  0.9210  0.9230
 32           PC  0.9252  0.9274  0.9296  0.9318  0.9340  0.9360  0.9380  0.9400  0.9420  0.9440
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  33          PC  0.9458  0.9476  0.9494  0.9512  0.9530  0.9550  0.9570  0.9590  0.9610  0.9630
  34          PC  0.9648  0.9666  0.9684  0.9702  0.9720  0.9738  0.9756  0.9774  0.9792  0.9810
  35          PC  0.9828  0.9846  0.9864  0.9882  0.9900  0.9920  0.9940  0.9960  0.9980  1.0000
  36          LS       0      74   23.75
  37          UD   0.154

  38          KK    LakeWishbone
  39          KM   STORAGE ROUTE THRU LAKE (RESERVOIR)
  40          RS       1    ELEV  1515.5       0
  41          SA       0      38      41
  42          SE    1510    1515    1520
  43          SS    1515      10   3.087     1.5

  44          KK  DryArmSub-Basin; Parallel to Wishbone Lake
  45          KM   KINEMATIC RUNOFF AND ROUTE THRU DRY ARM SUB-BASIN
  46          BA   0.133
  47          BF       0
  48          LS       0      74       0
  49          UK     575   0.383    0.45     100
  50          RK    4600   0.038   0.035   0.133    TRAP       2       2      NO

  51          KKJunction
  52          KM   COMBINE HYDROGRAPHS FROM LAKE AND DRY ARM
  53          HC       2       0

  54          KK BuffaloCreek Sub-Basin; Below Wishbone Lake & Dry Arm
  55          KM   KINEMATIC RUNOFF AND ROUTE THRU BUFFALO CREEK REACH
  56          BA   0.524
  57          BF       0
  58          LS       0      74       0
  59          UK    1575   0.140    0.45     100
  60          RK    8823   0.064   0.035   0.524    TRAP       2       2     YES
  61          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    6       Basin
               V
               V
   38        Lake
               .
               .
   44          .      DryArm
               .          .
               .          .
   51    Junction............
               V
               V
   54     Buffalo ***

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

McKinley /Hydrology/ AK Buffalo Creek Peak Flow Estimation
883-2146.000 J. Velimesis 18 May 1989

```
  5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          1  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
```

```
IT          HYDROGRAPH TIME DATA
                 NMIN          6  MINUTES IN COMPUTATION INTERVAL
                IDATE     18MAY89  STARTING DATE
                ITIME        1200  STARTING TIME
                   NQ         300  NUMBER OF HYDROGRAPH ORDINATES
               NDDATE     19MAY89  ENDING DATE
               NDTIME        1754  ENDING TIME

          COMPUTATION INTERVAL     .10 HOURS
               TOTAL TIME BASE   29.90 HOURS

     ENGLISH UNITS

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT									
	Basin	73.	29.90	35.	9.	7.	.25		
ROUTED TO									
	Lake	14.	29.90	9.	6.	6.	.25		
								1515.58	29.90
HYDROGRAPH AT									
	DryArm	31.	29.90	9.	2.	2.	.13		
2 COMBINED AT									
	Junction	45.	29.90	15.	7.	8.	.38		
HYDROGRAPH AT									
	Buffalo	147.	29.90	35.	12.	12.	.91		

*** NORMAL END OF HEC-1 ***

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

```
        LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          1           ID   McKinley /Hydrology/ AK  Buffalo Creek Peak Flow Estimation
          2           ID   883-2146.000  J. Velimesis  18 May 1989
          3           IT       6 18MAY89    1200     300
          4           IN       6 19MAY89    1206
          5           IO       5       1
*** FREE ***
                      *DIAGRAM

          6           KK   BasinAbove Wishbone Lake (Feeds Buffalo Creek)
          7           KM   100 yr, 24 hr storm; P = 4.0"; Type I Dist (24 hr)
          8           KM   SCS RUNOFF COMPUTATION, CN LOSS RATE
          9           BA   0.250
         10           BF       0
         11           PB     4.0
         12           PC  0.0018  0.0036  0.0054  0.0072  0.0090  0.0108  0.0126  0.0144  0.0162  0.0180
         13           PC  0.0198  0.0216  0.0234  0.0252  0.0270  0.0288  0.0306  0.0324  0.0342  0.0360
         14           PC  0.0380  0.0400  0.0420  0.0440  0.0460  0.0482  0.0504  0.0526  0.0548  0.0570
         15           PC  0.0592  0.0614  0.0636  0.0658  0.0680  0.0700  0.0720  0.0740  0.0760  0.0780
         16           PC  0.0802  0.0824  0.0846  0.0868  0.0890  0.0914  0.0938  0.0962  0.0986  0.1010
         17           PC  0.1034  0.1058  0.1082  0.1106  0.1130  0.1156  0.1182  0.1208  0.1234  0.1260
         18           PC  0.1288  0.1316  0.1344  0.1372  0.1400  0.1430  0.1460  0.1490  0.1520  0.1550
         19           PC  0.1592  0.1634  0.1676  0.1718  0.1760  0.1802  0.1844  0.1886  0.1928  0.1970
         20           PC  0.2020  0.2070  0.2115  0.2160  0.2220  0.2280  0.2345  0.2410  0.2485  0.2560
         21           PC  0.2660  0.2760  0.2860  0.2960  0.3115  0.3270  0.3590  0.4100  0.4620  0.5130
         22           PC  0.5330  0.5480  0.5610  0.5740  0.5835  0.5930  0.6015  0.6100  0.6170  0.6240
         23           PC  0.6310  0.6380  0.6445  0.6510  0.6565  0.6620  0.6670  0.6720  0.6765  0.6810
         24           PC  0.6860  0.6910  0.6960  0.7010  0.7060  0.7102  0.7144  0.7186  0.7228  0.7270
         25           PC  0.7310  0.7350  0.7390  0.7430  0.7470  0.7506  0.7542  0.7578  0.7614  0.7650
         26           PC  0.7684  0.7718  0.7752  0.7786  0.7820  0.7852  0.7884  0.7916  0.7948  0.7980
         27           PC  0.8010  0.8040  0.8070  0.8100  0.8130  0.8158  0.8186  0.8214  0.8242  0.8270
         28           PC  0.8298  0.8326  0.8354  0.8382  0.8410  0.8440  0.8470  0.8500  0.8530  0.8560
         29           PC  0.8584  0.8608  0.8632  0.8656  0.8680  0.8702  0.8724  0.8746  0.8768  0.8790
         30           PC  0.8812  0.8834  0.8856  0.8878  0.8900  0.8924  0.8948  0.8972  0.8996  0.9020
         31           PC  0.9042  0.9064  0.9086  0.9108  0.9130  0.9150  0.9170  0.9190  0.9210  0.9230
         32           PC  0.9252  0.9274  0.9296  0.9318  0.9340  0.9360  0.9380  0.9400  0.9420  0.9440
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  33          PC  0.9458  0.9476  0.9494  0.9512  0.9530  0.9550  0.9570  0.9590  0.9610  0.9630
  34          PC  0.9648  0.9666  0.9684  0.9702  0.9720  0.9738  0.9756  0.9774  0.9792  0.9810
  35          PC  0.9828  0.9846  0.9864  0.9882  0.9900  0.9920  0.9940  0.9960  0.9980  1.0000
  36          LS       0      74   23.75
  37          UD   0.154

  38          KK    LakeWishbone
  39          KM   STORAGE ROUTE THRU LAKE (RESERVOIR)
  40          RS       1    ELEV  1515.5       0
  41          SA       0      38      41
  42          SE    1510    1515    1520
  43          SS    1515      10   3.087     1.5

  44          KK  DryArmSub-Basin; Parallel to Wishbone Lake
  45          KM   KINEMATIC RUNOFF AND ROUTE THRU DRY ARM SUB-BASIN
  46          BA   0.133
  47          BF       0
  48          LS       0      74       0
  49          UK     575   0.383    0.45     100
  50          RK    4600   0.038   0.035   0.133    TRAP       2       2      NO

  51          KKJunction
  52          KM   COMBINE HYDROGRAPHS FROM LAKE AND DRY ARM
  53          HC       2       0

  54          KK BuffaloCreek Sub-Basin; Below Wishbone Lake & Dry Arm
  55          KM   KINEMATIC RUNOFF AND ROUTE THRU BUFFALO CREEK REACH
  56          BA   0.524
  57          BF       0
  58          LS       0      74       0
  59          UK    1575   0.140    0.45     100
  60          RK    8823   0.064   0.035   0.524    TRAP       2       2     YES
  61          ZZ
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    6        Basin
                V
                V
   38         Lake
                .
                .
   44           .      DryArm
                .           .
                .           .
   51     Junction............
                V
                V
   54      Buffalo ***

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1                                                          ****
                          FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
               U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                                           ****


                        McKinley /Hydrology/ AK  Buffalo Creek Peak Flow Estimation
                        883-2146.000  J. Velimesis  18 May 1989

   5 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          1  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
```

```
IT          HYDROGRAPH TIME DATA
                 NMIN          6  MINUTES IN COMPUTATION INTERVAL
                IDATE     18MAY89  STARTING DATE
                ITIME        1200  STARTING TIME
                   NQ         300  NUMBER OF HYDROGRAPH ORDINATES
               NDDATE     19MAY89  ENDING DATE
               NDTIME        1754  ENDING TIME

            COMPUTATION INTERVAL     .10 HOURS
                 TOTAL TIME BASE   29.90 HOURS

      ENGLISH UNITS

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT									
	Basin	108.	29.90	54.	14.	11.	.25		
ROUTED TO									
	Lake	22.	29.90	9.	6.	6.	.25		
								1515.79	29.90
HYDROGRAPH AT									
	DryArm	49.	29.90	17.	4.	3.	.13		
2 COMBINED AT									
	Junction	71.	29.90	26.	10.	10.	.38		
HYDROGRAPH AT									
	Buffalo	245.	29.90	72.	22.	19.	.91		

*** NORMAL END OF HEC-1 ***

APPENDIX G

SEDIMENT YIELD FOR BUFFALO CREEK

August 1989

883-2146

Golder Associates Inc.	SUBJECT UNIVERSAL SOIL LOSS EQUATION FOR BUFFALO CK		
	Job No. 883-2146	Made by J. VOLIMICIS	Date 12 MAY 89
	Ref.	Checked JR	Sheet 1 of 2
		Reviewed DPH	

EACH EQUATION: $A = R \times K \times LS \times C \times P$

A = ANNUAL EROSION (TONS/ACRE/YR.)

R = RAINFALL EROSIVITY FACTOR $= \frac{EI_{30}}{100}$

FOR ALASKA, TYPE-I PRECIPITATION DISTRIBUTION:

$\frac{EI_{30}}{100} = 16.55\, P_{2,6}^{2.2}$ WHERE $P_{2,6}$ = 2-YR 6-HR PRECIPITATION VOLUME

(HOTES, ET AL., 1973)

$P_{2,6}$ IS ESTIMATED TO BE 1.1 INCHES (MILLER, 1963)

$\therefore R = 16.55(1.1)^{2.2}$
$= 23.41$

K = SOIL ERODIBILITY FACTOR

K IS ESTIMATED TO BE ~0.41 AS A MAXIMUM FOR MOST OF THE SITE (NYENHUIS, 1988)

LS = LENGTH SLOPE FACTOR

$$= \left[\frac{\lambda}{72.6}\right]^m \left[\frac{430x^2 + 30x + 0.43}{6.613}\right]$$

WHERE λ = SLOPE LENGTH, FT
$m = 0.5$ FOR SLOPES $\geq 5\%$
$x = \sin\theta$
θ = SLOPE ANGLE

LS VARIES IN BUFFALO CREEK BASIN; $\therefore$ CHOOSE MORE UNIFORM SUBAREAS:

1. WISHBONE LAKE & DRAINAGE AREA: N/A - ASSUME LAKE EFFECTIVELY TRAPS MOST SEDIMENT INFLOW

2.

SUBBASIN	ΔX (FT)	ΔY (FT)	$\Delta L = (\Delta X^2 + \Delta Y^2)^{0.5} = \lambda$	S	LS
WISHBONE ARM	575	220	615	0.383	14.23
BUFFALO CANYON	500	125	515	0.250	7.93
MIDDLE ZONE	1575	212.5	1590	0.135	6.54
LOWER BUFFALO = COMPOUND SLOPE; APPLY CONTOUR FORM OF LS EQ'N.*					
a)	550	110	560	0.20	
b)	400	5	400	0.0125	
c)	125	60	139	0.42	
d)	100	10	100	0.10	NET 14.55

$$* \; LS = \frac{\sum_{j=1}^{n} \left[s_j(\lambda_j^{1+m}) - s_j(\lambda_{j-1}^{1+m}) \right]}{\lambda_e (72.6)^m} \; ; \; s_j = \frac{430x_j^2 + 30x_j + 0.43}{6.613} \; ; \; \lambda_j = \text{CUMMULATIVE DISTANCE}$$

Golder Associates Inc.

SUBJECT [illegible]		
Job No. [illegible]	Made by J. [illegible]	Date 12 MAY 25
Ref.	Checked [illegible]	Sheet 2 of 2
	Reviewed [illegible]	

C = COVER FACTOR: BRADFORD, ET AL. (1985); ADDENDUM SA3, SA4

WISHBONE ARM	UNMITIGATED WOODLAND	20-35% CANOPY	C = .009
BUFFALO CANYON	APPROXIMATE BASIN;	25% CANOPY, W, 40% COVER	C = .140
MID BUFFALO CK	APPROXIMATE BASIN;	50% CANOPY, G, 60% COVER	C = .038
LOWER BUFFALO CK	APPROXIMATE BASIN;	50% CANOPY, W, 60% COVER	C = .081

P = PRACTICE FACTOR = 1.0 BECAUSE "C" INCLUDES AS "C·P"

COMPUTE AVERAGE ANNUAL SOIL LOSS (FROM BUFFALO CK BASIN ABOVE WISHBONE ARM)

A = R·K·LS·C·P

WISHBONE ARM	A = 20.4 x .41 x 14.2 x 0.009 x 1.0 ≈ 1.07 TONS/AC/YR	x 85 AC	≈ 91 TON/YR
BUFFALO CANYON	20.4 x .41 x 7.9 x .14 x 1.0 ≈ 9.25	x 40 AC	≈ 370 TON/YR
MID-BUFFALO CK	20.4 x .41 x 6.5 x .038 x 1.0 ≈ 2.07	x 185 AC	≈ 382 TON/YR
LOWER BUFFALO CK	20.4 x .41 x 4.6 x .081 x 1.0 ≈ 4.89	x 110 AC	≈ 1078 TON/YR
		Σ = ~~500~~ 420 AC	Σ = 1931 TON/YR

TOTAL BASIN AREA = ~~500~~ 420 ACRES

AVERAGE SOIL LOSS = 1931 TON/YR / ~~500~~ 420 AC. = ~~3.5~~ 4.6 TON/AC/YR

APPENDIX H

DISCHARGE MEASUREMENT DATA

883-2146.000 McKinley /Hydrology/ AK John S. Velimesis

Location:Moose Creek Sta 1
File: Q_vs_Y1.WK1
Date: 24-Aug-89

Curve Fit of Power Function Coeffs. for Log/Log Relationship
Between Stage and Discharge

TRIAL 1: ALL DATA

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
04-NOV-88	1.09	35.8	26.14394	0.037426	1.553883	1.417371
09-MAY-89	1.21	32.9	39.88911	0.082785	1.517195	1.600854
16-SEP-88	1.39	64.2	69.90228	0.143014	1.807535	1.844491
30-SEP-88	1.41	64.0	74.06086	0.149219	1.806179	1.869588
07-OCT-88	1.41	82.8	74.06086	0.149219	1.918030	1.869588
23-SEP-88	1.52	86.6	100.3597	0.181843	1.937517	2.001559
20-AUG-88	1.58	152.0	117.3742	0.198657	2.181843	2.069572
30-AUG-88	1.64	157.0	136.4741	0.214843	2.195899	2.135050
24-JUN-89	2.15	471.9	408.0732	0.332438	2.673849	2.610738

Regression Output: ALL DATA COMBINED = POOR FIT

Constant	1.265975	18.44910 = A
Std Err of Y Est	0.091051	
R Squared	0.953067	
No. of Observations	7	
Degrees of Freedom	5	

X Coefficient(s)	4.045147	= B
Std Err of Coef.	0.401445	

TRIAL 2: ELIMINATE OUTLIERS AND GSL DATA (AUG88)

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
09-MAY-89	1.21	32.9	32.21017	0.082785	1.517195	1.507993
16-SEP-88	1.39	64.2	61.23839	0.143014	1.807535	1.787023
30-SEP-88	1.41	64.0	65.42852	0.149219	1.806179	1.815767
23-SEP-88	1.52	86.6	92.66370	0.181843	1.937517	1.966909
24-JUN-89	2.15	471.9	461.9393	0.332438	2.673849	2.664585

Regression Output: ELIMINATE OUTLIERS AND GSL DATA-AUG8

Constant	1.124465	13.31880 = A
Std Err of Y Est	0.022708	
R Squared	0.997943	
No. of Observations	5	
Degrees of Freedom	3	

X Coefficient(s)	4.632796	= B
Std Err of Coef.	0.121409	

883-2146.000 McKinley /Hydrology/ AK John S. Velimesis

Location: Moose Creek Sta 1
File: Q_vs_Y1.WK1
Date: 24-Aug-89

Curve Fit of Power Function Coeffs. for Log/Log Relationship
Between Stage and Discharge

TRIAL 3: ELIMINATE OUTLIERS ONLY = BEST FIT

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
09-MAY-89	1.21	32.9	33.67661	0.082785	1.517195	1.527328
16-SEP-88	1.39	64.2	64.98864	0.143014	1.807535	1.812837
30-SEP-88	1.41	64.0	69.54215	0.149219	1.806179	1.842248
23-SEP-88	1.52	86.6	99.28870	0.181843	1.937517	1.996899
20-AUG-88	1.58	152.0	119.2893	0.198657	2.181843	2.076601
30-AUG-88	1.64	157.0	142.3419	0.214843	2.195899	2.153332
24-JUN-89	2.15	471.9	513.7756	0.332438	2.673849	2.710773

Regression Output: ELIMINATE OUTLIERS ONLY = BEST FIT

Constant	1.134896	13.64257 = A
Std Err of Y Est	0.061982	
R Squared	0.976997	
No. of Observations	7	
Degrees of Freedom	5	

X Coefficient(s)	4.740358	= B
Std Err of Coef.	0.325289	

883-2146.000 McKinley /Hydrology/ AK John S. Velimesis

Location: Moose Creek Sta 1
File: Q_vs_Y5.WK1
Date: 24-Aug-89

Curve Fit of Power Function Coeffs. for Log/Log Relationship
Between Stage and Discharge

TRIAL 1: FALL/WINTER 1988 ONLY

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
16-SEP-88	2.29	89.5	85.734	0.359835	1.951823	1.933152
30-SEP-88	2.45	109.9	119.073	0.389166	2.040997	2.075812
20-AUG-88	2.53	151.0	139.215	0.403120	2.178976	2.143685
07-OCT-88	2.56	133.1	147.430	0.408239	2.124178	2.168585
30-AUG-88	2.66	180.0	177.635	0.424881	2.255272	2.249528
23-SEP-88	2.66	185.8	177.635	0.424881	2.269045	2.249528
04-NOV-88	3.34	33.6	BAD DATA: ICE!			
22-MAR-89	NA	16.0	BAD DATA: ICE!			

Regression Output: FALL/WINTER 1988 ONLY

Constant	0.182954	1.524 = A
Std Err of Y Est	0.036028	
R Squared	0.932445	
No. of Observations	6.0	
Degrees of Freedom	4	
X Coefficient(s)	4.864 = B	
Std Err of Coef.	0.654592	

TRIAL 2: SPRING 1989, POST BREAKUP ONLY

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
15-APR-89	2.30	44.0	39.706	0.361727	1.643452	1.598860
09-MAY-89	2.71	70.0	74.418	0.432969	1.845098	1.871679
02-JUN-89	3.43	158.9	183.456	0.535294	2.201123	2.263532

Regression Output: SPRING 1989, POST BREAKUP ONLY

Constant	0.463907	2.910 = A
Std Err of Y Est	0.022135	
R Squared	0.996927	
No. of Observations	3	
Degrees of Freedom	1	
X Coefficient(s)	3.232 = B	
Std Err of Coef.	0.179401	

883-2146.000 McKinley /Hydrology/ AK John S. Velimesis

Location: Moose Creek Sta 1
File: Q_vs_Y5.WK1
Date: 24-Aug-89

Curve Fit of Power Function Coeffs. for Log/Log Relationship
Between Stage and Discharge

TRIAL 3: SPRING 1989, POST BREAKUP + SITE BRIDGE HI FLOW

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
15-APR-89	2.30	44.0	39.706	0.361727	1.643452	1.598860
09-MAY-89	2.71	70.0	74.418	0.432969	1.845098	1.871679
02-JUN-89	3.43	158.9	183.456	0.535294	2.201123	2.263532
24-JUN-89 SB	4.45	550.7	497.185	0.648360	2.740915	2.696517

Regression Output: 1989 DATA, W/ SITE BRIDGE HI FLOW

Constant	0.213623	1.635 = A
Std Err of Y Est	0.065425	
R Squared	0.987667	
No. of Observations	4	
Degrees of Freedom	2	

X Coefficient(s)	3.829	= B
Std Err of Coef.	0.302585	

883-2146.000 McKinley /Hydrology/ AK John S. Velimesis

Location: Moose Creek Site Bridge (SB)
File: QvsYSB.WK1
Date: 24-Aug-89

Curve Fit of Power Function Coeffs. for Log/Log Relationship
Between Stage and Discharge

TRIAL 1: ALL DATA

Date	Meas. Stage Y	Meas. Dischg Q	Fit (Q^) Q^=a(Y**b)	Log10(Y)	Log10(Q)	Log10(Q^)
24-APR-89	1.48	47.3	51.82442	0.170261	1.674861	1.714534
04-MAY-89	1.65	81.1	78.37591	0.217483	1.909020	1.894182
02-JUN-89	2.00	183.6	162.9363	0.301029	2.263872	2.212017
24-JUN-89	2.80	550.7	586.0501	0.447158	2.740915	2.767934

Regression Output:

Constant	1.0668	11.663 = A
Std Err of Y Est	0.0511	
R Squared	0.9919	
No. of Observations	4.0000	
Degrees of Freedom	2.0000	

X Coefficient(s)	3.804 = B
Std Err of Coef.	0.2

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 1
Date: 20-AUG-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	10.0	1.1	0.4	0.45	0.4
1	12.0	1.0	0.9	1.80	2.2
2	14.0	1.0	0.8	1.60	3.8
3	16.0	1.2	1.4	3.36	7.2
4	18.0	1.7	2.8	9.52	16.7
5	20.0	2.1	3.3	13.86	30.6
6	22.0	1.8	4.0	14.40	45.0
7	24.0	1.8	4.3	15.48	60.5
8	26.0	1.8	3.8	13.68	74.1
9	28.0	1.9	2.0	7.60	81.7
10	30.0	2.3	4.3	19.78	101.5
11	32.0	1.8	1.0	3.60	105.1
12	34.0	1.7	2.7	9.18	114.3
13	36.0	1.6	2.0	6.40	120.7
14	38.0	1.4	2.3	6.44	127.1
15	40.0	1.3	1.8	4.68	131.8
16	42.0	1.3	2.1	5.46	137.3
17	44.0	1.1	0.6	1.32	138.6
18	46.0	1.4	1.7	4.76	143.4
19	48.0	1.1	2.4	5.28	148.6
20	50.0	0.8	1.3	2.08	150.7
21	52.0	0.7	0.3	0.42	151.1
22	54.0	0.8	0.2	0.32	151.5
23	56.0	0.9	0.1	0.18	151.6
24	58.0	0.3	0.0	0.00	151.6
25	60.0	0.1	0.0	0.00	151.6

Staff Gage Reading (ft): 1.58

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek, Sta 1
Date: 30-AUG-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	10.0	0.0	0.0	0.00	0.0
1	12.0	1.13	2.1	2.37	2.4
2	14.0	1.19	1.2	2.86	5.2
3	16.0	1.95	2.2	8.58	13.8
4	18.0	2.95	3.6	21.24	35.0
5	20.0	1.90	3.0	11.40	46.4
6	22.0	2.10	3.4	14.28	60.7
7	24.0	2.45	4.4	21.56	82.3
8	26.0	2.40	4.2	20.16	102.4
9	28.0	2.00	3.0	12.00	114.4
10	30.0	1.45	1.9	5.51	120.0
11	32.0	1.60	1.9	6.08	126.0
12	34.0	1.60	1.5	4.80	130.8
13	36.0	1.70	2.0	6.80	137.6
14	38.0	1.65	2.0	6.60	144.2
15	40.0	1.40	2.3	6.44	150.7
16	42.0	1.35	1.5	4.05	154.7
17	44.0	0.90	0.8	1.44	156.2
18	46.0	0.60	0.6	0.72	156.9
19	48.0	0.35	0.0	0.00	156.9
20	51.6	0.0	0.0	0.00	156.9

Staff Gage Reading (ft): 1.64

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (~50 ft Upstrm fm Datapod)
Date: 16-Sep-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	4.8	0.0	0.0	0.00	0.0
1	6.8	0.3	0.0	0.00	0.0
2	8.8	0.5	0.1	0.10	0.1
3	10.8	0.8	0.2	0.32	0.4
4	12.8	1.2	0.9	2.16	2.6
5	14.8	1.3	1.3	3.38	6.0
6	16.8	1.5	1.0	3.00	9.0
7	18.8	1.8	1.9	6.84	15.8
8	20.8	1.7	0.9	3.06	18.9
9	22.8	1.9	2.0	7.60	26.5
10	24.8	2.0	2.5	10.00	36.5
11	26.8	2.0	2.3	9.20	45.7
12	28.8	1.9	0.9	3.42	49.1
13	30.8	1.5	0.3	0.90	50.0
14	32.8	1.3	1.1	2.86	52.8
15	34.8	1.3	1.0	2.60	55.4
16	36.8	1.3	0.9	2.34	57.8
17	38.8	1.2	1.2	2.88	60.7
18	40.8	1.1	0.8	1.76	62.4
19	42.8	0.8	0.8	1.28	63.7
20	44.8	0.5	0.3	0.50	64.2
21	49.5	0.0	0.0	0.00	64.2

STAFF GAGE READING (FT): 1.39

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (~50 ft Upstrm fm Datapod)
Date: 23-Sep-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	4.2	0.00	0.0	0.00	0.0
1	6.2	0.35	0.0	0.00	0.0
2	8.2	0.52	0.1	0.10	0.1
3	10.2	0.85	0.1	0.17	0.3
4	12.2	1.00	0.6	1.20	1.5
5	14.2	1.45	1.0	2.90	4.4
6	16.2	1.45	1.0	2.90	7.3
7	18.2	1.80	1.8	6.48	13.8
8	20.2	2.00	1.8	7.20	21.0
9	22.2	2.20	2.1	9.24	30.2
10	24.2	2.30	1.4	6.44	36.6
11	26.2	2.20	2.6	11.44	48.1
12	28.2	2.30	3.0	13.80	61.9
13	30.2	1.80	0.6	2.16	64.0
14	32.2	1.90	1.0	3.80	67.8
15	34.2	1.60	0.8	2.56	70.4
16	36.2	1.50	1.6	4.80	75.2
17	38.2	1.40	2.3	6.44	81.6
18	40.2	1.30	0.9	2.34	84.0
19	42.2	0.90	0.9	1.62	85.6
20	44.2	0.60	0.5	1.05	86.6
21	49.2	0.00	0	0.00	86.6

STAFF GAGE READING (FT): 1.52

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (~50 ft Upstrm fm Datapod)
Date: 30-Sep-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	6.0	0.0	0.0	0.00	0.0
1	8.0	0.0	0.0	0.00	0.0
2	10.0	0.6	0.1	0.12	0.1
3	12.0	0.9	0.2	0.36	0.5
4	14.0	1.3	0.8	2.08	2.6
5	16.0	1.2	1.7	4.08	6.6
6	18.0	1.4	1.1	3.08	9.7
7	20.0	1.7	1.6	5.44	15.2
8	22.0	1.8	1.0	3.60	18.8
9	24.0	1.9	2.6	9.88	28.6
10	26.0	2.1	2.8	11.76	40.4
11	28.0	1.1	1.0	2.20	42.6
12	30.0	1.8	0.6	2.16	44.8
13	32.0	1.7	0.9	3.06	47.8
14	34.0	1.6	1.0	3.20	51.0
15	36.0	1.4	1.0	2.80	53.8
16	38.0	1.3	1.0	2.60	56.4
17	40.0	1.2	1.6	3.84	60.3
18	42.0	0.7	0.3	0.42	60.7
19	44.0	1.0	0.7	1.40	62.1
20	46.0	0.7	0.8	1.88	64.0
21	50.7	0.0	0.0	0.00	64.0

STAFF GAUGE READING (FT): 1.41

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (~50 ft Upstrm fm Datapod)
Date: 10-Oct-88 (Note: 4-6 inch fresh snow, no ice noted)

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	6.2	0.00	0.0	0.00	0.0
1	8.2	0.23	0.0	0.00	0.0
2	10.2	0.40	0.2	0.16	0.2
3	12.2	0.75	0.2	0.30	0.5
4	14.2	0.80	0.4	0.64	1.1
5	16.2	1.30	1.0	2.60	3.7
6	18.2	1.30	1.3	3.38	7.1
7	20.2	1.50	2.6	7.80	14.9
8	22.2	1.60	1.8	5.76	20.6
9	24.2	2.00	2.7	10.80	31.4
10	26.2	2.10	3.0	12.60	44.0
11	28.2	2.00	3.1	12.40	56.4
12	30.2	2.00	0.5	2.00	58.4
13	32.2	1.70	1.0	3.40	61.8
14	34.2	1.70	0.9	3.06	64.9
15	36.2	1.70	1.2	4.08	69.0
16	38.2	1.20	1.5	3.60	72.6
17	40.2	1.00	2.0	4.00	76.6
18	42.2	1.20	1.4	3.36	79.9
19	44.2	1.00	1.1	2.20	82.1
20	46.2	0.50	0.5	0.65	82.8
21	49.4	0.00	0.0	0.00	82.8

STAFF GAGE READING (FT): 1.41

NOTE: MEASUREMENT NOT USED IN STAGE-DISCHARGE CALIBRATION DUE TO ICING CONDITIONS

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (~50 ft Upstrm fm Datapod)
Date: 04-Nov-88 (Note: Min ice on rocks in stream and on edge

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.6	0.0	0.00	0.0
1	2.0	0.8	0.5	0.80	0.8
2	4.0	0.9	0.8	1.44	2.2
3	6.0	1.2	1.2	2.88	5.1
4	8.0	1.3	0.8	2.08	7.2
5	10.0	1.4	1.5	4.20	11.4
6	12.0	1.4	1.8	5.04	16.4
7	14.0	1.5	1.8	5.40	21.8
8	16.0	1.5	0.9	2.70	24.5
9	18.0	1.4	0.2	0.56	25.1
10	20.0	1.3	1.0	2.60	27.7
11	22.0	1.0	1.4	2.80	30.5
12	24.0	1.0	0.9	1.80	32.3
13	26.0	0.8	1.1	1.76	34.1
14	28.0	0.6	1.0	1.20	35.3
15	30.0	0.6	0.4	0.50	35.8
16	32.2	0.0	0.0	0.00	35.8

STAFF GAGE READING (FT): 1.09

NOTE: MEASUREMENT NOT USED IN STAGE-DISCHARGE CALIBRATION DUE TO ICING CONDITIONS

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (500 ft. Dwnstrm fm Datapod)
Date: 22-MAR-89 (Note: Includes inflow from Wishbone Creek)
(Section effected by Ice)
U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0	0.00	0.0	0.0
1	0.8	0.1	0	0	0.00	0.0	0.0
2	3.0	0.4	19	60	0.32	0.3	0.3
3	5.0	0.6	1	60	0.02	0.0	0.3
4	7.0	0.8	65	60	1.08	1.7	2.0
5	9.0	0.9	76	60	1.27	2.3	4.3
6	11.0	1.1	26	60	0.43	1.0	5.3
7	13.0	1.3	54	60	0.90	2.3	7.6
8	15.0	1.2	19	60	0.32	0.8	8.4
9	17.0	1.0	15	60	0.25	0.5	8.9
10	19.0	0.3	2	60	0.03	0.0	8.9
11	21.5	0.4	0	0	0.00	0.0	8.9
12	22.5	0.0	0	0	0.00	0.0	8.9

STAFF GAGE READING (FT): 0.75

NOTE: MEASUREMENT NOT USED IN STAGE-DISCHARGE CALIBRATION DUE TO ICING CONDITIONS.

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1 (1600 ft. Dwnstrm fm Datapod)
Date: 15-Apr-89 (Note: Includes inflow from Wishbone Creek)

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0	0.00	0.0	0.0
1	2.0	0.5	7	20	0.35	0.4	0.4
2	4.0	0.7	14	20	0.70	1.0	1.3
3	6.0	1.0	34	20	1.70	3.4	4.7
4	8.0	1.2	45	20	2.25	5.4	10.1
5	10.0	1.3	59	20	2.95	7.7	17.8
6	12.0	1.8	39	20	1.95	7.0	24.8
7	14.0	1.6	15	20	0.75	2.4	27.2
8	16.0	1.7	28	20	1.40	4.8	32.0
9	18.0	1.4	11	20	0.55	1.5	33.5
10	20.0	1.2	7	20	0.35	0.7	34.3
11	21.5	0.5	0	0	0.00	0.0	34.3

STAFF GAGE READING (FT): 0.75

NOTE: MEASUREMENT NOT USED IN STAGE-DISCHARGE CALCULATION DUE TO ICING CONDITIONS.

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 1
Date: 09-May-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0.0	0.00	0.0
1	2.0	0.20	0.1	0.04	0.0
2	4.0	0.50	0.4	0.40	0.4
3	6.0	0.70	0.9	1.26	1.7
4	8.0	0.70	0.9	1.26	3.0
5	10.0	1.00	1.4	2.80	5.8
6	12.0	0.90	1.1	1.98	7.7
7	14.0	1.40	2.4	6.72	14.5
8	16.0	1.30	2.2	5.72	20.2
9	18.0	1.20	1.5	3.60	23.8
10	20.0	1.00	0.8	1.60	25.4
11	22.0	0.95	0.5	0.95	26.3
12	24.0	0.95	0.8	1.52	27.9
13	26.0	1.00	1.3	2.60	30.5
14	28.0	0.80	0.4	0.64	31.1
15	30.0	0.85	0.3	0.51	31.6
16	32.0	0.75	0.6	0.90	32.5
17	34.0	0.60	0.3	0.36	32.9
18	36.0	0.30	0.0	0.00	32.9

STAFF GAGE READING (FT): 1.21

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck Sta 1 (@ Footbridge)
Date: 24-Jun-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0.0	0.00	0.0
1	3.0	0.3	0.0	0.00	0.0
2	5.0	0.5	0.0	0.00	0.0
3	7.0	0.9	0.0	0.00	0.0
4	9.0	1.3	0.8	2.08	2.1
5	11.0	2.4	0.9	4.32	6.4
6	13.0	3.1	4.9	30.38	36.8
7	15.0	3.1	6.1	37.82	74.6
8	17.0	4.1	7.8	63.96	138.6
9	19.0	4.8	8.0	76.80	215.4
10	21.0	4.6	9.3	85.56	300.9
11	23.0	4.0	8.6	68.80	369.7
12	25.0	3.0	5.8	34.80	404.5
13	27.0	2.7	3.8	20.52	425.0
14	29.0	1.6	3.9	12.48	437.5
15	31.0	1.4	2.5	7.00	444.5
16	33.0	1.0	3.0	6.00	450.5
17	35.0	1.6	2.9	9.28	459.8
18	37.0	1.9	2.2	8.36	468.2
19	39.0	1.2	0.9	3.78	471.9
20	44.0	0.4	0.0	0.00	471.9

STAFF GAGE READING (FT): 2.15

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Premier Creek: Sta 2 (400 ft. Upstrm fm Moose Ck.)
Date: 04-Apr-89

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0	0.0	0.00	0.0	0.0
1	1.0	0.25	15	24.1	0.62	0.2	0.2
2	2.0	0.70	50	40.0	1.25	0.9	1.0
3	3.0	0.90	50	24.7	2.02	1.8	2.9
4	4.0	1.10	50	22.6	2.21	2.4	5.3
5	5.0	1.00	40	40.5	0.99	1.0	6.3
6	6.0	0.75	20	32.7	0.61	0.5	6.7
7	7.0	0.50	50	35.4	1.41	0.5	7.3
8	7.5	0.10	0	0.0	0.00	0.0	7.3

Staff Gage Reading (ft.): 0.6

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Premier Creek, Sta. 2 - 2nd Seepage Anal.
Date: 22-Apr-89

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0	0.00	0.0	0.0
1	1.0	0.50	0	0	0.00	0.0	0.0
2	2.0	0.85	20	28.5	0.70	0.6	0.6
3	3.0	1.10	30	26.0	1.15	1.3	1.9
4	4.0	1.15	60	29.4	2.04	2.3	4.2
5	5.0	1.00	40	21.8	1.83	1.8	6.0
6	6.0	0.80	40	24.4	1.64	1.3	7.4
7	7.0	0.40	25	25.2	0.99	0.4	7.8
8	8.0	0.00	0	0	0.00	0.0	7.8

Staff Gage Reading (ft): 0.62

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location:Premier Creek, Station 2 (200ft. fm confluence)
Date: 16-MAY-89

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0	0	0.00	0.0	0.0
1	1.0	0.40	40	22.9	1.75	0.7	0.7
2	2.0	0.55	50	24.1	2.07	1.1	1.8
3	3.0	0.65	50	21.9	2.28	1.5	3.3
4	4.0	0.65	40	20.7	1.93	1.3	4.6
5	5.0	0.65	40	22.3	1.79	1.2	5.7
6	6.0	0.70	50	27.1	1.85	1.3	7.0
7	7.0	0.70	40	22.7	1.76	1.2	8.3
8	8.0	0.50	40	24.2	1.65	0.8	9.1
9	9.0	0.20	20	22.5	0.89	0.2	9.3
10	10.0	0.00	0	0	0.00	0.0	9.3

Staff Gage Reading (ft.): 0.65

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location:Premier Creek, Station 2 (~200ft. fm confluence)
Date: 19-JUN-89

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0.0	0.00	0.0	0.0
1	5.0	0.0	0	0.0	0.00	0.0	0.0
2	6.0	0.7	60	45.4	1.32	0.9	0.9
3	7.0	0.9	27	22.0	1.23	1.1	2.0
4	8.0	1.1	70	101.1	0.69	0.8	2.8
5	9.0	1.1	50	27.5	1.82	2.0	4.8
6	10.0	0.8	60	40.7	1.47	1.1	5.9
7	11.0	0.4	40	40.8	0.98	0.3	6.2
8	11.7	0.2	15	25.4	0.59	0.0	6.3

Staff Gage Reading (ft.): 0.6

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 5
Date: 20-AUG-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	2.0	0.0	0.0	0.00	0.0
1	4.0	0.2	0.0	0.00	0.0
2	6.0	1.0	0.0	0.00	0.0
3	8.0	1.0	0.0	0.00	0.0
4	10.0	1.1	0.1	0.22	0.2
5	12.0	1.1	0.1	0.22	0.4
6	14.0	1.1	0.1	0.22	0.7
7	16.0	1.3	0.1	0.26	0.9
8	18.0	1.3	0.1	0.26	1.2
9	20.0	1.3	0.2	0.52	1.7
10	22.0	1.3	0.1	0.26	2.0
11	24.0	1.4	0.8	2.24	4.2
12	26.0	1.5	1.6	4.80	9.0
13	28.0	1.7	2.3	7.82	16.8
14	30.0	1.5	3.8	11.40	28.2
15	32.0	1.5	2.9	8.70	36.9
16	34.0	1.8	4.7	16.92	53.8
17	36.0	1.3	3.3	8.58	62.4
18	38.0	1.6	1.9	6.08	68.5
19	40.0	1.5	2.8	8.40	76.9
20	42.0	1.6	4.0	12.80	89.7
21	44.0	1.1	3.3	7.26	97.0
22	46.0	1.0	2.0	4.00	101.0
23	48.0	1.0	3.1	6.20	107.2
24	50.0	1.1	2.3	5.06	112.2
25	52.0	1.4	2.8	7.84	120.1
26	54.0	1.4	2.9	8.12	128.2
27	56.0	1.5	2.5	7.50	135.7
28	58.0	1.4	2.6	7.28	143.0
29	60.0	1.0	2.0	4.00	147.0
30	62.0	1.0	2.0	4.00	151.0
31	64.0	0.6	0.5	0.60	151.6
32	66.0	0.1	0.0	0.00	151.6

Staff Gage Reading (ft): 1.88 + 0.65adj = 2.53

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 5
Date: 30-AUG-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	4.0	0.35	0.0	0.00	0.0
1	10.0	1.28	0.1	1.02	1.0
2	20.0	1.60	0.1	0.96	2.0
3	22.0	1.45	0.1	0.29	2.3
4	24.0	1.35	0.5	1.35	3.6
5	26.0	1.6	2.0	6.40	10.0
6	28.0	1.9	2.5	9.50	19.5
7	30.0	1.8	2.1	7.56	27.1
8	32.0	1.7	4.2	14.28	41.4
9	34.0	1.2	3.3	7.92	49.3
10	36.0	1.5	2.8	8.40	57.7
11	38.0	1.3	4.1	10.66	68.3
12	40.0	1.7	3.4	11.56	79.9
13	42.0	1.6	2.8	8.96	88.9
14	44.0	1.6	4.2	13.44	102.3
15	46.0	1.5	2.8	8.40	110.7
16	48.0	1.6	3.9	12.48	123.2
17	50.0	1.2	4.7	11.28	134.5
18	52.0	1.6	2.9	9.28	143.7
19	54.0	1.7	3.4	11.56	155.3
20	56.0	1.6	3.6	11.52	166.8
21	58.0	1.7	2.5	8.50	175.3
22	60.0	1.3	2.6	6.76	182.1
23	62.0	0.9	0.9	1.62	183.7
24	64.0	0.4	0.0	0.00	183.7

Staff Gage Reading (ft): 2.01 + 0.65adj = 2.66

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta 5 (~95 ft Dwnstrm fm Datapod)
Date: 16-Sep-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	2.4	0.0	0.0	0.00	0.0
1	4.4	0.5	0.6	0.60	0.6
2	6.4	0.7	1.8	2.52	3.1
3	8.4	1.0	1.6	3.20	6.3
4	10.4	1.2	1.9	4.56	10.9
5	12.4	1.6	2.3	7.36	18.2
6	14.4	1.4	2.9	8.12	26.4
7	16.4	1.7	3.1	10.54	36.9
8	18.4	1.7	2.8	9.52	46.4
9	20.4	1.5	2.0	6.00	52.4
10	22.4	1.5	3.1	9.30	61.7
11	24.4	1.5	3.0	9.00	70.7
12	26.4	1.8	3.0	10.80	81.5
13	28.4	1.2	0.6	1.44	83.0
14	30.4	1.2	2.1	5.04	88.0
15	32.4	0.7	0.7	1.54	89.5
16	36.7	0.0	0.0	0.00	89.5

STAFF GAGE READING (FT): 2.29

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 5 (~10 ft Upstrm fm Datapod)
Date: 23-Sep-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	5.0	0.0	0.0	0.00	0.0
1	7.0	0.5	0.0	0.00	0.0
2	9.0	1.1	0.0	0.00	0.0
3	11.0	1.2	0.0	0.00	0.0
4	13.0	1.2	0.0	0.00	0.0
5	15.0	1.0	0.0	0.00	0.0
6	17.0	1.0	0.0	0.00	0.0
7	19.0	1.5	0.1	0.30	0.3
8	21.0	1.6	0.2	0.64	0.9
9	23.0	1.6	0.2	0.64	1.6
10	25.0	1.6	0.2	0.64	2.2
11	27.0	1.4	0.2	0.56	2.8
12	29.0	1.6	2.0	6.40	9.2
13	31.0	1.8	2.6	9.36	18.5
14	33.0	2.2	3.0	13.20	31.7
15	35.0	1.8	3.2	11.52	43.3
16	37.0	1.4	4.4	12.32	55.6
17	39.0	1.4	5.2	14.56	70.1
18	41.0	1.4	2.9	8.12	78.3
19	43.0	1.8	1.8	6.48	84.7
20	45.0	2.0	2.5	10.00	94.7
21	47.0	1.6	2.3	7.36	102.1
22	49.0	1.9	4.0	15.20	117.3
23	51.0	1.5	3.8	11.40	128.7
24	53.0	1.4	3.1	8.68	137.4
25	55.0	1.5	3.2	9.60	147.0
26	57.0	1.6	2.9	9.28	156.3
27	59.0	1.5	3.2	9.60	165.9
28	61.0	1.5	2.8	8.40	174.3
29	63.0	1.5	3.2	9.60	183.9
30	65.0	0.9	0.8	1.98	185.8
31	68.5	0.0	0.0	0.00	185.8

STAFF GAGE READING (FT): 2.66

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta 5 (~95 ft Dwnstrm fm Datapod)
Date: 30-Sep-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	3.0	0.0	0.0	0.00	0.0
1	5.0	0.8	1.0	1.60	1.6
2	7.0	1.0	2.7	5.40	7.0
3	9.0	1.4	1.3	3.64	10.6
4	11.0	1.5	0.7	2.10	12.7
5	13.0	1.7	2.0	6.80	19.5
6	15.0	1.5	3.0	9.00	28.5
7	17.0	1.7	3.2	10.88	39.4
8	19.0	1.3	3.5	9.10	48.5
9	21.0	1.3	4.8	12.48	61.0
10	23.0	1.3	3.7	9.62	70.6
11	25.0	1.7	2.7	9.18	79.8
12	27.0	1.7	4.3	14.62	94.4
13	29.0	1.6	2.0	6.40	100.8
14	31.0	1.4	2.3	6.44	107.3
15	33.0	1.0	1.2	2.40	109.7
16	35.0	0.4	0.4	0.28	109.9
17	36.5	0.0	0.0	0.00	109.9

STAFF GAGE READING (FT): 2.45

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta 5 (~95 ft Dwnstrm fm Datapod)
Date: 07-Oct-88 (Note: 4 inches new snow, no ice noted)

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	4.5	0.0	0.0	0.00	0.0
1	6.5	0.6	0.1	0.12	0.1
2	8.5	1.0	0.8	1.60	1.7
3	10.5	1.1	2.5	5.50	7.2
4	12.5	1.3	2.2	5.72	12.9
5	14.5	1.6	0.6	1.92	14.9
6	16.5	2.0	4.4	17.60	32.5
7	18.5	1.7	4.1	13.94	46.4
8	20.5	1.7	4.2	14.28	60.7
9	22.5	1.5	3.5	10.50	71.2
10	24.5	1.6	4.4	14.08	85.3
11	26.5	1.6	2.8	8.96	94.2
12	28.5	1.9	3.9	14.82	109.0
13	30.5	1.8	3.2	11.52	120.6
14	32.5	1.5	1.1	3.30	123.9
15	34.5	1.1	3.3	7.26	131.1
16	36.5	0.6	1.5	1.80	132.9
17	38.5	0.4	0.2	0.17	133.1
18	40.8	0.0	0.0	0.00	133.1

STAFF GAGE READING (FT): 2.56

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta 5 (~50 ft Dwnstrm fm Datapod)
Date: 04-NOV-88 (Note: Major Ice Buildup in Channel)

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0	0.0	0.00	0.0
1	1.0	1.3	0.1	0.20	0.2
2	3.0	1.8	1.1	3.96	4.2
3	5.0	1.8	0.9	3.24	7.4
4	7.0	2.0	0.4	1.60	9.0
5	9.0	2.0	1.3	5.20	14.2
6	11.0	2.1	1.3	5.46	19.7
7	13.0	1.5	1.2	3.60	23.3
8	15.0	1.8	1.7	6.12	29.4
9	17.0	1.8	0.2	0.72	30.1
10	19.0	2.1	0.7	2.94	33.0
11	21.0	2.1	0.1	0.42	33.5
12	23.0	1.9	0.1	0.19	33.6

STAFF GAGE READING (FT): 3.34
NOTE: MEASUREMENT NOT USED IN STAGE-DISCHARGE CALIBRATION
DUE TO ICING CONDITIONS.

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 5 (0.5 mi Dwnstrm fm Datapod)
Date: 22-Mar-89 (Note: Ice & snow on banks; clear section)

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0	0	0.00	0.0	0.0
1	4.4	0.65	24	60	0.40	0.9	0.9
2	7.0	0.70	52	60	0.87	1.4	2.3
3	9.0	0.80	35	60	0.58	0.9	3.2
4	11.0	0.80	74	60	1.23	2.0	5.2
5	13.0	0.90	84	60	1.40	2.5	7.7
6	15.0	0.70	63	60	1.05	1.5	9.2
7	17.0	0.80	91	60	1.52	2.4	11.6
8	19.0	0.90	24	60	0.40	0.7	12.3
9	21.0	1.00	40	60	0.67	1.3	13.7
10	23.0	0.90	66	60	1.10	2.0	15.7
11	25.0	0.60	29	60	0.48	0.4	16.1
12	26.0	0.50	0	0	0.00	0.0	16.1
13	27.0	0.00	0	0	0.00	0.0	16.1

STAFF GAGE READING (FT): NA

NOTE: MEASUREMENT NOT USED IN STAGE-DISCHARGE CALIBRATION DUE TO ICING CONDITIONS

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. 5 (0.5 mi Dwnstrm fm Datapod)_
Date: 15-Apr-89 (Note: Section influenced by Ice Dam)

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.3	0	0	0.00	0.0	0.0
1	2.0	0.3	15	15	1.00	0.6	0.6
2	4.0	0.4	3	15	0.20	0.2	0.8
3	6.0	0.7	10	15	0.67	0.9	1.7
4	8.0	0.7	3	15	0.20	0.3	2.0
5	10.0	0.8	50	20	2.50	4.0	6.0
6	12.0	0.8	72	20	3.60	5.8	11.7
7	14.0	0.9	55	20	2.75	5.0	16.7
8	16.0	1.3	73	20	3.65	9.5	26.2
9	18.0	1.3	73	20	3.65	10.7	36.8
10	20.5	1.2	20	20	1.00	2.4	39.2
11	22.0	1.1	33	20	1.65	3.2	42.4
12	24.0	0.8	14	20	0.70	1.1	43.5
13	26.0	0.4	12	20	0.60	0.5	44.0
14	28.0	0.0	0	0	0.00	0.0	44.0

STAFF GAGE READING (FT): 2.3

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta_5
Date: 09-May-89 14:50

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0.0	0.00	0.0
1	2.0	0.55	0.1	0.11	0.1
2	4.0	0.80	0.6	0.96	1.1
3	6.0	1.15	1.9	4.37	5.4
4	8.0	1.30	1.3	3.38	8.8
5	10.0	1.50	3.7	11.10	19.9
6	12.0	0.70	2.6	3.64	23.6
7	14.0	1.60	2.5	8.00	31.6
8	16.0	1.30	2.5	6.50	38.1
9	18.0	0.80	2.6	4.16	42.2
10	20.0	1.30	3.5	9.10	51.3
11	22.0	1.30	2.9	7.54	58.9
12	24.0	1.50	2.8	8.40	67.3
13	26.0	1.00	0.2	0.40	67.7
14	28.0	1.00	0.1	0.20	67.9
15	30.0	0.60	1.8	2.16	70.0
16	32.0	0.50	0.0	0.00	70.0
17	34.0	0.30	0.0	0.00	70.0
18	35.0	0.00	0.0	0.00	70.0

STAFF GAGE READING (FT): 2.71

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck Sta. 5 (~20 ft upstrm of datapod)
Date: 02-Jun-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	7.0	0.00	0.0	0.00	0.0
1	9.0	0.30	0.0	0.00	0.0
2	11.0	0.75	0.0	0.00	0.0
3	13.0	1.25	0.0	0.00	0.0
4	17.0	1.25	0.0	0.00	0.0
5	19.0	1.15	0.0	0.00	0.0
6	21.0	1.40	0.0	0.00	0.0
7	23.0	1.50	0.0	0.00	0.0
8	25.0	1.35	0.0	0.00	0.0
9	27.0	1.60	0.0	0.00	0.0
10	29.0	1.50	0.0	0.00	0.0
11	31.0	1.60	0.3	0.96	1.0
12	33.0	1.90	2.2	8.36	9.3
13	35.0	1.90	2.6	9.88	19.2
14	37.0	1.80	1.8	6.48	25.7
15	39.0	1.60	4.2	13.44	39.1
16	41.0	1.50	3.0	9.00	48.1
17	43.0	1.40	3.7	10.36	58.5
18	45.0	1.60	2.4	7.68	66.2
19	47.0	1.90	2.5	9.50	75.7
20	49.0	1.80	3.8	13.68	89.3
21	51.0	1.50	2.9	8.70	98.0
22	53.0	1.60	3.5	11.20	109.2
23	55.0	1.60	2.9	9.28	118.5
24	57.0	1.40	1.9	5.32	123.8
25	59.0	1.60	2.5	8.00	131.8
26	61.0	1.70	1.8	6.12	138.0
27	63.0	1.70	2.5	8.50	146.5
28	65.0	1.30	2.5	6.50	153.0
29	67.0	1.00	2.0	4.00	157.0
30	69.0	0.40	1.7	1.36	158.3
31	71.0	0.20	1.0	0.56	158.9
32	74.6	0.00	0.0	0.00	158.9

STAFF GAGE READING (FT): 3.43

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 6 (~100 ft Upstrm fm Buffalo Ck)
Date: 22-OCT-88

U.S.G.S. Method for Computation of Discharge Using a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	6.0	0.0	0.0	0.00	0.0
1	8.0	0.7	1.8	2.52	2.5
2	10.0	0.5	0.8	0.80	3.3
3	12.0	0.0	0.0	0.00	3.3
4	14.0	0.0	0.0	0.00	3.3
5	16.0	0.7	1.8	2.52	5.8
6	18.0	0.9	0.2	0.36	6.2
7	20.0	0.7	0.5	0.70	6.9
8	22.0	0.5	0.3	0.30	7.2
9	24.0	0.8	2.9	4.64	11.8
10	26.0	1.0	0.5	1.00	12.8
11	28.0	1.1	2.5	5.50	18.3
12	30.0	1.2	0.9	2.16	20.5
13	32.0	1.1	3.1	6.82	27.3
14	34.0	1.0	0.9	1.80	29.1
15	36.0	1.5	3.6	10.80	39.9
16	38.0	1.0	4.3	8.60	48.5
17	40.0	1.0	4.0	8.00	56.5
18	42.0	1.3	2.9	7.54	64.1
19	44.0	1.1	1.9	4.18	68.2
20	46.0	1.2	0.3	0.86	69.1
21	48.8	0	0	0.00	69.1

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 6 (~100 ft Upstrm fm Buffalo Ck)
Date: 16-MAY-89

U.S.G.S. Method for Computation of Discharge Using a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	4.0	0.0	0.0	0.00	0.0
1	5.0	0.9	1.6	2.16	2.2
2	7.0	1.0	0.8	1.60	3.8
3	9.0	1.2	2.1	5.04	8.8
4	11.0	1.4	3.4	9.52	18.3
5	13.0	1.5	1.7	5.10	23.4
6	15.0	1.5	1.3	3.90	27.3
7	17.0	1.7	1.4	4.76	32.1
8	19.0	1.5	2.3	6.90	39.0
9	21.0	1.9	2.2	8.36	47.3
10	23.0	1.7	1.2	4.08	51.4
11	25.0	1.4	1.0	2.80	54.2
12	27.0	1.1	0.8	1.76	56.0
13	29.0	0.6	0.3	0.45	56.4
14	32.0	0.0	0.0	0.00	56.4

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 7 (500 Dwnstrm fm Sta)
Date: 22-OCT-88

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	7.0	0.0	0.0	0.00	0.0
1	9.0	0.6	0.3	0.36	0.4
2	11.0	1.2	3.3	7.92	8.3
3	13.0	1.2	3.3	7.92	16.2
4	15.0	1.1	3.6	7.92	24.1
5	17.0	1.2	1.8	4.32	28.4
6	19.0	1.2	3.5	8.40	36.8
7	21.0	1.2	3.6	8.64	45.5
8	23.0	1.2	2.7	6.48	52.0
9	25.0	1.0	2.5	5.00	57.0
10	27.0	1.1	0.3	0.66	57.6
11	29.0	0.9	1.7	3.06	60.7
12	31.0	0.8	1.3	2.08	62.8
13	33.0	0.8	0.4	0.64	63.4
14	35.0	0.4	2.0	1.60	65.0
15	37.0	0.5	0.1	0.10	65.1
16	39.0	0.0	0.0	0.00	65.1

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek, Sta. III (A') - 2nd Seepage Anal
Date: 22-Apr-89 (~200ft dwnstrm Sta 7)

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.5	0.0	0.00	0.0
1	2.0	0.8	0.1	0.16	0.2
2	4.0	0.9	0.8	1.44	1.6
3	6.0	1.2	1.4	3.36	5.0
4	8.0	0.9	0.8	1.44	6.4
5	10.0	1.0	1.4	2.80	9.2
6	12.0	1.0	1.6	3.20	12.4
7	14.0	1.1	3.5	7.70	20.1
8	16.0	1.0	2.8	5.60	25.7
9	18.0	0.9	2.2	3.96	29.7
10	20.0	0.7	1.6	2.24	31.9
11	22.0	0.9	0.3	0.54	32.4
12	24.0	1.3	1.3	3.38	35.8
13	26.0	1.7	2.1	7.14	43.0
14	28.0	1.3	1.3	3.38	46.3
15	30.0	0.4	0.2	0.16	46.5
16	32.0	0.5	0.7	0.58	47.1
17	33.7	0.0	0.0	0.00	47.1

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Sta 7 (~500ft Dwnstrm fm Station)
Date: 16-MAY-89

U.S.G.S. Method for Computation of Discharge Using a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0.0	0.00	0.0
1	3.0	1.0	0.0	0.00	0.0
2	5.0	1.5	3.5	10.50	10.5
3	7.0	1.7	2.6	8.84	19.3
4	9.0	1.7	2.7	9.18	28.5
5	11.0	1.6	1.5	4.80	33.3
6	13.0	1.5	2.3	6.90	40.2
7	15.0	1.5	1.6	4.80	45.0
8	17.0	1.4	1.8	5.04	50.1
9	19.0	1.6	2.2	7.04	57.1
10	21.0	1.7	2.6	8.84	65.9
11	23.0	1.4	4.1	11.48	77.4
12	25.0	1.1	1.3	2.86	80.3
13	27.0	0.6	0.4	0.48	80.8
14	29.0	0.0	0.0	0.00	80.8

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek @ Site Bridge
Date: 24-APR-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0.0	0.00	0.0
1	0.5	1.12	0.2	0.17	0.2
2	1.5	1.12	0.6	1.01	1.2
3	3.5	0.88	0.5	0.88	2.1
4	5.5	0.40	0.8	0.64	2.7
5	7.5	0.94	1.0	1.88	4.6
6	9.5	1.10	1.1	2.42	7.0
7	11.5	0.85	1.3	2.21	9.2
8	13.5	1.14	1.3	2.96	12.2
9	15.5	1.50	0.7	2.10	14.3
10	17.5	0.55	3.3	3.63	17.9
11	19.5	1.60	3.2	10.24	28.1
12	21.5	0.50	2.2	2.20	30.3
13	23.5	0.60	1.6	1.92	32.3
14	25.5	1.25	2.6	6.50	38.8
15	27.5	1.32	1.6	4.22	43.0
16	29.5	1.45	0.3	0.87	43.9
17	31.5	1.05	0.8	1.68	45.5
18	33.5	0.96	0.9	1.73	47.3
19	35.5	0.65	0.1	0.08	47.3
20	36.0	0.00	0.0	0.00	47.3

Staff Gage Reading (ft): 1.48

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek @ Site Bridge
Date: 04-MAY-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0.0	0.00	0.0
1	1.0	0.80	0.0	0.00	0.0
2	3.0	1.40	0.0	0.00	0.0
3	5.0	1.10	1.2	2.64	2.6
4	7.0	1.00	1.5	3.00	5.6
5	9.0	1.20	0.9	2.16	7.8
6	11.0	1.35	0.9	2.43	10.2
7	13.0	1.00	2.2	4.40	14.6
8	15.0	1.55	1.9	5.89	20.5
9	17.0	1.80	1.7	6.12	26.6
10	19.0	1.40	3.2	8.96	35.6
11	21.0	1.60	3.0	9.60	45.2
12	23.0	1.40	2.6	7.28	52.5
13	25.0	0.70	2.8	3.92	56.4
14	27.0	1.40	3.4	9.52	65.9
15	29.0	1.40	3.1	8.68	74.6
16	31.0	1.60	0.6	1.92	76.5
17	33.0	1.60	0.8	2.56	79.1
18	35.0	0.45	1.2	1.08	80.2
19	37.0	1.00	0.5	0.90	81.1
20	38.6	0.45	0.0	0.00	81.1

Staff Gage Reading (ft): 1.65

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek @ Site Bridge
Date: 02-JUN-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0.0	0.00	0.0
1	2.0	0.9	0.0	0.00	0.0
2	4.0	1.6	0.0	0.00	0.0
3	6.0	1.6	1.5	4.80	4.8
4	8.0	1.5	3.0	9.00	13.8
5	10.0	1.6	1.8	5.76	19.6
6	12.0	1.6	1.2	3.84	23.4
7	14.0	1.7	3.4	11.56	35.0
8	16.0	1.7	3.5	11.90	46.9
9	18.0	2.2	2.5	11.00	57.9
10	20.0	2.1	3.4	14.28	72.1
11	22.0	1.2	5.7	13.68	85.8
12	24.0	2.0	4.8	19.20	105.0
13	26.0	1.6	4.6	14.72	119.7
14	28.0	1.6	3.7	11.84	131.6
15	30.0	1.9	4.1	15.58	147.2
16	32.0	1.8	2.7	9.72	156.9
17	34.0	2.2	2.8	12.32	169.2
18	36.0	2.0	3.0	12.00	181.2
19	38.0	1.6	0.6	1.92	183.1
20	40.0	1.1	0.2	0.44	183.6
21	42.0	0.6	0.0	0.00	183.6
22	42.5	0.6	0.0	0.00	183.6

Staff Gage Reading (ft): 2.0

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek @ Site Bridge
Date: 24-JUN-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0.0	0.00	0.0
1	2.0	1.6	0.0	0.00	0.0
2	4.0	2.0	1.0	4.00	4.0
3	6.0	2.6	5.4	28.08	32.1
4	8.0	2.2	3.2	14.08	46.2
5	10.0	2.0	5.6	22.40	68.6
6	12.0	2.3	4.4	20.24	88.8
7	14.0	1.6	5.4	17.28	106.1
8	16.0	2.5	7.0	35.00	141.1
9	18.0	2.7	7.7	41.58	182.7
10	20.0	2.8	6.8	38.08	220.7
11	22.0	2.8	6.2	34.72	255.5
12	24.0	2.8	6.8	38.08	293.5
13	26.0	2.6	7.6	39.52	333.1
14	28.0	2.9	6.0	34.80	367.9
15	30.0	3.0	7.6	45.60	413.5
16	32.0	2.8	7.5	42.00	455.5
17	34.0	3.0	6.4	38.40	493.9
18	36.0	2.6	5.3	27.56	521.4
19	38.0	2.5	3.5	17.50	538.9
20	40.0	2.1	2.8	11.76	550.7
21	42.0	1.2	0.0	0.00	550.7
22	42.5	1.1	0.0	0.00	550.7

Staff Gage Reading (ft): 2.8

NOTE: MEASUREMENT USED TO HELP CALIBRATE SPRING '89 RATING CURVE AT STATION 5, MOOSE CR. (DOWNSTREAM STATION)

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Station A -
Date: 11-NOV-88 First Seepage Analysis

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	10.0	1.0	1.3	1.30	1.3
1	12.0	1.1	1.1	2.42	3.7
2	14.0	1.1	3.0	6.60	10.3
3	16.0	1.3	3.7	9.62	19.9
4	18.0	1.5	4.5	13.50	33.4
5	20.0	1.8	4.3	15.48	48.9
6	22.0	1.3	1.8	4.68	53.6
7	24.0	1.3	0.6	1.83	55.4
8	26.7	0.6	0.3	0.24	55.7

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Ck, Station B -
Date: 11-NOV-88 First Seepage Analysis

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	6.0	1.2	0.0	0.00	0.0
1	8.0	1.3	1.4	3.64	3.6
2	10.0	1.5	1.6	4.80	8.4
3	12.0	1.8	2.9	10.44	18.9
4	14.0	1.8	2.2	7.92	26.8
5	16.0	2.0	3.0	12.00	38.8
6	18.0	1.7	5.0	17.00	55.8
7	20.0	1.7	0.3	1.12	56.9
8	22.4	1.6	0.0	0.00	56.9

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location:Tributary B - First Seepage Analysis
Date: 11-NOV-88

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0	0.00	0.0	0.0
1	1.0	0.4	15	28.3	0.53	0.2	0.2
2	2.0	0.6	15	24.7	0.61	0.4	0.6
3	3.0	0.8	20	18.3	1.09	0.9	1.5
4	4.0	1.0	30	25.9	1.16	1.2	2.6
5	5.0	0.6	30	25.3	1.19	0.7	3.3
6	6.0	0.8	20	16.4	1.22	1.0	4.3
7	7.0	0.0	0	0	0.00	0.0	4.3

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station LocationMoose Creek Sta. I - 2nd Seepage Anal.
Date:22-Apr-89 Upstream of Tributaries C & D

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter
AND a Pygmy Meter (in combination)

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0			0.0	0.00	0.0
1	2.0	0.2			1.0	0.30	0.3
2	4.0	0.9			1.2	2.16	2.5
3	6.0	1.2			2.6	6.24	8.7
4	8.0	1.2			3.7	8.88	17.6
5	10.0	1.2			1.6	3.84	21.4
6	12.0	1.0			2.2	4.40	25.8
7	14.0	1.0			0.3	0.60	26.4
8	16.0	0.6			2.2	2.64	29.1
9	18.0	0.6			1.9	2.28	31.3
10	20.0	0.8			1.7	2.72	34.1
11	22.0	0.4			1.3	1.04	35.1
12	24.0	0.2	25	23.4	1.1	0.43	35.5
13	26.0	0.4	15	31.9	0.5	0.38	35.9
14	28.0	0.4	20	22.4	0.9	0.71	36.6
15	30.0	0.2	10	30.6	0.3	0.12	36.7
16	31.6	0.0	0	0.0	0.0	0.00	36.7

Staff Gage Reading (ft) NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek Sta. II - 2nd Seepage Anal.
Date: 22-Apr-89 10 ft. Upstream fm Premier Ck.

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0.0	0.00	0.0
1	2.0	0.7	0.3	0.42	0.4
2	4.0	0.8	1.6	2.56	3.0
3	6.0	0.9	1.2	2.16	5.1
4	8.0	1.0	2.4	4.80	9.9
5	10.0	1.1	2.7	5.94	15.9
6	12.0	1.4	2.4	6.72	22.6
7	14.0	1.4	2.2	6.16	28.8
8	16.0	0.6	1.8	2.16	30.9
9	18.0	1.5	2.6	7.80	38.7
10	20.0	1.2	0.8	1.92	40.6
11	22.0	0.6	0.8	0.96	41.6
12	24.0	0.0	0.0	0.00	41.6

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek, Sta. III (A') - 2nd Seepage Anal
Date: 22-Apr-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.5	0.0	0.00	0.0
1	2.0	0.8	0.1	0.16	0.2
2	4.0	0.9	0.8	1.44	1.6
3	6.0	1.2	1.4	3.36	5.0
4	8.0	0.9	0.8	1.44	6.4
5	10.0	1.0	1.4	2.80	9.2
6	12.0	1.0	1.6	3.20	12.4
7	14.0	1.1	3.5	7.70	20.1
8	16.0	1.0	2.8	5.60	25.7
9	18.0	0.9	2.2	3.96	29.7
10	20.0	0.7	1.6	2.24	31.9
11	22.0	0.9	0.3	0.54	32.4
12	24.0	1.3	1.3	3.38	35.8
13	26.0	1.7	2.1	7.14	43.0
14	28.0	1.3	1.3	3.38	46.3
15	30.0	0.4	0.2	0.16	46.5
16	32.0	0.5	0.7	0.58	47.1
17	33.7	0.0	0.0	0.00	47.1

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Moose Creek, Sta. IV (B') - 2nd Seepage Anal.
Date: 22-Apr-89

U.S.G.S. Method for Computation of Discharge Using
a Price Type A or AA Current Meter

Sta	Cum. Dist. (ft)	Depth (ft)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.5	0.5	0.45	0.5
1	3.6	0.7	1.8	3.53	4.0
2	5.6	0.8	2.1	3.36	7.3
3	7.6	0.8	1.5	2.40	9.7
4	9.6	1.0	0.9	1.80	11.5
5	11.6	1.0	2.0	4.00	15.5
6	13.6	0.8	2.1	3.36	18.9
7	15.6	0.9	2.8	6.30	25.2
8	18.6	0.9	1.0	1.80	27.0
9	19.6	1.2	1.2	2.16	29.2
10	21.6	0.8	0.7	1.12	30.3
11	23.6	1.0	1.3	2.60	32.9
12	25.6	0.5	1.1	1.10	34.0
13	27.6	0.5	0.5	0.50	34.5
14	29.6	0.7	1.2	1.55	36.0
15	31.3	0.0	0.0	0.00	36.0

Staff Gage Reading (ft): NA

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Buffalo Creek, Sta. 4 - 2nd Seepage Anal.
Date: 22-Apr-89

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0	0.00	0.0	0.0
1	0.6	0.9	3	17.2	0.17	0.1	0.1
2	1.3	0.9	9	37.8	0.24	0.1	0.2
3	1.9	0.9	20	16.7	1.20	0.7	0.9
4	2.5	0.0	0	0	0.00	0.0	0.9

Staff Gage Reading (ft): NA Icing conditions in Flume and Stilling Basin

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Premier Creek, Sta. 2 - 2nd Seepage Anal.
Date: 22-Apr-89

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.0	0	0	0.00	0.0	0.0
1	1.0	0.50	0	0	0.00	0.0	0.0
2	2.0	0.85	20	28.5	0.70	0.6	0.6
3	3.0	1.10	30	26.0	1.15	1.3	1.9
4	4.0	1.15	60	29.4	2.04	2.3	4.2
5	5.0	1.00	40	21.8	1.83	1.8	6.0
6	6.0	0.80	40	24.4	1.64	1.3	7.4
7	7.0	0.40	25	25.2	0.99	0.4	7.8
8	8.0	0.00	0	0	0.00	0.0	7.8

Staff Gage Reading (ft): 0.62

883-2146.000 John S. Velimesis
McKinley /Hydrology/ AK
Station Location: Tributary C, 100 ft. Upstream from Moose Ck.
Date: 22-Apr-89 - 2nd Seepage Analysis

U.S.G.S. Method for Computation of Discharge Using
a Price Pygmy Meter

Sta	Cum. Dist. (ft)	Depth (ft)	# Counts	Time (sec)	Inc. Vel. (fps)	Inc. Q (cfs)	Sum Q (cfs)
0	0.0	0.00	0	0	0.00	0.00	0.0
1	0.4	0.15	5	12.3	0.41	0.01	0.0
2	1.0	0.25	0	0	0.00	0.00	0.0
3	1.5	0.25	1	60	0.02	0.00	0.0
4	2.0	0.15	1	60	0.02	0.00	0.0
5	2.5	0.45	5	15.6	0.32	0.07	0.1
6	3.0	0.45	5	24.5	0.20	0.05	0.1
7	3.5	0.30	1	60	0.02	0.00	0.1
8	4.0	0.05	0	0	0.00	0.00	0.1
9	4.5	0.20	1	60	0.02	0.00	0.1
10	5.0	0.00	0	0	0.00	0.00	0.1

Staff Gage Reading (ft): NA

ADDENDA

ADDENDUM 1

HISTORICAL SURFACE WATER MONITORING DATA

TABLE 1
STREAM STATION INFORMATION

Stream Station ID	Stream Name	Notes
15283550	Moose Creek	USGS stream gauge near Station 1
15283700	Moose Creek	USGS stream gauge near Station 1
Station 1	Moose Creek	
Station 1-F	Moose Creek	Flow measurements only. Located at Station 1
Station 2	Premier Creek	
Station 3	Buffalo Creek	Parshall Flume with stilling well
Station 4	Buffalo Creek	Parshall Flume with stilling well
Station 5	Moose Creek	
Station 5-F	Moose Creek	Flow measurements only. Located approximately 1000 ft down stream of Station 5
Station 6	Moose Creek	
Station 7	Moose Creek	

Table 2 - Mean Stream Discharge

Station ID	Stream Name	Date Gauged	Gauge Type	Mean Discharge (cubic feet/second)
STA1	Moose Ck	8/31/1988	flow meter	142.80
		9/23/1988	flow meter	109.70
		10/21/1988	flow meter	44.50
		11/18/1988	flow meter	18.70
		12/20/1988	flow meter	12.50
		1/27/1989	flow meter	11.10
		2/24/1989	flow meter	10.00
		3/22/1989	flow meter	9.00
		4/15/1989	flow meter	34.00
		5/16/1989	flow meter	27.00
		6/19/1989	flow meter	379.40
		7/17/1989	flow meter	221.80
		7/20/1989	flow meter	222.00
		8/23/1989	flow meter	127.00
		9/27/1989	flow meter	173.00
		10/28/1989	flow meter	66.10
		12/29/1989	flow meter	16.80
		1/30/1990	flow meter	10.00
		2/27/1990	flow meter	8.30
		4/27/1990	flow meter	27.60
		6/28/1990	flow meter	224.10
		7/27/1990	flow meter	82.00
		8/30/1990	flow meter	105.60
		10/1/1990	flow meter	26.50
STA1-F	Moose Ck	11/14/2008	flow meter	27.17
STA2	Premier Ck.	6/28/1990	flow meter	9.20
		7/27/1990	flow meter	3.00
		8/30/1990	flow meter	4.40
		10/1/1990	flow meter	14.20
		10/30/1990	flow meter	5.10
STA3	Buffalo Ck.	8/30/1990	flow meter	0.30
		10/1/1990	flow meter	1.40
		10/30/1990	flow meter	0.30
	For 1991	4/11/1992	flume	0.12
	Discharge	4/12/1992	flume	0.10
	Data See	4/13/1992	flume	0.15
	Attachment 1	4/14/1992	flume	0.58
		4/15/1992	flume	0.71
		4/16/1992	flume	0.85
		4/17/1992	flume	1.41
		4/18/1992	flume	3.54
		4/19/1992	flume	4.34
		4/20/1992	flume	2.60
		4/21/1992	flume	3.17
		4/22/1992	flume	4.50
		4/23/1992	flume	5.46
		4/24/1992	flume	6.09
		4/25/1992	flume	7.24
		4/26/1992	flume	8.77

Table 2 - Mean Stream Discharge

Station ID	Stream Name	Date Gauged	Gauge Type	Mean Discharge (cubic feet/second)
STA3	Buffalo Ck.	4/27/1992	flume	10.63
		4/28/1992	flume	11.31
		4/29/1992	flume	11.54
		4/30/1992	flume	11.66
		5/1/1992	flume	11.89
		5/2/1992	flume	11.54
		5/3/1992	flume	11.42
		5/4/1992	flume	11.19
		5/5/1992	flume	10.40
		5/6/1992	flume	9.85
		5/7/1992	flume	9.63
		5/8/1992	flume	9.85
		5/9/1992	flume	11.77
		5/10/1992	flume	11.31
		5/11/1992	flume	10.63
		5/12/1992	flume	8.77
		5/13/1992	flume	8.46
		5/14/1992	flume	8.04
		5/15/1992	flume	7.74
		5/16/1992	flume	7.24
		5/17/1992	flume	7.04
		5/18/1992	flume	6.95
		5/19/1992	flume	6.56
		5/20/1992	flume	5.83
		5/21/1992	flume	5.37
		5/22/1992	flume	4.93
		5/23/1992	flume	4.67
		5/24/1992	flume	4.50
		5/25/1992	flume	4.34
		5/26/1992	flume	3.41
		5/27/1992	flume	2.54
		5/28/1992	flume	2.35
		5/29/1992	flume	2.21
		5/30/1992	flume	2.13
		5/31/1992	flume	2.16
		6/1/1992	flume	2.03
		6/2/1992	flume	2.00
		6/3/1992	flume	1.82
		6/4/1992	flume	1.65
		6/5/1992	flume	1.51
		6/6/1992	flume	1.40
		6/7/1992	flume	1.30
		6/8/1992	flume	1.21
		6/9/1992	flume	1.11
		6/10/1992	flume	1.03
		6/11/1992	flume	0.94
		6/12/1992	flume	0.86
		6/13/1992	flume	0.78
		6/14/1992	flume	0.72

Table 2 - Mean Stream Discharge

Station ID	Stream Name	Date Gauged	Gauge Type	Mean Discharge (cubic feet/second)
STA3	Buffalo Ck.	6/15/1992	flume	0.77
		6/16/1992	flume	0.83
		6/17/1992	flume	0.73
		6/18/1992	flume	0.65
		6/19/1992	flume	0.62
		6/20/1992	flume	0.58
		6/21/1992	flume	0.64
		6/22/1992	flume	0.64
		6/23/1992	flume	0.58
		6/24/1992	flume	0.64
		6/25/1992	flume	0.66
		6/26/1992	flume	0.60
		6/27/1992	flume	0.63
		6/28/1992	flume	0.62
		6/29/1992	flume	0.56
		6/30/1992	flume	0.53
		7/1/1992	flume	0.52
		7/2/1992	flume	0.49
		7/3/1992	flume	0.46
		7/4/1992	flume	0.44
		7/5/1992	flume	0.43
		7/6/1992	flume	0.42
		7/7/1992	flume	0.40
		7/8/1992	flume	0.38
		7/9/1992	flume	0.36
		7/10/1992	flume	0.35
		7/11/1992	flume	0.42
		7/12/1992	flume	0.42
		7/13/1992	flume	0.41
		7/14/1992	flume	0.40
		7/15/1992	flume	0.39
		7/16/1992	flume	0.42
		7/17/1992	flume	0.49
		7/18/1992	flume	0.55
		7/19/1992	flume	0.52
		7/20/1992	flume	0.47
		7/21/1992	flume	0.51
		7/22/1992	flume	0.48
		7/23/1992	flume	0.44
		7/24/1992	flume	0.41
		7/25/1992	flume	0.44
		7/26/1992	flume	0.44
		7/27/1992	flume	0.40
		7/28/1992	flume	0.38
		7/29/1992	flume	0.41
		7/30/1992	flume	0.43
		7/31/1992	flume	0.44
		8/1/1992	flume	0.43
		8/2/1992	flume	0.45

Table 2 - Mean Stream Discharge

Station ID	Stream Name	Date Gauged	Gauge Type	Mean Discharge (cubic feet/second)
STA3	Buffalo Ck.	8/3/1992	flume	0.42
		8/4/1992	flume	0.46
		8/5/1992	flume	0.42
		8/6/1992	flume	0.61
		8/7/1992	flume	0.50
		8/8/1992	flume	0.45
		8/9/1992	flume	0.41
		8/10/1992	flume	0.38
		8/11/1992	flume	0.35
		8/12/1992	flume	0.33
		8/13/1992	flume	0.32
		8/14/1992	flume	0.29
		8/15/1992	flume	0.28
		8/16/1992	flume	0.30
		8/17/1992	flume	0.43
		8/18/1992	flume	0.47
		8/19/1992	flume	0.43
		8/20/1992	flume	0.38
		8/21/1992	flume	0.39
		8/22/1992	flume	0.38
		8/23/1992	flume	0.37
		8/24/1992	flume	0.39
		8/25/1992	flume	0.09
		8/26/1992	flume	0.13
		8/27/1992	flume	0.13
		8/28/1992	flume	0.13
		8/29/1992	flume	0.13
		8/30/1992	flume	0.13
		8/31/1992	flume	0.15
		9/1/1992	flume	0.15
		9/2/1992	flume	0.18
		9/3/1992	flume	0.17
		9/4/1992	flume	0.17
		9/5/1992	flume	0.15
		9/6/1992	flume	0.15
		9/7/1992	flume	0.16
		9/8/1992	flume	0.15
		9/9/1992	flume	0.14
		9/10/1992	flume	0.14
		9/11/1992	flume	0.14
		9/12/1992	flume	0.13
		9/13/1992	flume	0.13
		9/14/1992	flume	0.13
		9/15/1992	flume	0.15
		9/16/1992	flume	0.17
		9/17/1992	flume	0.16
		9/18/1992	flume	0.25
		9/19/1992	flume	0.42
		9/20/1992	flume	0.41

Table 2 - Mean Stream Discharge

Station ID	Stream Name	Date Gauged	Gauge Type	Mean Discharge (cubic feet/second)
STA3	Buffalo Ck.	9/21/1992	flume	0.39
		9/22/1992	flume	0.36
		9/23/1992	flume	0.43
STA4	Buffalo Ck.	8/31/1988	flume	2.70
		9/23/1988	flume	7.30
		10/21/1988	flume	2.90
		5/16/1989	flume	7.10
		6/19/1989	flume	3.80
		7/17/1989	flume	2.60
		7/20/1989	flume	0.18
		8/23/1989	flume	0.19
		9/27/1989	flume	1.29
		10/28/1989	flume	1.04
		4/29/1990	flume	20.90
		7/2/1990	flume	0.20
		7/27/1990	flume	0.00
		8/30/1990	flume	0.30
		10/1/1990	flume	1.60
STA5	Moose Ck	8/31/1988	flow meter	172.70
		9/23/1988	flow meter	178.30
		10/21/1988	flow meter	83.30
		11/19/1988	flow meter	36.00
		12/20/1988	flow meter	28.10
		1/27/1989	flow meter	26.30
		2/24/1989	flow meter	24.90
		3/22/1989	flow meter	16.00
		4/15/1989	flow meter	44.00
		5/16/1989	flow meter	80.00
		6/19/1989	flow meter	355.90
		7/17/1989	flow meter	185.80
		7/20/1989	flow meter	192.00
		8/23/1989	flow meter	127.00
		6/28/1990	flow meter	304.30
		7/27/1990	flow meter	97.70
		8/30/1990	flow meter	250.20
		10/1/1990	flow meter	143.60
		10/30/1990	flow meter	317.60
STA5-F	Moose Ck	11/14/2008	flow meter	35.31
15283700	Moose Ck	6/1998 to 9/2001	transducer	See Note Below
15283701	Moose Ck	9/2007 to present	transducer	See Note Below

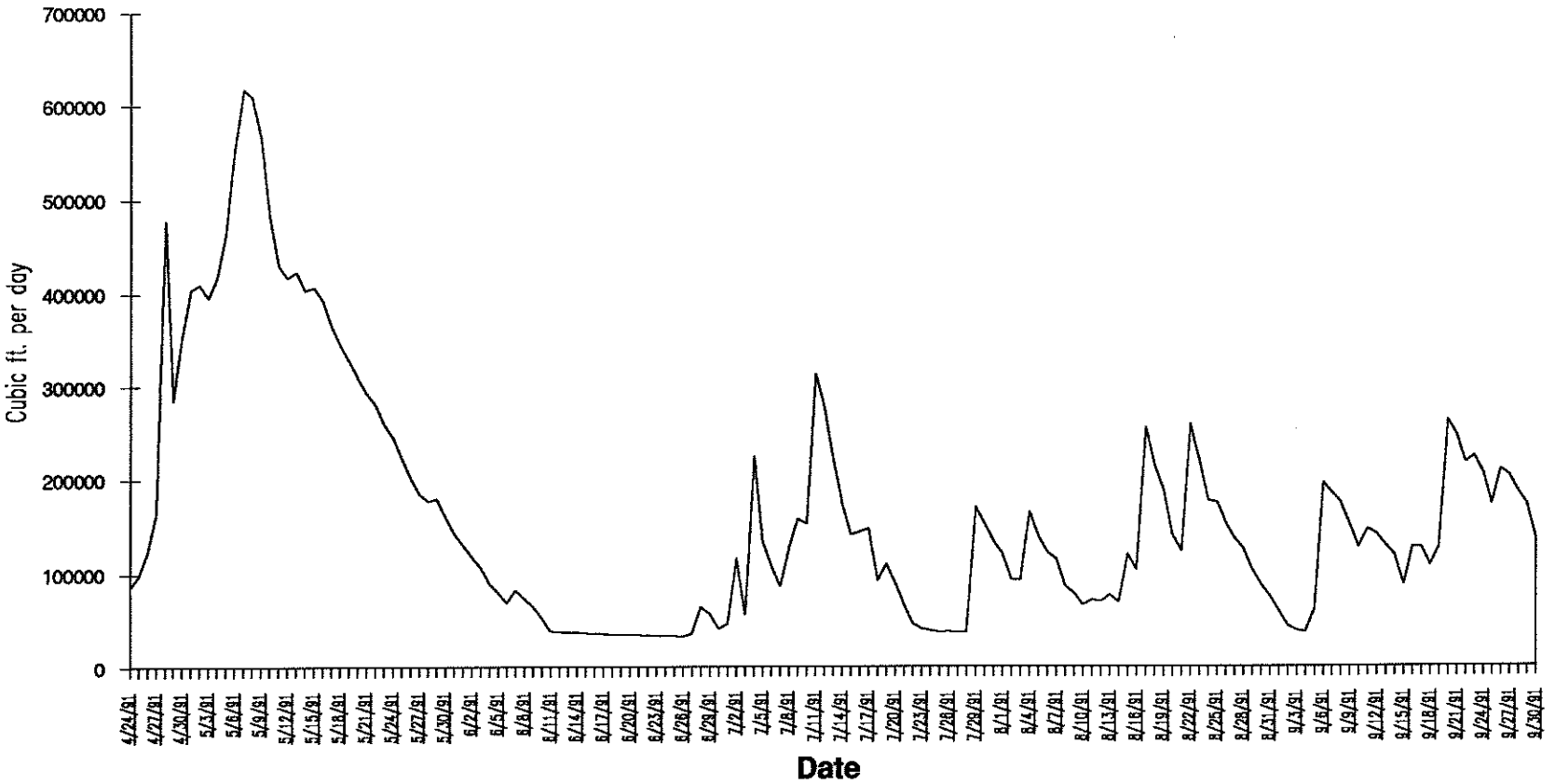
Note: For stream discharge data, see Attachment 2

ATTACHMENT 1

STATION 3
AVERAGE DISCHARGE READINGS
APRIL 24, 1991 – SEPTEMBER 30, 1991

Station 3

Average Discharge



ATTACHMENT 2

FLOW MONITORING DATA FROM U.S.G.S. MONITORING STATION 15283700

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - ALASKA DISTRICT 05/03/2002

STATION NUMBER 15283700 MOOSE C NR PALMER AK STREAM SOURCE AGENCY USGS
LATITUDE 614100 LONGITUDE 1490236 DRAINAGE AREA 47.3 DATUM 450 STATE 02 COUNTY 170

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1997 TO SEPTEMBER 1998
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	---	e210	e130	e120
2	---	---	---	---	---	---	---	---	---	e180	e130	e115
3	---	---	---	---	---	---	---	---	---	e170	e130	e110
4	---	---	---	---	---	---	---	---	---	e170	e130	e110
5	---	---	---	---	---	---	---	---	---	e170	e140	e105
6	---	---	---	---	---	---	---	---	---	e190	e180	e105
7	---	---	---	---	---	---	---	---	---	e160	e190	e100
8	---	---	---	---	---	---	---	---	---	e150	e180	e95
9	---	---	---	---	---	---	---	---	---	e150	e170	e95
10	---	---	---	---	---	---	---	---	---	e150	e160	e90
11	---	---	---	---	---	---	---	---	---	e150	e160	e85
12	---	---	---	---	---	---	---	---	---	e150	e150	e90
13	---	---	---	---	---	---	---	---	---	e140	e150	e95
14	---	---	---	---	---	---	---	---	---	e150	e140	e100
15	---	---	---	---	---	---	---	---	---	e190	e140	e110
16	---	---	---	---	---	---	---	---	---	e170	e200	e120
17	---	---	---	---	---	---	---	---	---	e160	e240	e130
18	---	---	---	---	---	---	---	---	---	e160	e300	e135
19	---	---	---	---	---	---	---	---	---	e150	e250	e135
20	---	---	---	---	---	---	---	---	---	e140	e200	e140
21	---	---	---	---	---	---	---	---	---	e140	e200	e160
22	---	---	---	---	---	---	---	---	---	e140	e230	e165
23	---	---	---	---	---	---	---	---	---	e140	e300	e170
24	---	---	---	---	---	---	---	---	---	e130	e230	e170
25	---	---	---	---	---	---	---	---	---	e130	e200	e190
26	---	---	---	---	---	---	---	---	---	e130	e190	e200
27	---	---	---	---	---	---	---	---	---	e130	e180	e190
28	---	---	---	---	---	---	---	---	---	e130	e150	e170
29	---	---	---	---	---	---	---	---	---	e130	e140	e160
30	---	---	---	---	---	---	---	---	e260	e130	e130	e150
31	---	---	---	---	---	---	---	---	---	e130	e125	---
TOTAL	---	---	---	---	---	---	---	---	---	4720	5545	3910
MEAN	---	---	---	---	---	---	---	---	---	152	179	130
MAX	---	---	---	---	---	---	---	---	---	210	300	200
MIN	---	---	---	---	---	---	---	---	---	130	125	85
AC-FT	---	---	---	---	---	---	---	---	---	9360	11000	7760
CFSM	---	---	---	---	---	---	---	---	---	3.22	3.78	2.76
IN.	---	---	---	---	---	---	---	---	---	3.71	4.36	3.08

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - ALASKA DISTRICT 05/03/2002

STATION NUMBER 15283700 MOOSE C NR PALMER AK STREAM SOURCE AGENCY USGS
LATITUDE 614100 LONGITUDE 1490236 DRAINAGE AREA 47.3 DATUM 450 STATE 02 COUNTY 170

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	e150	e48	e30	e22	e15	e14	e14	29	101	223	229	128
2	e140	e48	e30	e22	e14	e14	e14	25	100	224	210	131
3	e130	e46	e28	e22	e13	e14	e14	25	99	241	186	171
4	e130	e46	e28	e22	e13	e14	e14	29	108	236	167	166
5	e120	e44	e28	e22	e14	e14	e14	33	130	218	157	147
6	e120	e44	e28	e20	e15	e14	e14	36	174	195	142	132
7	e110	e42	e28	e20	e15	e14	e14	36	208	176	133	123
8	e110	e42	e26	e20	e15	e14	e14	41	259	163	127	117
9	e100	e42	e26	e20	e15	e15	e14	41	329	139	130	109
10	e100	e42	e26	e19	e15	e15	e14	36	324	131	125	103
11	e100	e38	e26	e19	e16	e15	e14	37	325	131	115	96
12	e95	e38	e26	e18	e16	e14	e13	48	351	130	234	93
13	e90	e38	e24	e18	e16	e14	e13	56	400	115	508	91
14	e85	e38	e24	e18	e16	e14	e13	69	403	116	382	87
15	e85	e36	e24	e18	e15	e14	e14	81	377	117	455	88
16	e80	e36	e24	e18	e15	e14	e14	86	390	145	387	89
17	e80	e36	e22	e18	e15	e14	e14	93	447	190	322	83
18	e75	e36	e22	e18	e15	e14	e15	92	390	172	270	80
19	e75	e36	e22	e19	e15	e14	e18	82	325	160	231	88
20	e70	e34	e22	e19	e15	e14	e22	84	381	165	202	84
21	e70	e34	e22	e20	e14	e14	e22	82	307	205	179	85
22	e70	e34	e22	e20	e14	e14	e24	76	239	185	161	84
23	e65	e34	e24	e22	e14	e14	29	74	213	149	146	79
24	e65	e34	e24	e20	e14	e14	32	84	241	142	137	77
25	e65	e32	e24	e19	e14	e14	33	88	256	150	203	82
26	e60	e32	e24	e18	e14	e14	31	118	244	175	218	79
27	e60	e32	e24	e17	e14	e14	31	110	221	188	181	75
28	e55	e32	e24	e17	e14	e14	37	103	199	190	165	96
29	e55	e30	e22	e16	---	e14	40	93	206	174	147	96
30	e50	e30	e22	e16	---	e14	38	86	210	304	137	103
31	e50	---	e22	e15	---	e14	---	87	---	274	127	---
TOTAL	2710	1134	768	592	410	437	607	2060	7957	5523	6513	3062
MEAN	87.4	37.8	24.8	19.1	14.6	14.1	20.2	66.5	265	178	210	102
MAX	150	48	30	22	16	15	40	118	447	304	508	171
MIN	50	30	22	15	13	14	13	25	99	115	115	75
AC-FT	5380	2250	1520	1170	813	867	1200	4090	15780	10950	12920	6070
CFSM	1.85	.80	.52	.40	.31	.30	.43	1.40	5.61	3.77	4.44	2.16
IN.	2.13	.89	.60	.47	.32	.34	.48	1.62	6.26	4.34	5.12	2.41

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1998 - 1999, BY WATER YEAR (WY)

MEAN	87.4	37.8	24.8	19.1	14.6	14.1	20.2	66.5	265	165	194	116
MAX	87.4	37.8	24.8	19.1	14.6	14.1	20.2	66.5	265	178	210	130
(WY)	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1998
MIN	87.4	37.8	24.8	19.1	14.6	14.1	20.2	66.5	265	152	179	102
(WY)	1999	1999	1999	1999	1999	1999	1999	1999	1999	1998	1998	1999

SUMMARY STATISTICS	FOR 1999 WATER YEAR	WATER YEARS 1998 - 1999
ANNUAL TOTAL	31773	

ANNUAL MEAN	87.0		87.0		
HIGHEST ANNUAL MEAN			87.0		1999
LOWEST ANNUAL MEAN			87.0		1999
HIGHEST DAILY MEAN	508	Aug 13	508	Aug 13	1999
LOWEST DAILY MEAN	13	Feb 3	13	Feb 3	1999
ANNUAL SEVEN-DAY MINIMUM	14	Apr 8	14	Apr 8	1999
MAXIMUM PEAK FLOW	604	Aug 13			
MAXIMUM PEAK STAGE	14.61	Aug 13			
ANNUAL RUNOFF (AC-FT)	63020		63060		
ANNUAL RUNOFF (CFSM)	1.84		1.84		
ANNUAL RUNOFF (INCHES)	24.99		25.01		
10 PERCENT EXCEEDS	215		210		
50 PERCENT EXCEEDS	42		85		
90 PERCENT EXCEEDS	14		14		

STATISTICS COMPUTED BY: rrickman DATE: 03/14/2001 AT: 15:58:14

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - ALASKA DISTRICT 05/03/2002

STATION NUMBER 15283700 MOOSE C NR PALMER AK STREAM SOURCE AGENCY USGS
LATITUDE 614100 LONGITUDE 1490236 DRAINAGE AREA 47.3 DATUM 450 STATE 02 COUNTY 170

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	122	e75	e34	e20	e22	e18	e16	82	137	487	188	183
2	125	e70	e32	e20	e22	e18	e16	84	162	460	227	186
3	132	e70	e32	e20	e22	e18	e16	89	216	425	248	171
4	113	e70	e30	e20	e22	e18	e16	95	282	437	226	156
5	103	e70	e30	e22	e22	e18	e18	82	346	476	200	152
6	97	e65	e28	e22	e22	e17	e18	92	389	408	193	145
7	91	e65	e28	e22	e22	e17	e18	93	344	372	167	129
8	88	e65	e26	e22	e22	e17	e18	88	308	376	166	137
9	83	e65	e26	e22	e20	e17	e20	88	325	332	163	127
10	80	e65	e25	e22	e20	e17	22	86	368	301	154	127
11	77	e60	e24	e22	e20	e17	23	82	366	285	144	122
12	76	e60	e24	e22	e20	e17	23	85	416	328	139	127
13	75	e60	e22	e22	e20	e17	25	89	480	436	153	114
14	73	e60	e22	e22	e20	e17	27	91	457	462	258	109
15	71	e55	e20	e22	e20	e17	31	83	402	378	238	103
16	73	e55	e20	e22	e20	e16	34	83	389	339	180	103
17	91	e55	e20	e22	e20	e16	36	80	398	364	151	101
18	214	e55	e20	e22	e20	e16	37	82	379	365	171	e95
19	217	e50	e20	e22	e20	e16	37	87	391	307	188	93
20	162	e50	e20	e22	e20	e16	39	89	339	271	185	91
21	130	e48	e26	e22	e20	e16	42	87	303	254	184	112
22	111	e48	e40	e22	e18	e16	43	81	312	245	219	754
23	96	e46	e38	e22	e18	e16	43	80	381	269	216	479
24	e95	e46	e30	e22	e18	e16	46	85	519	239	197	445
25	e95	e44	e26	e22	e18	e16	47	84	515	221	188	524
26	e90	e42	e26	e22	e18	e15	48	89	490	208	179	715
27	e85	e40	e24	e22	e18	e15	55	93	514	200	182	521
28	e80	e38	e24	e22	e18	e15	66	97	551	229	175	398
29	e80	e36	e24	e22	e18	e15	76	109	554	247	184	314
30	e75	e34	e24	e22	---	e15	76	123	510	226	232	261
31	e75	---	e20	e22	---	e16	---	129	---	199	200	---
TOTAL	3175	1662	805	674	580	511	1032	2787	11543	10146	5895	7094
MEAN	102	55.4	26.0	21.7	20.0	16.5	34.4	89.9	385	327	190	236
MAX	217	75	40	22	22	18	76	129	554	487	258	754
MIN	71	34	20	20	18	15	16	80	137	199	139	91
AC-FT	6300	3300	1600	1340	1150	1010	2050	5530	22900	20120	11690	14070
CFSM	2.17	1.17	.55	.46	.42	.35	.73	1.90	8.13	6.92	4.02	5.00
IN.	2.50	1.31	.63	.53	.46	.40	.81	2.19	9.08	7.98	4.64	5.58

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1998 - 2000, BY WATER YEAR (WY)

MEAN	94.9	46.6	25.4	20.4	17.4	15.3	27.3	78.2	325	219	193	156
MAX	102	55.4	26.0	21.7	20.0	16.5	34.4	89.9	385	327	210	236
(WY)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	1999	2000
MIN	87.4	37.8	24.8	19.1	14.6	14.1	20.2	66.5	265	152	179	102
(WY)	1999	1999	1999	1999	1999	1999	1999	1999	1999	1998	1998	1999

SUMMARY STATISTICS	FOR 1999 CALENDAR YEAR	FOR 2000 WATER YEAR	WATER YEARS 1998 - 2000
ANNUAL TOTAL	32803	45904	

ANNUAL MEAN	89.9		125		106	
HIGHEST ANNUAL MEAN					125	2000
LOWEST ANNUAL MEAN					87.0	1999
HIGHEST DAILY MEAN	508	Aug 13	754	Sep 22	754	Sep 22 2000
LOWEST DAILY MEAN	13	Feb 3	15	Mar 26	13	Feb 3 1999
ANNUAL SEVEN-DAY MINIMUM	14	Apr 8	15	Mar 24	14	Apr 8 1999
MAXIMUM PEAK FLOW			1080	Sep 22	1080	Sep 22 2000
MAXIMUM PEAK STAGE			15.32	Sep 22	15.32	Sep 22 2000
ANNUAL RUNOFF (AC-FT)	65060		91050		76980	
ANNUAL RUNOFF (CFSM)	1.90		2.65		2.25	
ANNUAL RUNOFF (INCHES)	25.80		36.10		30.52	
10 PERCENT EXCEEDS	217		367		258	
50 PERCENT EXCEEDS	60		75		80	
90 PERCENT EXCEEDS	14		18		16	

STATISTICS COMPUTED BY: rrickman DATE: 03/14/2001 AT: 16:45:04

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - ALASKA DISTRICT 05/03/2002

STATION NUMBER 15283700 MOOSE C NR PALMER AK STREAM SOURCE AGENCY USGS
LATITUDE 614100 LONGITUDE 1490236 DRAINAGE AREA 47.3 DATUM 450 STATE 02 COUNTY 170

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	219	e65	e40	e24	e23	e20	e18	64	171	230	231	84
2	192	e65	e40	e24	e22	e20	e19	55	239	211	217	83
3	176	e65	e40	e24	e22	e20	e19	50	299	212	204	98
4	164	e65	e40	e24	e22	e20	e19	45	308	211	218	92
5	160	e60	e38	e24	e22	e20	e20	42	289	276	189	137
6	158	e60	e38	e24	e22	e20	e20	42	269	281	171	161
7	143	e60	e38	e24	e21	e20	e20	46	253	242	158	126
8	132	e60	e38	e24	e21	e20	e20	56	240	204	155	113
9	123	e60	e36	e24	e21	e20	e20	59	278	188	164	104
10	115	e55	e36	e24	e21	e20	e21	58	322	172	154	98
11	109	e55	e34	e24	e21	e20	e21	59	403	162	142	94
12	103	e55	e34	e24	e21	e20	e21	65	415	148	137	91
13	100	e55	e34	e24	e21	e20	e21	77	367	147	134	89
14	97	e55	e32	e24	e21	e20	e21	85	396	149	144	86
15	93	e50	e32	e24	e21	e20	e22	87	465	142	167	82
16	90	e50	e32	e26	e20	e20	24	87	514	136	158	78
17	87	e50	e32	e25	e20	e20	24	83	564	135	145	76
18	85	e50	e30	e26	e20	e20	25	86	542	132	152	76
19	83	e48	e30	e26	e20	e20	27	87	503	137	148	79
20	80	e50	e30	e25	e20	e20	30	91	477	177	134	78
21	80	e48	e30	e25	e20	e20	34	89	460	172	123	75
22	82	e46	e29	e25	e20	e20	38	86	429	158	121	72
23	80	e46	e28	e24	e20	e19	42	85	415	147	116	70
24	78	e46	e27	e24	e20	e19	45	80	408	147	143	65
25	76	e44	e27	e24	e20	e19	49	77	371	150	131	65
26	72	e44	e26	e24	e20	e18	55	78	368	165	120	64
27	e70	e44	e26	e24	e20	e18	59	83	354	204	114	62
28	e65	e42	e25	e23	e20	e18	64	110	345	219	103	61
29	e65	e42	e26	e23	---	e18	66	143	308	276	98	59
30	e65	e42	e26	e23	---	e18	68	152	260	258	92	58
31	e65	---	e24	e23	---	e18	---	168	---	294	89	---
TOTAL	3307	1577	998	750	582	605	952	2475	11032	5882	4572	2576
MEAN	107	52.6	32.2	24.2	20.8	19.5	31.7	79.8	368	190	147	85.9
MAX	219	65	40	26	23	20	68	168	564	294	231	161
MIN	65	42	24	23	20	18	18	42	171	132	89	58
AC-FT	6560	3130	1980	1490	1150	1200	1890	4910	21880	11670	9070	5110
CFSM	2.26	1.11	.68	.51	.44	.41	.67	1.69	7.77	4.01	3.12	1.82
IN.	2.60	1.24	.78	.59	.46	.48	.75	1.95	8.68	4.63	3.60	2.03

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1998 - 2001, BY WATER YEAR (WY)

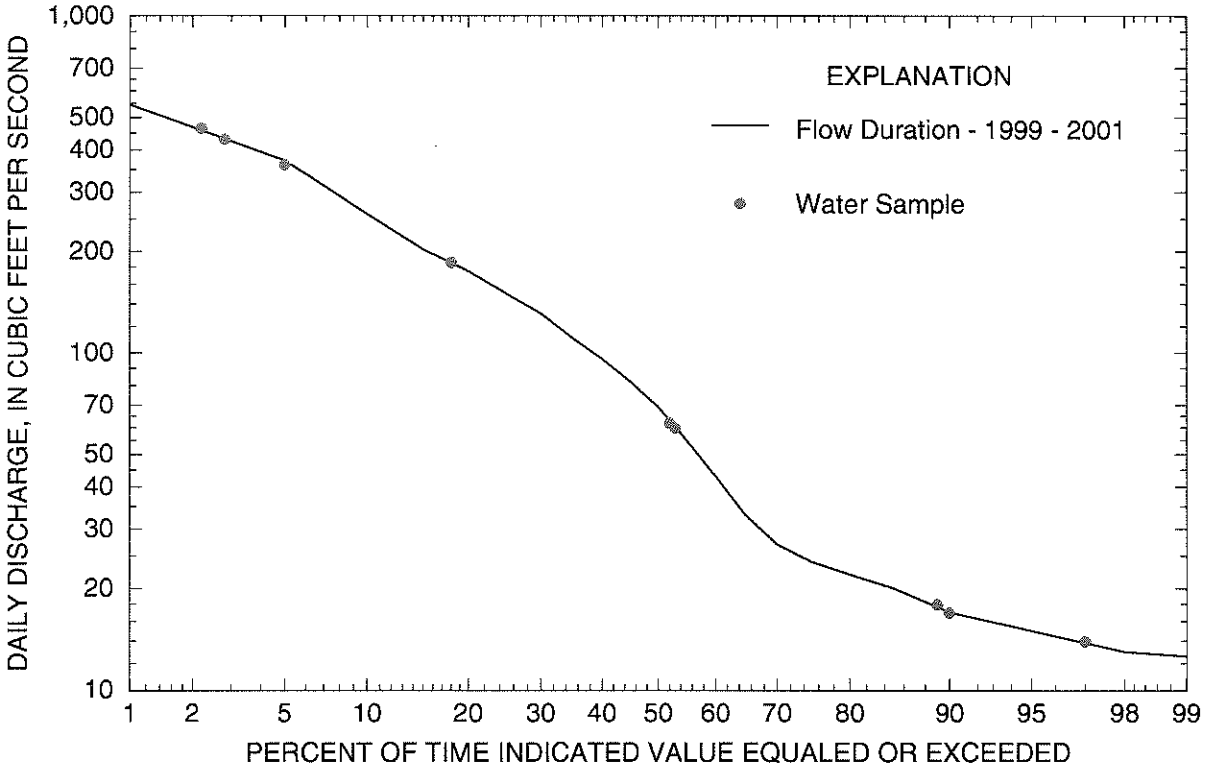
MEAN	98.8	48.6	27.6	21.7	18.5	16.7	28.8	78.7	339	212	182	139
MAX	107	55.4	32.2	24.2	20.8	19.5	34.4	89.9	385	327	210	236
(WY)	2001	2000	2001	2001	2001	2001	2000	2000	2000	2000	1999	2000
MIN	87.4	37.8	24.8	19.1	14.6	14.1	20.2	66.5	265	152	147	85.9
(WY)	1999	1999	1999	1999	1999	1999	1999	1999	1999	1998	2001	2001

SUMMARY STATISTICS	FOR 2000 CALENDAR YEAR	FOR 2001 WATER YEAR	WATER YEARS 1998 - 2001
ANNUAL TOTAL	46144	35308	

ANNUAL MEAN	126		96.7		103	
HIGHEST ANNUAL MEAN					125	2000
LOWEST ANNUAL MEAN					87.0	1999
HIGHEST DAILY MEAN	754	Sep 22	564	Jun 17	754	Sep 22 2000
LOWEST DAILY MEAN	15	Mar 26	18	Mar 26	13	Feb 3 1999
ANNUAL SEVEN-DAY MINIMUM	15	Mar 24	18	Mar 26	14	Apr 8 1999
MAXIMUM PEAK FLOW			658	Jun 17	1080	Sep 22 2000
MAXIMUM PEAK STAGE			14.70	Jun 17	15.32	Sep 22 2000
ANNUAL RUNOFF (AC-FT)	91530		70030		74680	
ANNUAL RUNOFF (CFSM)	2.67		2.05		2.18	
ANNUAL RUNOFF (INCHES)	36.29		27.77		29.61	
10 PERCENT EXCEEDS	367		230		248	
50 PERCENT EXCEEDS	66		60		72	
90 PERCENT EXCEEDS	18		20		18	

STATISTICS COMPUTED BY: rrickman DATE: 03/01/2002 AT: 09:54:00

e Estimated



MOOSE CREEK NEAR PALMER

Table 3 - Field Measured Surface Water Quality Parameter Results

Well ID	Sample Date	Temperature (^oC)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
STA1	30-Jul-88	9.5	7.2		1.6	11.7		70	
	31-Aug-88	6.5	6.1		1.2	11.4		80	
	23-Sep-88	2.5	7.29		0.7	13.2		112	
	22-Oct-88	1.5	6.39		0.65	12.3		100	33.1
	18-Nov-88	3	7.17		0.58	11.2		163	30.2
	20-Dec-88	1	7.25		0.36	12.8		128	81
	27-Jan-89	1	7.36		0.2	13.2		164	50
	24-Feb-89	0	6.71		1.1	13.7		169	23
	22-Mar-89	0.5	7.33		0.5	14.3		173	30
	15-Apr-89	2	7.6		8.3	13.4		187	43.2
	16-May-89	2	6.81		2.6	13.6		134	34
	19-Jun-89	8	7.25		2.3	12.4		59	18.5
	20-Jul-89	7.5	7.1		3.5	11.2		53	19.2
	23-Aug-89	7.5	6.91		5.6	11.4		76	23
	27-Sep-89	5.6	8.2		1.5	10.9			17
	28-Oct-89	0	6.3					91	24.9
	29-Dec-89	0	7.4			12.6		110	31.2
	30-Jan-90	-0.7	6.5		0.3	14.2		117	30
	27-Feb-90	-0.6	7.2		0.3	13.4		120	32
	29-Mar-90	1	7.9		0.3	12.7		125	32
	27-Apr-90	2.8	7.3			5.8		115	32.7
	28-Jun-90	8.3	7.3		46	10.7		52	
	27-Jul-90	8.9	7.4		2.3	11.7		72	12
	30-Aug-90	5.5	7.22		2.6	11.5		71	22.6
	01-Oct-90	1.7	7.3		2	11.9		79	25
	30-Oct-90	0.6	7.6		0.2	12.1		95	27
	13-Nov-08	0.38	7.67	1054	3.31	10.86	154		
	29-Dec-08	0.06	5.45	52	1.35	14.11	310		
STA2	30-Jul-88	11	7.8		1.2	10.2		120	
	31-Aug-88	7	6.3		1	11.5		114	
	23-Sep-88	6.5	7.3		7.2	10.6		93	
	22-Oct-88	1.5	6.3		2.6	13.1		86	43.5
	18-Nov-88	2	7.29		0.84	11.4		114	49.2
	20-Dec-88	1	7.49		0.7	12.6		133	53
	27-Jan-89	3	7.2		1	14.2		150	86
	24-Feb-89	0	6.16		2.6	14		135	39
	22-Mar-89	0.5	6.11		0.5	14.7		140	47
	15-Apr-89	1	7.65		16	14.7		107	36
	16-May-89	7	7.81		7.5	13		86	34.7
	19-Jun-89	9	7.82		3.5	13.6		101	43.1
	20-Jul-89	7	7.59		2.6	11.8		95	48.1
	23-Aug-89	7	7.58		2	11.9		118	51.3
	27-Sep-89	8.8	5.4		3.2				15
	28-Oct-89	0	6.45					104	43.4
	28-Dec-89	0	7.4			12.8		105	51
	30-Jan-90	-0.1	7.8		0.4	11.8		104	53
	27-Feb-90	2.6	7.8		0.6			105	50
	29-Mar-90	0.5	8		0.4	13		115	50
	29-Apr-90	3.9	6.56			6.8		61	24
	28-Jun-90	11.1	7.79		9	10.5		111	

Table 3 - Field Measured Surface Water Quality Parameter Results

Well ID	Sample Date	Temperature (^oC)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
STA2	27-Jul-90	8.5	7.8		0.3	12.2		114	50
	30-Aug-90	8.9	8.13		3.5	10.9		106	50.9
	01-Oct-90	3.3	7.27		1.4	12		87	41.3
	30-Oct-90	1.1	7.3		0.6	13		105	46
	13-Nov-08	0.28	7.03	96	2.6	13.5	153.8		
	29-Dec-08	0.03	6.83		6.89	8.29	143.4		
STA3	30-Jul-88	14	6.6		17	7.9		52	
	31-Aug-88	10	5.9		20	9.8		45	
	22-Oct-88	3	6.06		3	11.8		40	19
	18-Nov-88	1	7.01		0.3	11.2		51	11.2
	20-Dec-88	1	7.12		0.25	11.4		57	21
	27-Jan-89	3.5	7.09		0.25	14		66	30
	24-Feb-89	0	5.6		0.9	10.2		59	11
	22-Mar-89	3	5.94			11.3		49	60
	15-Apr-89	0	6.26		0.8	9.3		53	17.6
	16-May-89	5	7.17		1.5	13.4		45	16
	19-Jun-89	15	6.97		1.6	8.2		45	17.8
	20-Jul-89	12	6.5		2	6.3		45	21.4
	23-Aug-89	11	6.4		0.6	6.6		50	19.2
	26-Sep-89	8.7	5.2		9	10			119
	28-Oct-89	1	6.52					52	19.7
	28-Dec-89	0	7.1					55	22
	30-Jan-90	-1	7.67		0.5	11.4		48	21
	27-Feb-90	1.2	6.9		3.2			50	27
	27-Apr-90	2.8	6.97			4.7		51	16.8
	28-Jun-90	20	6.79		7	7.7		67	
	27-Jul-90	8.7	6.8		0.7	10.7		61	26
	30-Aug-90	9.4	7.22		1	11.1		64	24
	01-Oct-90	5.6	7.25		0.8	10.3		44	17.4
	30-Oct-90	0.6	7.1		0.6	12.7		47	22
	16-Nov-08	0.91	6.77	51	1.32	10.87	166.6		
	30-Dec-08	0.94	7.01	35	1.69	12.23	183.6		
STA4	30-Jul-88	9.5	6.5		0.58	12		59	
	31-Aug-88	8.5	6.3		0.47	10.2		64	
	23-Sep-88	6.5	6.88		2.7	10.4		48	
	22-Oct-88	2	6.02		0.58	12.2		241	19
	18-Nov-88	1	7.2		0.5	11.6		59	22.6
	20-Dec-88	1	7.19		0.65	13.5		85	32
	22-Mar-89	1	6.29		0.5	7.2		62	22.4
	15-Apr-89	2	6.54		4	12.2		69	20.3
	16-May-89	5	7.08		2.4	13.6		47	15.7
	19-Jun-89	8.5	7.22		0.4	13		53	15.7
	20-Jul-89	6.5	6.85		1.4	11.1		61	15.7
	23-Aug-89	6.5	6.94		0.6	11.4		79	30.8
	27-Sep-89	6.7	7.9		4.1	10.5			12
	28-Oct-89	1	6.53					53	20.1
	28-Dec-89	0	6.8			12.4		60	25
	30-Jan-90	-2	7.33		0.4	12.4		56	25
	29-Apr-90	3.3	6.42			7.2		35	12
	02-Jul-90	9.9	7.1		11.5	10.9		69	

Table 3 - Field Measured Surface Water Quality Parameter Results

Well ID	Sample Date	Temperature (^oC)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
STA4	27-Jul-90	9.6	6.8		0.5	10.5		74	30
	30-Aug-90	8.3	7.34		0.6	10.8		77	29.1
	01-Oct-90	4.4	7.27		1.1	11.2		48	19.7
	16-Nov-08	1.1	7.33	150	0.53	12.68	98.3		
	30-Dec-08	0.02	8.09	41	2.69	5.79	226.8		
STA5	30-Jul-88	10.5	6.9		1.2	10.2		84	
	31-Aug-88	9	6.5		0.75	8.5		91	
	23-Sep-88	6	7.36		5	12.6		115	
	22-Oct-88	0	6.31		0.65	13.8		109	37.5
	18-Nov-88	3	7.09		0.3	11.2		132	44.6
	20-Dec-88	0	7.14		0.24	13.2		148	51
	27-Jan-89	1	7.3		0.23	15		180	50
	24-Feb-89	2	6.26		0.5	12.4		171	40
	22-Mar-89	0	7.2		0.5	14.2		189	35
	15-Apr-89	1	7.8		4.5	14		168	45
	16-May-89	8	7.47		2.7	10.6		120	44.6
	19-Jun-89	6	7.25		3.8	13.2		68	22.3
	20-Jul-89	6.5	6.59		3.4	11.6		71	25.4
	23-Aug-89	7	7.5		3	12		92	30.5
	27-Sep-89	4.4	7.2		3.5	11.9			5
	28-Oct-89	0	7.05					115	35.6
	28-Dec-89	-1	7.4			13.4		135	47
	30-Jan-90	-1	7.8		0.8	12.6		125	48
	27-Feb-90	0.2	6.8		1.1			140	50
	28-Mar-90	1.3	7.6		0.3	12.7		145	52
	29-Apr-90	5.4	6.93			6.5		105	37
	28-Jun-90	7.8	7.21		37	11.6		62	
	27-Jul-90	8.3	7.54		0.2	11.6		86	29
	30-Aug-90	9.4	7.91		3.1	11.3		80	28.9
	01-Oct-90	2.8	7.28		0.8	12.3		102	37.7
	30-Oct-90	1.1	7.8		0.4	13.3		121	45
	13-Nov-08	0.01	6.95	94	4.12	13.32	176		
	30-Dec-08	0.05	7.37	68	1.58	9.6	271.3		
STA6	31-Aug-88	7	6.3		2.3	11.6		85	
	23-Sep-88	8.5	7.02		2.4	10.2		110	
	22-Oct-88	0	6.3		0.5	14.8		111	33
	18-Nov-88	3.5	7.22		0.78	11.4		138	40.2
	20-Dec-88	0	7.4		0.44	13.9		148	46
	24-Feb-89	0	6.66		0.55	13.7		181	36
	22-Mar-89	0.5	7.1		0.9	14		155	34
	15-Apr-89	2	7.93		4.5	13.6		183	47.6
	16-May-89	8	7.55		4.5	11.2		124	40.1
	19-Jun-89	8	7.17		2.7	12.6		68	20.7
	20-Jul-89	7	7.37		2.4	12.2		60	23.1
	23-Aug-89	6.5	7.34		3.5	12.2		87	27.9
	27-Sep-89	5.6	7.4		1.4	11.5			29
	13-Nov-08	0.33	7.46	120	2.84	13.16	126.6		
	29-Dec-08	0.06	5.45	52	1.35	14.11	310		
STA7	31-Aug-88	7.5	6.4		1	11.8		90	

Table 3 - Field Measured Surface Water Quality Parameter Results

Well ID	Sample Date	Temperature (^oC)	pH	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos)	Alkalinity (mg/L)
STA7	23-Sep-88	7	7.11		3.4	10.9		110	
	22-Oct-88	0	6.2		0.58	14.3		108	39
	18-Nov-88	3	7.26		0.3	10.4		128	43.8
	20-Dec-88	0	7.4		0.3	13.2		146	113
	24-Feb-89	1	6.75			14		165	29
	22-Mar-89	1	7.08		0.7	13.2		151	39
	15-Apr-89	1	7.8		7.5	14.6		167	44.5
	16-May-89	9	7.79		3.9	11.2		120	39.7
	19-Jun-89	9.5	7.37		2.5	13.1		65	21.5
	20-Jul-89	7.5	7.07		2.5	11.2		62	25
	23-Aug-89	7	7.44		3	12		89	29.1
	26-Sep-89	6.7	6		4.3	12.3			69
	13-Nov-08	0.02	7.5	42	6.61	5.07	207		
	29-Dec-08	0.03	6.08		7.01	11.63	132		

Note: Blank cells indicate data not collected.

Abbreviations

^oC: Degrees Celsius
µmhos: Micromhos
µS/cm: Microsiemens per centimeter
mg/L: Milligrams per liter
mV: Millivolts
NTU: Nephelometric Turbidity Units
ORP: Oxidation reduction potential
pH: Power of hydrogen

Table 4 - Analytical Methods and Detection Limits

Method	Analyte	PQL (mg/L)	Matrix
180.1	Turbidity	0.2 NTU	Groundwater and Surface Water
300	Chloride	0.2	
	Fluoride	0.2	
	Sulfate	0.2	
	Nitrate	0.1	
	Nitrite	0.1	
SM 2540C	Total Dissolved Solids	5	
SM 2320B	Alkalinity as $CaCO_3$	2	
200.7/SM 2340B	Hardness as $CaCO_3$	0.4	
365.3	Phosphorous, Total	0.01	Groundwater
	Phosphorous, Dissolved	0.01	
200.7 Metals – Total and Dissolved	Calcium	0.05	
	Iron	0.02	
	Magnesium	0.02	
	Potassium	0.4	
	Sodium	0.1	
200.8 Metals – Total and Dissolved	Aluminum	0.002	
	Arsenic	0.0005	
	Barium	0.00005	
	Cadmium	0.00002	
	Chromium	0.0002	
	Copper	0.0001	
	Lead	0.00002	
	Manganese	0.00005	
	Nickel	0.0002	
	Selenium	0.001	
	Zinc	0.0005	
200.7 Metals – Total and Dissolved	Iron	0.02	Surface Water
	Magnesium	0.02	
200.8 Metals – Total and Dissolved	Aluminum	0.002	
	Arsenic	0.0005	
	Barium	0.00005	
	Beryllium	0.00002	
	Cadmium	0.00002	
	Chromium	0.0002	
	Copper	0.001	
	Lead	0.00002	
	Nickel	0.0002	
	Selenium	0.001	
	Zinc	0.0005	
120.1	Conductivity	2 µMHOS/cm	
350.1	Ammonia as Nitrogen	0.05	
353.2	Nitrate + Nitrite as Nitrogen	0.05	
SM 2120 B	Color	5 color units	
SM 2540 D	Total Suspended Solids (TSS)	5	
SM 2540 F	Settleable Solids	0.1	
SM 4500- H+B	pH	na	
7195/7191	Hexavalent Chromium	0.002	

Abbreviations

$CaCO_3$: Calcium carbonate
µMHOS/cm: Micromhos per centimeter
mg/L: Milligrams per liter
NTU: Nephelometric Turbidity Units
pH: Power of hydrogen
PQL: Practical quantitation limit

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Acidity, Total (mg/L)	Alkalinity as CaCO3, Dissolved (mg/L)	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia + org-N (as N) (mg/L)	Ammonia + Org-N and Nitrogen, Dissolved (mg/L)	Ammonia + Org-N as Nitrogen, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Ammonia as Nitrogen, Dissolved (mg/L)	Anions (meq/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Beryllium, Dissolved (mg/L)
15283550	18-Mar-99	ND	35			0.02	ND			0.002				0.003		0.033	
15283550	29-Jun-99	ND	24			0.04	0.07			0.005				ND		0.0236	
15283550	12-Nov-99	ND	33			0.03	0.06			0.005				0.002		0.0296	
15283550	05-Apr-00		36				ND			ND				0.002		0.0342	
15283550	28-Jun-00	ND	21				ND			ND				ND			
15283550	23-Sep-00	ND	26				ND			0.003				0.002			
15283550	27-Mar-01		36				0.05			0.014				0.001		0.0333	
15283550	19-Jun-01		20			0.21	ND			0.002				0.001		0.0223	
15283550	12-Oct-01		32			0.02	0.05			ND				0.001		0.0278	
15283700	04-Oct-48																
15283700	19-Apr-49																
15283700	18-Apr-51																
15283700	05-May-51																
15283700	14-May-51																
15283700	21-Nov-51																
15283700	11-Feb-52																
15283700	12-Mar-52																
15283700	18-Apr-52																
15283700	07-May-52																
15283700	12-Jun-52																
15283700	16-Jul-52																
15283700	13-Sep-52																
15283700	29-Sep-52																
15283700	12-May-56																
15283700	09-Aug-71																
15283700	30-Jun-98					0.14					0.03			0.001			
15283700	18-Mar-99		48											0.003		0.0321	
15283700	29-Jun-99		29			0.05					0.002			0.001		0.0237	
15283700	12-Nov-99		50						0.11		0.005					0.0297	
15283700	05-Apr-00		53													0.0329	
15283700	28-Jun-00		24														
15283700	23-Sep-00		32								0.002						
15283700	27-Mar-01		54								0.006					0.0322	
15283700	19-Jun-01		24			0.36					0.002					0.0233	
15283700	12-Oct-01		43													0.0257	
STA1	30-Jul-88	ND		24	ND					0.03		0.63	ND				
STA1	31-Aug-88	ND		27	ND					0.05		0.7	ND				
STA1	23-Sep-88	ND		31	ND					ND		0.87	ND				
STA1	21-Oct-88	ND			ND								ND		ND		
STA1	22-Oct-88			36						ND		1.03					
STA1	18-Nov-88	ND		32	0.1					0.05		1.04	ND		ND		
STA1	20-Dec-88	ND		37	ND					0.15		1.24	ND		ND		
STA1	27-Jan-89	ND		33	0.1					0.03		1.21	ND		ND		
STA1	24-Feb-89	ND		36	0.2					ND		1.28	ND		ND		
STA1	22-Mar-89	ND		35	ND					0.03		1.32	ND		ND		
STA1	15-Apr-89	ND		51	ND					ND		1.61	ND		ND		
STA1	16-May-89	ND		45	ND					ND		1.28	ND		ND		
STA1	19-Jun-89	ND		21	ND					0.04		0.57	ND		ND		
STA1	20-Jul-89	ND		22	ND					ND		0.55	ND		ND		
STA1	23-Aug-89	ND		29	ND					ND		0.81	ND		ND		
STA1	27-Sep-89	ND		28	ND					ND		0.79	ND		ND		
STA1	28-Oct-89	ND		31	ND					ND		0.92	ND		ND		
STA1	30-Jan-90	ND		33	ND					0.04		1.21	ND		ND		
STA1	27-Apr-90	ND		34	ND					0.05		1.03	ND		ND		
STA1	27-Jul-90	ND		24	ND					ND		0.68	ND		ND		
STA1	30-Oct-90	ND		30	ND					0.12		0.96	ND		ND		
STA1	13-Nov-08			32	0.0021	0.0117				ND			0.0012	0.0012	0.0338	0.0333	ND

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Acidity, Total (mg/L)	Alkalinity as CaCO3, Dissolved (mg/L)	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia + org-N (as N) (mg/L)	Ammonia + Org-N and Nitrogen, Dissolved (mg/L)	Ammonia + Org-N as Nitrogen, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Ammonia as Nitrogen, Dissolved (mg/L)	Anions (meq/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Beryllium, Dissolved (mg/L)
STA2	30-Jul-88	ND		50	ND					0.02		1.1	ND				
STA2	31-Aug-88	ND		54	ND					0.05		1.13	ND				
STA2	23-Sep-88	ND		43	ND					ND		0.95	ND				
STA2	21-Oct-88	ND		46	ND					ND		1.01	ND		ND		
STA2	18-Nov-88			52						0.08		1.12					
STA2	19-Nov-88	ND			0.1								ND		ND		
STA2	19-Dec-88	ND		52	ND					0.35		1.11	ND		ND		
STA2	29-Jan-89	ND		51	ND					0.02		1.12	ND		ND		
STA2	24-Feb-89	ND		58	0.2					ND		1.2	ND		ND		
STA2	21-Mar-89	ND		57	ND					0.03		1.23	ND		ND		
STA2	14-Apr-89	ND		41	ND					0.03		0.92	ND		ND		
STA2	15-May-89	ND		40						0.03							
STA2	16-May-89				ND							0.91	ND		ND		
STA2	19-Jun-89	ND		47	ND					0.02		1.02	ND		ND		
STA2	20-Jul-89	ND		54	ND					ND		1.25	ND		ND		
STA2	23-Aug-89	ND		59	ND					ND		1.25	ND		ND		
STA2	27-Sep-89	ND		52	ND					ND		1.14	ND		ND		
STA2	28-Oct-89	ND		49	ND					ND		1.08	ND		ND		
STA2	30-Jan-90	ND		55	ND					0.05		1.18	ND		ND		
STA2	29-Apr-90	ND		26	ND					0.13		0.65	ND		ND		
STA2	27-Jul-90	ND		55	0.1					ND		1.16	ND		ND		
STA2	30-Oct-90	ND		48	ND					0.03		1.05	ND		ND		
STA2	13-Nov-08			42	0.0089	0.0311				ND			ND	ND	0.0159	0.0162	ND
STA3	30-Jul-88	ND		21	0.1					0.02		0.45	ND				
STA3	31-Aug-88	ND		21	ND					0.05		0.47	ND				
STA3	23-Sep-88																
STA3	21-Oct-88	ND		22	ND					ND		0.47	ND		ND		
STA3	19-Nov-88	ND		23	0.2					ND		0.49	ND		ND		
STA3	19-Dec-88	ND		24	ND					0.42		0.51	ND		ND		
STA3	27-Jan-89	ND		23	ND					0.02		0.52	ND		ND		
STA3	24-Feb-89	ND		23	0.2					ND		0.49	ND		ND		
STA3	21-Mar-89	ND		22	ND					0.02		0.49	ND		ND		
STA3	15-Apr-89	ND		23	ND					ND		0.58	ND		ND		
STA3	16-May-89	ND		20	ND					ND		0.45	ND		ND		
STA3	19-Jun-89	ND		22	ND					0.03		0.5	ND		ND		
STA3	20-Jul-89	ND		25	ND					ND		0.52	ND		ND		
STA3	23-Aug-89	ND		23	ND					0.01		0.55	ND		ND		
STA3	26-Sep-89	ND		23	ND					ND		0.53	ND		ND		
STA3	28-Oct-89	ND		25	ND					ND		0.5	ND		ND		
STA3	31-Jan-90	ND		24	ND					0.02		0.51	ND		ND		
STA3	27-Apr-90	ND		17	ND					0.06		0.39	ND		ND		
STA3	27-Jul-90	ND		27	0.1					ND		0.58	ND		ND		
STA3	30-Oct-90	ND		21	ND					0.01		0.47	ND		ND		
STA3	16-Nov-08			26	0.0063	0.0206				ND			ND	ND	0.00194	0.00221	ND
STA4	30-Jul-88	ND		28	0.1					0.08		0.62	ND				
STA4	31-Aug-88	ND		31	ND					0.05		0.65	ND				
STA4	23-Sep-88	ND		21	ND					ND		0.51	ND				
STA4	21-Oct-88	ND		22	ND					ND		0.48	ND		ND		
STA4	19-Nov-88	ND		27	0.1					ND		0.57	ND		ND		
STA4	19-Dec-88											0.61					
STA4	27-Jan-89																
STA4	24-Feb-89																
STA4	20-Mar-89	ND		30	ND					0.04		0.66	ND		ND		
STA4	14-Apr-89	ND		25	ND					ND		0.56	ND		ND		
STA4	16-May-89	ND		19	ND					ND		0.43	ND		ND		
STA4	19-Jun-89	ND		24	ND					0.04		0.54	ND		ND		
STA4	20-Jul-89	ND		33	ND					ND		0.67	ND		ND		

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Acidity, Total (mg/L)	Alkalinity as CaCO3, Dissolved (mg/L)	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia + org-N (as N) (mg/L)	Ammonia + Org-N and Nitrogen, Dissolved (mg/L)	Ammonia + Org-N as Nitrogen, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Ammonia as Nitrogen, Dissolved (mg/L)	Anions (meq/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Beryllium, Dissolved (mg/L)
STA4	23-Aug-89	ND		36	ND					0.11		0.75	ND		ND		
STA4	27-Sep-89	ND		25	ND					ND		0.56	ND		ND		
STA4	28-Oct-89	ND		24	ND					ND		0.51	ND		ND		
STA4	19-Dec-89	ND		29	ND					0.27			ND		ND		
STA4	31-Jan-90	ND		28	ND					0.06		0.6	ND		ND		
STA4	29-Apr-90	ND		16	ND					0.04		0.37	ND		ND		
STA4	27-Jul-90	ND		27	0.1					ND		0.75	ND		ND		
STA4	16-Nov-08			20	0.0175	0.0235				ND			ND	ND	0.00224	0.00232	ND
STA5	30-Jul-88	ND		31	ND					0.01		0.78	ND				
STA5	31-Aug-88	ND		34	ND					0.05		0.89	ND				
STA5	23-Sep-88	ND		45	ND					ND		1.16	ND				
STA5	21-Oct-88	ND		45	ND					ND		1.18	ND		ND		
STA5	19-Nov-88											1.3					
STA5	20-Dec-88											1.3					
STA5	29-Jan-89	ND		48	0.1					0.05		1.41	ND		ND		
STA5	24-Feb-89	ND		51	0.2					0.1		1.47	ND		ND		
STA5	22-Mar-89	ND		51	ND					0.02		1.51	ND		ND		
STA5	15-Apr-89				ND							1.47	ND		ND		
STA5	16-Apr-89	ND		52						ND							
STA5	16-May-89	ND		47	ND					ND		1.28	ND		ND		
STA5	19-Jun-89	ND		26	ND					0.03		0.65	ND		ND		
STA5	20-Jul-89	ND		29	ND					ND		0.69	ND		ND		
STA5	23-Aug-89	ND		33	ND					ND		0.88	ND		ND		
STA5	27-Sep-89	ND		43	ND					ND		1.09	ND		ND		
STA5	28-Oct-89	ND		43	ND					ND		1.16	ND		ND		
STA5	19-Nov-89	ND		48	0.2					0.36			ND		ND		
STA5	20-Dec-89	ND		47	ND					0.15			ND		ND		
STA5	30-Jan-90	ND		52	ND					ND		1.47	ND		ND		
STA5	29-Apr-90	ND		39	ND					0.05		1.07	ND		ND		
STA5	27-Jul-90	ND		30	0.1					ND		0.8	ND		ND		
STA5	30-Oct-90	ND		44	ND					ND		0.47	ND		ND		
STA5	13-Nov-08			45	0.0033	0.0081				ND			0.0008	0.0008	0.0325	0.0316	ND
STA6	12-May-88																
STA6	30-Jul-88																
STA6	31-Aug-88																
STA6	23-Sep-88																
STA6	22-Oct-88																
STA6	18-Nov-88																
STA6	20-Dec-88																
STA6	29-Jan-89																
STA6	24-Feb-89																
STA6	25-Feb-89																
STA6	20-Mar-89																
STA6	22-Mar-89																
STA6	14-Apr-89																
STA6	12-May-89																
STA6	16-May-89																
STA6	19-Jun-89																
STA6	20-Jul-89																
STA6	23-Aug-89																
STA6	27-Sep-89																
STA6	13-Nov-08			42	0.0034	0.0105				ND			0.0009	0.0012	0.0319	0.0319	ND
STA7	30-Jul-88																
STA7	31-Aug-88																
STA7	23-Sep-88																
STA7	22-Oct-88																
STA7	18-Nov-88																

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Acidity, Total (mg/L)	Alkalinity as CaCO3, Dissolved (mg/L)	Alkalinity as CaCO3, Total (mg/L)	Aluminum, Dissolved (mg/L)	Aluminum, Total (mg/L)	Ammonia + org-N (as N) (mg/L)	Ammonia + Org-N and Nitrogen, Dissolved (mg/L)	Ammonia + Org-N as Nitrogen, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Ammonia as Nitrogen, Dissolved (mg/L)	Anions (meq/L)	Arsenic, Dissolved (mg/L)	Arsenic, Total (mg/L)	Barium, Dissolved (mg/L)	Barium, Total (mg/L)	Beryllium, Dissolved (mg/L)
STA7	19-Dec-88																
STA7	20-Dec-88																
STA7	29-Jan-89																
STA7	24-Feb-89																
STA7	25-Feb-89																
STA7	20-Mar-89																
STA7	22-Mar-89																
STA7	14-Apr-89																
STA7	12-May-89																
STA7	16-May-89																
STA7	19-Jun-89																
STA7	20-Jul-89																
STA7	23-Aug-89																
STA7	26-Sep-89																
STA7	13-Nov-08			42	0.0081	0.0079				0.011			0.001	0.009	0.0318	0.0319	ND
SWEQB	13-Nov-08				ND								ND		0.39		ND

Note: Blank cells indicate component was not analyzed.

Abbreviations

CaCO3: Calcium carbonate
meq/L Milliequivalents per liter
mg/L: Milligrams per liter
µS/cm: Microsiemens per centimeter
NTU: Nephelometric Turbidity Units
ND: Not detected. If available, reporting limits are provided in the database (Attachment 3).

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Beryllium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Carbonate, CO3 (mg/L)	Cation/Anion Difference (%)	Cations (meq/L)	Chloride (mg/L)	Chloride, Dissolved (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Hexavalent, Total (mg/L)	Chromium, Total (mg/L)	Color (Color Units)	Conductivity at 25 Degrees Celsius (µS/cm)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)
15283550	18-Mar-99		40		ND		16.6				7.95				ND		130		ND	
15283550	29-Jun-99		28		ND		9.3				0.75				ND		48		0.0015	
15283550	12-Nov-99		37		ND		13.8				2.95				ND		100		0.001	
15283550	05-Apr-00		42		ND		16.6				6.75				ND		125		0.0006	
15283550	28-Jun-00		25		ND		7.91				0.39				0.0007		50			
15283550	23-Sep-00		32		ND		9.84				0.63				0.0006		67			
15283550	27-Mar-01		38		ND		17.9				6.49				ND		129		ND	
15283550	19-Jun-01		23		ND		7.42				0.44				ND		51		0.0012	
15283550	12-Oct-01		36		ND		13.2				2.23				ND		90		ND	
15283700	04-Oct-48						13					2					88			
15283700	19-Apr-49											7					139			
15283700	18-Apr-51						14					3.4					102			
15283700	05-May-51						13					2.2					97			
15283700	14-May-51						11					1.9					82			
15283700	21-Nov-51						15					5.2					110			
15283700	11-Feb-52						16					5.5					117			
15283700	12-Mar-52						16					5.8					126			
15283700	18-Apr-52						16					5					121			
15283700	07-May-52						16					5.5					116			
15283700	12-Jun-52						8.4					1.8					54			
15283700	16-Jul-52						10					0.8					66			
15283700	13-Sep-52						13					0.5					80			
15283700	29-Sep-52						13					1.5					89			
15283700	12-May-56						13					3					104			
15283700	09-Aug-71																130			
15283700	30-Jun-98						9.96					1.03			0.00128		66		0.0021	
15283700	18-Mar-99						18.1					5.98					137		0.001	
15283700	29-Jun-99						10.1					0.79					58			
15283700	12-Nov-99						16.7					2.31					120		0.0016	
15283700	05-Apr-00						17.4					4.87					140			
15283700	28-Jun-00						8.44					0.44					56			
15283700	23-Sep-00						10.6					0.78					78			
15283700	27-Mar-01						19.4					4.47					144			
15283700	19-Jun-01						8.1					0.62					57		0.0019	
15283700	12-Oct-01						14.5					1.98					105			
STA1	30-Jul-88		29	0.04	ND		9.2	0	0	0.63	1.4		ND		ND		69			0.07
STA1	31-Aug-88		32	0.05	ND		11	0	0	0.7	1.8		ND		ND		78			0.05
STA1	23-Sep-88		38	0.07	ND		13	0	1.75	0.84	2.1		ND		ND		92			0.1
STA1	21-Oct-88				ND								ND		ND			ND		
STA1	22-Oct-88		44	0.08			14	0	1.9	1.07	3.2						104			0.02
STA1	18-Nov-88		39	0.36	ND		14	0	1.96	1	3.2		ND		ND		118	ND		0.03
STA1	20-Dec-88		45	0.08	ND		16	0	2.48	1.18	5		ND		ND		135	ND		0.02
STA1	27-Jan-89		40	0.34	ND		17	0	0.41	1.2	6		ND		ND		120	ND		0.09
STA1	24-Feb-89		43	0.28	ND		8.1	0	0.39	1.29	8.2		ND		ND		130	ND		0.05
STA1	22-Mar-89		42	0.2	ND		18	0	1.15	1.29	9		ND		ND		129	ND		0.07
STA1	15-Apr-89		62	0.39	ND		15	0	0.31	1.6	5.7		ND		ND		155	ND		0.09
STA1	16-May-89		54	ND	ND		15	0	1.19	1.25	2.8		ND		ND		110	ND		0.06
STA1	19-Jun-89		25	ND	ND		4.1	0	0.88	0.56	1.1		ND		ND		57	ND		0.06
STA1	20-Jul-89		27	ND	ND		9	0	2.8	0.52	2.1		ND		ND		65	ND		0.03
STA1	23-Aug-89		35	0.01	ND		5.6	0	2.53	0.77	2.1		ND		ND		70	ND		0.05
STA1	27-Sep-89		34	ND	ND		12	0	0.63	0.8	2.1		ND		ND		73	0.02		0.04
STA1	28-Oct-89		37	0.2	ND		13	0	2.22	0.88	2.8		ND		ND		93	ND		
STA1	30-Jan-90		40	ND	ND		16	0	0	1.21	7.8		ND		ND		118	ND		
STA1	27-Apr-90		41	0.07	ND		17	0	0.48	1.04	3.2		ND		ND		108	ND		0.02
STA1	27-Jul-90		30	0.2	ND		10	0	0	0.68	1.5		ND		ND		60	ND		0.05
STA1	30-Oct-90		37	0.01	ND		13	0	0.52	0.95	3.5		ND		ND		97	ND		0.07
STA1	13-Nov-08	ND			ND	ND					2.6		ND	ND	0.0003	5	120	0.0006	0.0005	0.023

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Beryllium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Carbonate, CO3 (mg/L)	Cation/Anion Difference (%)	Cations (meq/L)	Chloride (mg/L)	Chloride, Dissolved (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Hexavalent, Total (mg/L)	Chromium, Total (mg/L)	Color (Color Units)	Conductivity at 25 Degrees Celsius (µS/cm)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)
STA2	30-Jul-88		61	0.03	ND		13	0	0	1.1	1		ND		ND		108			0.08
STA2	31-Aug-88		65	0.02	ND		15	0	0.88	1.15	0.7		ND		ND		114			0.06
STA2	23-Sep-88		52	ND	ND		13	0	1.04	0.97	0.4		ND		ND		97			0.1
STA2	21-Oct-88		56	0.02	ND		14	0	1.46	1.04	1.1		ND		ND		92	ND		0.04
STA2	18-Nov-88		63	0.28			15	0	0	1.12	0.4						98			0.04
STA2	19-Nov-88				ND								ND		ND			ND		
STA2	19-Dec-88		63	0.01	ND		15	0	0.89	1.13	0.7		ND		ND		103	ND		0.03
STA2	29-Jan-89		62	0.26	ND		17	0	2.18	1.17	1.1		ND		ND		109	ND		0.09
STA2	24-Feb-89		70	0.21	ND		7.7	0	0.41	1.21	ND		ND		ND		102	ND		0.08
STA2	21-Mar-89		70	0.26	ND		15.7	0	0.41	1.22	0.7		ND		ND		105	ND		0.07
STA2	14-Apr-89		49	0.4	ND		13	0	0.54	0.93	0.7		ND		ND		89	ND		0.08
STA2	15-May-89			ND																0.06
STA2	16-May-89		48		ND		12	0	1.09	0.93	ND		ND		ND		77	ND		
STA2	19-Jun-89		57	ND	ND		6.9	0	0.99	1	0.7		ND		ND		106	ND		0.06
STA2	20-Jul-89		71	ND	ND		8.3	0	2.04	1.2	1		ND		ND		105	ND		0.05
STA2	23-Aug-89		71	ND	ND		8.3	ND	2.04	1.2	1		ND		ND		105	ND		0.04
STA2	27-Sep-89		63	ND	ND		15	0	0.44	1.13	1.8		ND		ND		86	ND		0.04
STA2	28-Oct-89		60	0.16	ND		15	0	0.47	1.07	1.1		ND		ND		104	ND		
STA2	30-Jan-90		66	ND	ND		16	0	0.39	1.19	0.5		ND		ND		107	ND		
STA2	29-Apr-90		31	0.04	ND		10	0	0.78	0.64	0.5		ND		ND		65	ND		0.02
STA2	27-Jul-90		67	0.16	ND		17	0	0.87	1.14	0.4		ND		ND		108	ND		0.06
STA2	30-Oct-90		59	0.01	ND		15	0	0.47	1.06	0.7		ND		ND		105	ND		0.07
STA2	13-Nov-08	ND			ND	ND					0.5		ND	ND	0.0002	15	101	0.001	0.001	0.097
STA3	30-Jul-88		25	0.05	ND		1.1	0	0	0.45	0.7		ND		ND		51			0.06
STA3	31-Aug-88		26	0.01	ND		5.2	0	0	0.47	1.4		ND		ND		49			0.05
STA3	23-Sep-88																			
STA3	21-Oct-88		26	ND	ND		4.9	0	3.09	0.5	1.1		ND		ND		43	ND		0.03
STA3	19-Nov-88		28	0.28	ND		4.9	0	2.97	0.52	0.7		ND		ND		48	ND		0.03
STA3	19-Dec-88		29	0.01	ND		1.6	0	5.15	0.46	1.1		ND		ND		50	ND		0.02
STA3	27-Jan-89		28	0.26	ND		5.7	0	0.97	0.51	1.1		ND		ND		48	ND		0.08
STA3	24-Feb-89		27	0.22	ND		3.1	0	2.08	0.47	0.7		ND		ND		53	ND		0.04
STA3	21-Mar-89		27	0.25	ND		5	0	0	0.49	1.4		ND		ND		45	ND		0.04
STA3	15-Apr-89		27	0.4	ND		5.7	0	0.85	0.59	2.1		ND		ND		46	ND		0.05
STA3	16-May-89		24	ND	ND		4.6	0	2.27	0.43	1.1		ND		ND		41	ND		0.03
STA3	19-Jun-89		26	ND	ND		2.4	0	0	0.5	1.1		ND		ND		46	ND		0.05
STA3	20-Jul-89		30	ND	ND		5.9	0	1.96	0.5	0.7		ND		ND		49	ND		0.04
STA3	23-Aug-89		28	ND	ND		2.5	0	1.85	0.53	ND		ND		ND		49	ND		0.04
STA3	26-Sep-89		28	ND	ND		6	0	2.91	0.5	2.5		ND		ND		38	ND		0.04
STA3	28-Oct-89		60	0.17	ND		5.8	0	1.96	0.52	ND		ND		ND		49	ND		
STA3	31-Jan-90		29	ND	ND		6.6	0	1.31	0.52	0.8		ND		ND		43	ND		
STA3	27-Apr-90		21	0.03	ND		4.8	0	0	0.39	0.7		ND		ND		42	ND		0.02
STA3	27-Jul-90		33	0.12	ND		8	0	0	0.58	0.4		ND		ND		52	ND		0.06
STA3	30-Oct-90		26	0.01	ND		5	0	0	0.47	1.1		ND		ND		48	0.01		0.05
STA3	16-Nov-08	ND			0.00004	ND					0.5		ND	ND	ND	15	58	0.0007	0.0006	ND
STA4	30-Jul-88		34	ND	ND		7.2	0	1.64	0.6	0.4		ND		ND		64			0.06
STA4	31-Aug-88		37	0.02	ND		7.4	0	0.76	0.66	0.7		ND		ND		67			0.06
STA4	23-Sep-88		25	ND	ND		5.3	0	0.99	0.5	2.8		ND		ND		56			0.09
STA4	21-Oct-88		27	ND	ND		4.9	0	3.03	0.51	1.1		ND		ND		46	ND		0.03
STA4	19-Nov-88		31	0.3	ND		6.1	0	1.72	0.59	0.7		ND		ND		50	ND		0.03
STA4	19-Dec-88		35	ND	ND		7.3	0	4.27	0.56	ND		ND				64			0.02
STA4	27-Jan-89																			
STA4	24-Feb-89																			
STA4	20-Mar-89		36	0.12	ND		6.9	0	0	0.66	0.7		ND		ND		61	0.02		0.05
STA4	14-Apr-89		30	0.32	ND		7.5	0	0.88	0.57	1.1		ND		ND		58	ND		0.05
STA4	16-May-89		23	ND	ND		4.6	0	1.15	0.44	0.7		ND		ND		43	ND		0.04
STA4	19-Jun-89		29	ND	ND		3	0	0.93	0.53	1.1		ND		ND		53	ND		0.05
STA4	20-Jul-89		40	ND	ND		8.4	0	0	0.67	ND		ND		ND		64	ND		0.04

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Beryllium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Carbonate, CO3 (mg/L)	Cation/Anion Difference (%)	Cations (meq/L)	Chloride (mg/L)	Chloride, Dissolved (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Hexavalent, Total (mg/L)	Chromium, Total (mg/L)	Color (Color Units)	Conductivity at 25 Degrees Celsius (µS/cm)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)
STA4	23-Aug-89		43	ND	ND		4.1	0	0.67	0.74	ND		ND		ND		70	ND		0.04
STA4	27-Sep-89		31	ND	ND		6.8	0	1.75	0.58	1.8		ND		ND		85	ND		0.04
STA4	28-Oct-89		29	0.16	ND		6.1	0	2.86	0.54	ND		ND		ND		52	ND		
STA4	19-Dec-89														ND			ND		
STA4	31-Jan-90		34	ND	ND		7.3	0	0.52	0.61	0.6		ND		ND		55	ND		
STA4	29-Apr-90		19	0.08	ND		4	0	1.37	0.36	0.8		ND		ND		35	ND		0.02
STA4	27-Jul-90		42	0.16	ND		8.8	0	0.67	0.74	0.5		ND		ND		60	ND		0.1
STA4	16-Nov-08	ND			ND	ND					0.4		ND	ND	ND	15	49	0.0008	0.0007	ND
STA5	30-Jul-88		37	0.04	ND		11	0	0.64	0.79	1.4		ND		ND		86			0.05
STA5	31-Aug-88		41	0.05	ND		12	0	1.14	0.87	1.8		ND		ND		93			0.05
STA5	23-Sep-88		54	0.03	ND		14	0	0.87	1.14	1.8		ND		ND		116			0.1
STA5	21-Oct-88		55	0.06	ND		14	0	0.42	1.19	2.5		ND		ND		108	ND		0.03
STA5	19-Nov-88		58	0.46			16	0	0.39	1.29	2.8						107			0.03
STA5	20-Dec-88		57	0.09			17	0	1.56	1.26	3.9						118			0.02
STA5	29-Jan-89		59	0.35	ND		18	0	0.71	1.39	5		ND		ND		121	ND		0.08
STA5	24-Feb-89		62	0.27	ND		8.7	0	1.03	1.44	5.7		ND		ND		150	ND		0.05
STA5	22-Mar-89		62	0.29	ND		19	0	2.03	1.45	6.7		ND		ND		135	ND		0.04
STA5	15-Apr-89		63		ND		15	0	0	1.47	4.3		ND		ND		144	ND		
STA5	16-Apr-89			0.36																0.05
STA5	16-May-89		57	ND	ND		15	0	1.19	1.25	2.8		ND		ND		107	ND		0.04
STA5	19-Jun-89		31	ND	ND		4.3	0	1.56	0.63	0.7		ND		ND		63	ND		0.04
STA5	20-Jul-89		35	ND	ND		10.1	0	2.22	0.66	0.7		ND		ND		68	ND		0.03
STA5	23-Aug-89		40	ND	ND		5.9	0	0.57	0.87	1.1		ND		ND		78	ND		0.03
STA5	27-Sep-89		52	ND	ND		14	0	1.87	1.05	2.1		ND		ND		82	ND		0.03
STA5	28-Oct-89		52	0.2	ND		15	0	0.43	1.17	1.8		ND		ND		109	ND		
STA5	19-Nov-89				ND								ND		ND			ND		
STA5	20-Dec-89				ND								ND		ND			0.01		
STA5	30-Jan-90		63	ND	ND		19	0	0.36	1.48	5		ND		ND		138	ND		
STA5	29-Apr-90		47	0.08	ND		12	0	0.47	1.08	1.5		ND		ND		110	ND		0.03
STA5	27-Jul-90		37	0.16	ND		12	0	0.63	0.79	1.3		ND		ND		71	ND		0.04
STA5	30-Oct-90		26	0.01	ND		5	0	0	0.47	1.1		ND		ND		48	0.01		0.05
STA5	13-Nov-08	ND			ND	ND					2.0		ND	ND	ND	5	133	0.0008	0.0007	0.030
STA6	12-May-88																			
STA6	30-Jul-88																			
STA6	31-Aug-88																			
STA6	23-Sep-88																			
STA6	22-Oct-88																			
STA6	18-Nov-88																			
STA6	20-Dec-88																			
STA6	29-Jan-89																			
STA6	24-Feb-89																			
STA6	25-Feb-89																			
STA6	20-Mar-89																			
STA6	22-Mar-89																			
STA6	14-Apr-89																			
STA6	12-May-89																			
STA6	16-May-89																			
STA6	19-Jun-89																			
STA6	20-Jul-89																			
STA6	23-Aug-89																			
STA6	27-Sep-89																			
STA6	13-Nov-08	ND			ND	ND					2.2		ND	ND	ND	5	132	0.6	0.6	0.031
STA7	30-Jul-88																			
STA7	31-Aug-88																			
STA7	23-Sep-88																			
STA7	22-Oct-88																			
STA7	18-Nov-88																			

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Beryllium, Total (mg/L)	Bicarbonate, HCO3 (mg/L)	Boron (mg/L)	Cadmium, Dissolved (mg/L)	Cadmium, Total (mg/L)	Calcium, Dissolved (mg/L)	Carbonate, CO3 (mg/L)	Cation/Anion Difference (%)	Cations (meq/L)	Chloride (mg/L)	Chloride, Dissolved (mg/L)	Chromium, Dissolved (mg/L)	Chromium, Hexavalent, Total (mg/L)	Chromium, Total (mg/L)	Color (Color Units)	Conductivity at 25 Degrees Celsius (µS/cm)	Copper, Dissolved (mg/L)	Copper, Total (mg/L)	Fluoride (mg/L)
STA7	19-Dec-88																			
STA7	20-Dec-88																			
STA7	29-Jan-89																			
STA7	24-Feb-89																			
STA7	25-Feb-89																			
STA7	20-Mar-89																			
STA7	22-Mar-89																			
STA7	14-Apr-89																			
STA7	12-May-89																			
STA7	16-May-89																			
STA7	19-Jun-89																			
STA7	20-Jul-89																			
STA7	23-Aug-89																			
STA7	26-Sep-89																			
STA7	13-Nov-08	ND			ND	ND					2.0		ND	ND	ND	5	130	0.7	0.7	0.029
SWEQB	13-Nov-08				ND								ND					ND		

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Fluoride, Dissolved (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate + Nitrite as Nitrogen, Dissolved (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrate+Nitrite as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)
15283550	18-Mar-99		49	ND	0.007			ND	1.79		ND	0.0025	ND				1.44		0.003
15283550	29-Jun-99		27	ND	0.056			ND	0.877		ND	ND	ND				0.403		0.003
15283550	12-Nov-99		41	ND	0.028			ND	1.51		0.0012	ND	ND						
15283550	05-Apr-00		49	ND	ND			0.0007	1.83		ND	ND	ND						
15283550	28-Jun-00		23	ND				ND	0.721		ND		ND				0.372		0.003
15283550	23-Sep-00		28	ND				ND	0.9		ND		ND						
15283550	27-Mar-01		52	ND	ND			ND	1.82		ND	ND	ND				1.45		0.003
15283550	19-Jun-01		22	ND	0.224			ND	0.725		ND	0.0051	0.000007						
15283550	12-Oct-01		38	ND	0.014			ND	1.33		ND	ND	ND						
15283700	04-Oct-48	0	43						2.5										
15283700	19-Apr-49																		
15283700	18-Apr-51		42						1.8										
15283700	05-May-51	0.1	40						1.9										
15283700	14-May-51	0.1	35						1.8										
15283700	21-Nov-51	0.2	47						2.4										
15283700	11-Feb-52	0.3	50						2.4										
15283700	12-Mar-52	0.1	51						2.7										
15283700	18-Apr-52	0	51						2.6										
15283700	07-May-52	0.1	52						3										
15283700	12-Jun-52	0.1	27						1.5										
15283700	16-Jul-52	0	30						1.3										
15283700	13-Sep-52	0	36						1.2										
15283700	29-Sep-52		42						2.3										
15283700	12-May-56		42						2.2										
15283700	09-Aug-71																		
15283700	30-Jun-98		29	0.016	0.3				1.11						0.0251	0.13			
15283700	18-Mar-99		56		0.02				2.71			0.0037				0.403			
15283700	29-Jun-99		30		0.079				1.17							0.102			
15283700	12-Nov-99		53	0.016	0.034				2.71							0.606			
15283700	05-Apr-00		55		0.022				2.81							0.481			
15283700	28-Jun-00		25						0.932		0.0027					0.102			
15283700	23-Sep-00		32	0.013					1.25							0.201			
15283700	27-Mar-01		60						2.83							0.4			
15283700	19-Jun-01		24		0.478				0.946			0.0138				0.099			
15283700	12-Oct-01		45	0.018	0.046				2.02							0.201			
STA1	30-Jul-88		27	ND	0.17	ND	ND		1.1		ND	ND	ND				0.12		ND
STA1	31-Aug-88		31	ND	ND	ND	ND		1		ND	ND	ND				0.18		ND
STA1	23-Sep-88		36	ND	ND	0.1	ND		1.2		ND	ND	ND				0.21		ND
STA1	21-Oct-88			ND	0.09		ND				ND	ND	ND						
STA1	22-Oct-88		42			0.1			1.9								0.26		ND
STA1	18-Nov-88		43	ND	0.11	0.1	ND		1.7		ND	ND	ND				0.31		ND
STA1	20-Dec-88		47	ND	0.08	0.2	ND		1.5		ND	ND	ND				0.94		ND
STA1	27-Jan-89		50	ND	0.08	ND	ND		2.1		ND	ND	ND				0.65		ND
STA1	24-Feb-89		50	ND	ND	ND	ND		7.3		ND	ND	ND				0.5		ND
STA1	22-Mar-89		52	ND	ND	ND	ND		1.5		ND	ND	ND				0.34		ND
STA1	15-Apr-89		46	0.12	0.66	0.2	ND		2.3		0.02	0.05	ND				0.69		ND
STA1	16-May-89		42	0.06	0.06	0.1	0.08		1.1		ND	ND	ND				0.89		ND
STA1	19-Jun-89		25	ND	0.19	ND	ND		3.6		ND	ND	ND				0.14		ND
STA1	20-Jul-89		23	ND	0.17	0.3	ND		0.1		ND	ND	ND				ND		ND
STA1	23-Aug-89		35	ND	0.34	ND	ND		5		ND	ND	ND				0.31		ND
STA1	27-Sep-89		37	0.06	0.24	ND	ND		1.6		ND	ND	ND				0.2		ND
STA1	28-Oct-89		38	ND	ND	0.5	ND		1.5		ND	ND	ND				0.25		ND
STA1	30-Jan-90		49	ND	ND	ND	ND		2.4		ND	ND	ND				0.38		ND
STA1	27-Apr-90		43	ND	0.32	0.5	ND		0.5		ND	ND	ND				1.58		ND
STA1	27-Jul-90		30	ND	0.16	1.1	ND		1		ND	ND	ND				0.08		ND
STA1	30-Oct-90		42	ND	ND	0.1	ND		2.3		0.03	ND	ND				0.29		ND
STA1	13-Nov-08		43.1	ND	ND		ND	0.00003	1.69	1.67				ND	ND		0.2	0.31	ND

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Fluoride, Dissolved (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate + Nitrite as Nitrogen, Dissolved (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrate+Nitrite as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)
STA2	30-Jul-88		47	ND	0.41	0.2	ND		3.4		ND	0.02	ND				0.37		ND
STA2	31-Aug-88		50	ND	0.09	0.2	ND		2.8		ND	ND	ND				0.34		ND
STA2	23-Sep-88		41	0.05	0.25	0.1	ND		1.9		ND	ND	ND				0.53		ND
STA2	21-Oct-88		45	ND	0.35	ND	ND		2.6		ND	ND	ND				0.57		ND
STA2	18-Nov-88		48			0.1			2.8								0.49		ND
STA2	19-Nov-88			ND	0.16		ND				ND	ND	ND						
STA2	19-Dec-88		51	ND	0.11	0.4	ND		3		ND	ND	ND				0.56		ND
STA2	29-Jan-89		50	ND	0.24	ND	ND		2.1		ND	ND	ND				0.58		ND
STA2	24-Feb-89		50	ND	0.07	0.1	ND		7.5		ND	ND	ND				0.6		ND
STA2	21-Mar-89		53	ND	0.07	ND	ND		3.2		ND	ND	ND				0.5		ND
STA2	14-Apr-89		39	0.05	1.42	0.4	ND		1.3		ND	0.04	ND				0.91		ND
STA2	15-May-89		38			0.7													
STA2	16-May-89			0.06	0.06		ND		1.8		ND	ND	ND				0.93		ND
STA2	19-Jun-89		43	ND	0.55	ND	ND		6.4		ND	ND	ND				0.39		ND
STA2	20-Jul-89		46	ND	0.37	0.5	ND		7.8		ND	ND	ND				0.46		ND
STA2	23-Aug-89		53	ND	0.2	ND	ND		7.8		ND	ND	ND				0.46		ND
STA2	27-Sep-89		50	0.09	0.49	ND	ND		3.2		ND	ND	ND				0.67		ND
STA2	28-Oct-89		46	ND	ND	0.5	ND		1.9		ND	ND	ND				0.58		ND
STA2	30-Jan-90		50	ND	0.1	ND	ND		2.3		ND	ND	ND				0.66		ND
STA2	29-Apr-90		27	0.07	6.24	0.6	ND		0.1		ND	0.19	ND				1.47		ND
STA2	27-Jul-90		50	ND	0.06	0.6	ND		1.9		ND	ND	ND				0.26		ND
STA2	30-Oct-90		47	ND	0.16	0.3	ND		2.6		ND	ND	ND				0.51		ND
STA2	13-Nov-08		40.2	ND	0.067		0.00002	0.00003	2.32	2.33				0.3	0.2		0.8	0.48	ND
STA3	30-Jul-88		16	0.16	2.43	ND	ND		3.3		ND	0.8	ND				0.05		ND
STA3	31-Aug-88		17	0.12	1.33	0.1	ND		1.1		0.03	0.03	ND				ND		ND
STA3	23-Sep-88																		
STA3	21-Oct-88		19	0.06	0.13	0.3	ND		1.7		ND	ND	ND				ND		ND
STA3	19-Nov-88		20	0.1	0.16	0.1	ND		1.7		ND	ND	ND				0.03		ND
STA3	19-Dec-88		19	0.05	0.15	1.6	ND		3.8		ND	ND	ND				0.04		ND
STA3	27-Jan-89		20	0.05	0.29	ND	ND		1.5		ND	ND	ND				0.21		ND
STA3	24-Feb-89		17	ND	0.1	0.3	ND		2.3		ND	ND	ND				0.12		ND
STA3	21-Mar-89		18	ND	0.09	ND	ND		1.2		ND	ND	ND				0.06		ND
STA3	15-Apr-89		23	ND	0.07	0.1	0.03		2.2		ND	ND	ND				0.1		ND
STA3	16-May-89		15	ND	ND	0.1	ND		1		ND	ND	ND				0.06		ND
STA3	19-Jun-89		20	ND	0.21	ND	ND		3.3		ND	ND	ND				0.01		ND
STA3	20-Jul-89		18	0.08	0.25	0.6	ND		1		0.03	0.05	ND				ND		ND
STA3	23-Aug-89		20	0.11	0.18	0.3	ND		3.3		0.05	0.05	ND				0.75		ND
STA3	26-Sep-89		20	ND	0.18	ND	ND		1.2		ND	ND	ND				0.04		ND
STA3	28-Oct-89		20	0.07	0.07	1	ND		1.2		ND	ND	ND				0.06		ND
STA3	31-Jan-90		19	0.08	0.12	ND	ND		0.5		ND	ND	ND				0.08		ND
STA3	27-Apr-90		14	0.1	0.27	0.2	ND		0.4		ND	0.02	ND				0.09		ND
STA3	27-Jul-90		22	ND	0.27	1.9	ND		0.5		ND	0.02	ND				0.1		ND
STA3	30-Oct-90		19	0.1	0.16	0.1	ND		1.5		ND	ND	ND				0.11		ND
STA3	16-Nov-08		19.1	0.026	0.084		0.00006	ND	1.31	1.42				0.0003	0.0003		ND	0.11	ND
STA4	30-Jul-88		23	ND	0.13	0.1	ND		1.2		ND	ND	ND				0.58		ND
STA4	31-Aug-88		26	0.24	0.48	ND	ND		1.8		ND	ND	ND				0.18		ND
STA4	23-Sep-88		19	0.06	0.15	0.3	ND		1.3		ND	ND	ND				0.01		ND
STA4	21-Oct-88		20	ND	0.12	0.1	ND		1.7		ND	ND	ND				0.1		ND
STA4	19-Nov-88		24	0.08	0.15	ND	ND		1.8		ND	ND	ND				0.16		ND
STA4	19-Dec-88		24			0.4			1.5								0.21		ND
STA4	27-Jan-89																		
STA4	24-Feb-89																		
STA4	20-Mar-89		24	ND	0.2	0.1	0.09		1.7		ND	ND	ND				0.29		ND
STA4	14-Apr-89		21	0.1	0.17	ND	ND		0.5		ND	ND	ND				0.41		ND
STA4	16-May-89		16	ND	ND	0.6	ND		1.1		ND	ND	ND				0.1		ND
STA4	19-Jun-89		21	0.07	0.12	ND	ND		3.3		ND	ND	ND				0.05		ND
STA4	20-Jul-89		26	0.11	0.14	0.7	ND		1.2		ND	ND	ND				0.17		ND

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Fluoride, Dissolved (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate + Nitrite as Nitrogen, Dissolved (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrate+Nitrite as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)
STA4	23-Aug-89		29	0.15	0.24	0.1	ND		4.6		0.02	0.02	ND				0.16		ND
STA4	27-Sep-89		23	0.15	1.99	ND	ND		1.5		ND	0.04	ND				0.14		ND
STA4	28-Oct-89		20	ND	ND	0.5	ND		1.3		ND	ND	ND				0.17		ND
STA4	19-Dec-89			0.12	0.18		ND				ND	ND	ND						
STA4	31-Jan-90		23	ND	0.15	0.2	ND		1.2		ND	ND	ND				0.28		ND
STA4	29-Apr-90		12	0.06	0.75	0.3	ND		0.6		ND	0.02	ND				0.24		ND
STA4	27-Jul-90		22	0.11	0.2	1.9	ND		1.5		0.02	0.02	ND				0.21		ND
STA4	16-Nov-08		15.8	0.031	0.048		0.00002	ND	1.17	1.16				ND	ND		0.1	0.16	ND
STA5	30-Jul-88		32	ND	0.14	0.1	ND		1.3		ND	ND	ND				0.13		ND
STA5	31-Aug-88		36	0.05	0.07	0.1	ND		1.5		ND	ND	ND				0.12		ND
STA5	23-Sep-88		42	ND	0.11	0.2	ND		1.8		ND	ND	ND				0.25		ND
STA5	21-Oct-88		47	ND	0.05	ND	ND		2.6		ND	ND	ND				0.31		ND
STA5	19-Nov-88		52			0.5			2.9								0.39		ND
STA5	20-Dec-88		53			0.7			2.7								0.43		ND
STA5	29-Jan-89		55	ND	0.1	ND	ND		2.8		ND	ND	ND				0.47		ND
STA5	24-Feb-89		57	ND	0.05	0.1	ND		8.8		ND	ND	ND				0.49		ND
STA5	22-Mar-89		59	ND	0.05	ND	0.02		2.9		ND	ND	ND				0.38		ND
STA5	15-Apr-89			0.08	0.3		ND		3.2		ND	ND	ND				0.68		ND
STA5	16-Apr-89		51			0.1													
STA5	16-May-89		44	ND	ND	0.6	ND		1.7		ND	ND	ND				0.78		ND
STA5	19-Jun-89		27	ND	0.29	ND	ND		4		ND	ND	ND				0.15		ND
STA5	20-Jul-89		28	ND	0.14	0.7	ND		0.7		ND	ND	ND				0.09		ND
STA5	23-Aug-89		36	ND	0.27	ND	ND		5.4		ND	ND	ND				0.51		ND
STA5	27-Sep-89		43	0.05	0.96	ND	ND		1.7		ND	ND	ND				0.31		ND
STA5	28-Oct-89		46	ND	ND	ND	ND		1.9		ND	ND	ND				0.38		ND
STA5	19-Nov-89			ND	0.08		ND				ND	ND	ND						
STA5	20-Dec-89			ND	0.08		ND				ND	ND	ND						
STA5	30-Jan-90		56	ND	0.07	ND	ND		2.2		ND	ND	ND				0.49		ND
STA5	29-Apr-90		36	0.1	6.14	0.5	ND		1.6		ND	0.18	ND				1.59		ND
STA5	27-Jul-90		34	ND	0.11	0.3	ND		1		ND	ND	ND				0.13		ND
STA5	30-Oct-90		50	ND	0.4	ND	ND		1.5		ND	ND	ND				0.11		ND
STA5	13-Nov-08		50.4	ND	0.035		0.00003	ND	2.57	2.53				ND	ND		0.3	0.32	ND
STA6	12-May-88																		
STA6	30-Jul-88																		
STA6	31-Aug-88																		
STA6	23-Sep-88																		
STA6	22-Oct-88																		
STA6	18-Nov-88																		
STA6	20-Dec-88																		
STA6	29-Jan-89																		
STA6	24-Feb-89																		
STA6	25-Feb-89																		
STA6	20-Mar-89																		
STA6	22-Mar-89																		
STA6	14-Apr-89																		
STA6	12-May-89																		
STA6	16-May-89																		
STA6	19-Jun-89																		
STA6	20-Jul-89																		
STA6	23-Aug-89																		
STA6	27-Sep-89																		
STA6	13-Nov-08		47.5	0.023	0.059		0.00003	ND	2.38	2.31				ND	ND		0.3	0.34	ND
STA7	30-Jul-88																		
STA7	31-Aug-88																		
STA7	23-Sep-88																		
STA7	22-Oct-88																		
STA7	18-Nov-88																		

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Fluoride, Dissolved (mg/L)	Hardness as CaCO3 (mg/L)	Iron, Dissolved (mg/L)	Iron, Total (mg/L)	Kjeldahl Nitrogen, Total (mg/L)	Lead, Dissolved (mg/L)	Lead, Total (mg/L)	Magnesium, Dissolved (mg/L)	Magnesium, Total (mg/L)	Manganese, Dissolved (mg/L)	Manganese, Total (mg/L)	Mercury, Dissolved (mg/L)	Nickel, Dissolved (mg/L)	Nickel, Total (mg/L)	Nitrate + Nitrite as Nitrogen, Dissolved (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrate+Nitrite as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)
STA7	19-Dec-88																		
STA7	20-Dec-88																		
STA7	29-Jan-89																		
STA7	24-Feb-89																		
STA7	25-Feb-89																		
STA7	20-Mar-89																		
STA7	22-Mar-89																		
STA7	14-Apr-89																		
STA7	12-May-89																		
STA7	16-May-89																		
STA7	19-Jun-89																		
STA7	20-Jul-89																		
STA7	23-Aug-89																		
STA7	26-Sep-89																		
STA7	13-Nov-08		49.4	0.037	0.036		ND	ND	2.37	2.45				ND	ND		0.3	0.31	ND
SWEQB	13-Nov-08			ND			ND		ND					ND					

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Nitrite as Nitrogen, Dissolved (mg/L)	Organic Phosphorus, Total (mg/L)	Ortho Phosphorus (mg/L)	Orthophosphate (mg/L)	Orthophosphate (as P) (mg/L)	Orthophosphate as P, Dissolved (mg/L)	Orthophosphate, Dissolved (mg/L)	Oxygen, Dissolved (%)	Oxygen, Dissolved (mg/L)	pH	Phosphorus as P (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Total (as P) (mg/L)	Potassium, Dissolved (mg/L)	Selenium, Dissolved (mg/L)
15283550	18-Mar-99				0.003	0.001					7.7				ND	0.47	
15283550	29-Jun-99				0.006	0.002					7.6				ND	0.35	
15283550	12-Nov-99					ND					7.6				ND	0.44	
15283550	05-Apr-00				0.015	0.005					7.6				ND	0.52	
15283550	28-Jun-00					ND					7.7					0.28	
15283550	23-Sep-00					ND					7.3					0.41	
15283550	27-Mar-01				0.015	0.005					7.5				0.002	0.52	
15283550	19-Jun-01					ND					7.6				0.019	0.29	
15283550	12-Oct-01					ND					7.5				ND	0.38	
15283700	04-Oct-48	0.25															
15283700	19-Apr-49																
15283700	18-Apr-51	0.45															
15283700	05-May-51	0.63															
15283700	14-May-51	0.41															
15283700	21-Nov-51	0.23															
15283700	11-Feb-52	0.25															
15283700	12-Mar-52	0.25															
15283700	18-Apr-52	0.36															
15283700	07-May-52	0.36															
15283700	12-Jun-52	0.2															
15283700	16-Jul-52	0.16															
15283700	13-Sep-52	0.36														0.9	
15283700	29-Sep-52	0.2														0.8	
15283700	12-May-56															0.6	
15283700	09-Aug-71																
15283700	30-Jun-98								99	10.8	7.9					0.37	
15283700	18-Mar-99	0.4					0.002	0.006	98	14.1	7.8					0.49	
15283700	29-Jun-99						0.001	0.003	93	11.2	7.7					0.42	
15283700	12-Nov-99								80	11.5	7.7					0.58	
15283700	05-Apr-00						0.005	0.015	93	13	7.8					0.56	
15283700	28-Jun-00	0.1							111	13	7.6					0.29	
15283700	23-Sep-00	0.2					0.001	0.003		11.5	7.6					0.46	
15283700	27-Mar-01								96	13.1	7.8					0.51	
15283700	19-Jun-01								99	11.6	7.7	0.013				0.31	
15283700	12-Oct-01								100	14.1	7.5					0.44	
STA1	30-Jul-88		0.002	0.002							7.28					0.4	ND
STA1	31-Aug-88		ND	0.001							7.16					0.3	ND
STA1	23-Sep-88		0.003	0.008							7.42			0.011		0.4	ND
STA1	21-Oct-88																ND
STA1	22-Oct-88		0.002	0.012							7.05			0.022		0.4	
STA1	18-Nov-88		ND	0.003							7.17			0.005		0.4	ND
STA1	20-Dec-88		ND	0.001							7.53			0.007		0.6	ND
STA1	27-Jan-89		ND	ND							7.31			ND		ND	ND
STA1	24-Feb-89		0.013	0.008							7.33			0.024		0.7	ND
STA1	22-Mar-89		0.002	0.005							7.51			0.006		0.3	ND
STA1	15-Apr-89		0.023	0.015							7.81			0.045		1.4	ND
STA1	16-May-89		0.001	0.02							7.68			0.026		0.7	ND
STA1	19-Jun-89		0.004	0.007							6.72			0.019		0.1	ND
STA1	20-Jul-89		0.004	0.003							7.4			0.009		0.4	ND
STA1	23-Aug-89		0.01	0.003							7.1			0.019		0.5	ND
STA1	27-Sep-89		0.001	0.005							7.44			0.006		0.4	ND
STA1	28-Oct-89		0.005	0.005							7.33			0.02		0.3	ND
STA1	30-Jan-90		ND	0.014							7.1			0.03		0.8	ND
STA1	27-Apr-90		ND	0.008							7.7			0.019		0.6	ND
STA1	27-Jul-90		0.011	0.008							7			0.019		0.4	ND
STA1	30-Oct-90		0.008	0.002							6.95			0.012		0.7	ND
STA1	13-Nov-08										7.64						ND

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Nitrite as Nitrogen, Dissolved (mg/L)	Organic Phosphorus, Total (mg/L)	Ortho Phosphorus (mg/L)	Orthophosphate (mg/L)	Orthophosphate (as P) (mg/L)	Orthophosphate as P, Dissolved (mg/L)	Orthophosphate, Dissolved (mg/L)	Oxygen, Dissolved (%)	Oxygen, Dissolved (mg/L)	pH	Phosphorus as P (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Total (as P) (mg/L)	Potassium, Dissolved (mg/L)	Selenium, Dissolved (mg/L)
STA2	30-Jul-88		0.007	ND							7.66					0.4	ND
STA2	31-Aug-88		0.002	0.001							7.57					0.3	ND
STA2	23-Sep-88		0.002	0.008							7.62			0.018		0.6	ND
STA2	21-Oct-88		0.014	0.012							7.1			0.042		0.3	ND
STA2	18-Nov-88		0.004	0.006							7.19			0.013		0.3	
STA2	19-Nov-88																ND
STA2	19-Dec-88		0.003	0.005							7.68			0.011		0.3	ND
STA2	29-Jan-89		ND	ND							7.74			ND		ND	ND
STA2	24-Feb-89		ND	0.002							7.61			ND		0.6	ND
STA2	21-Mar-89		0.013	0.006							7.68			0.005		0.7	ND
STA2	14-Apr-89		0.036	0.013							7.55			0.02		0.8	ND
STA2	15-May-89		0.003	0.018										0.021			
STA2	16-May-89										7.68					0.7	ND
STA2	19-Jun-89		0.006	0.006							7.16			0.084		0.2	ND
STA2	20-Jul-89		0.007	0.003							7.76			0.014		0.1	ND
STA2	23-Aug-89		0.007	0.003							7.5			0.017		0.5	ND
STA2	27-Sep-89		0.009	0.005							7.58			0.02		0.5	ND
STA2	28-Oct-89		0.009	0.007							7.64			0.027		0.6	ND
STA2	30-Jan-90		0.003	0.011							8.3			0.037		0.6	ND
STA2	29-Apr-90		0.06	0.009							7.2			0.191		0.7	ND
STA2	27-Jul-90		0.012	0.004							7.7			0.017		0.4	ND
STA2	30-Oct-90		0.011	0.004							7.4			0.019		0.7	ND
STA2	13-Nov-08										7.74						ND
STA3	30-Jul-88		0.077	0.003							7.07					0.4	ND
STA3	31-Aug-88		0.028	0.003							6.64					0.4	ND
STA3	23-Sep-88																
STA3	21-Oct-88		0.012	0.012							6.65			0.032		0.3	ND
STA3	19-Nov-88		0.013	0.003							6.56			0.021		0.3	ND
STA3	19-Dec-88		ND	0.002							7.17			0.009		0.2	ND
STA3	27-Jan-89		ND	ND							7.23			ND		ND	ND
STA3	24-Feb-89		ND	0.002							6.67			0.004		0.3	ND
STA3	21-Mar-89		0.004	0.006							6.74			0.013		0.2	ND
STA3	15-Apr-89		0.018	0.01							6.52			0.033		0.2	ND
STA3	16-May-89		0.002	0.016							7.09			0.026		0.4	ND
STA3	19-Jun-89		0.001	0.005							6.62			0.025		0.2	ND
STA3	20-Jul-89		0.011	0.02							6.74			0.018		0.4	ND
STA3	23-Aug-89		0.012	0.003							6.3			0.022		ND	ND
STA3	26-Sep-89		0.06	0.005							7.25			0.012		0.4	ND
STA3	28-Oct-89		0.012	0.004							7.01			0.025		0.4	ND
STA3	31-Jan-90		0.003	0.008							7			0.034		0.7	ND
STA3	27-Apr-90		0.006	0.009							6.8			0.022		0.6	ND
STA3	27-Jul-90		0.017	0.005							7			0.029		0.3	ND
STA3	30-Oct-90		0.008	0.004							6.7			0.014		0.5	ND
STA3	16-Nov-08										6.73						ND
STA4	30-Jul-88		0.006	ND							7.33					0.5	ND
STA4	31-Aug-88		0.01	0.002							7.02					0.4	ND
STA4	23-Sep-88		0.008	0.01							7.15			0.019		0.6	ND
STA4	21-Oct-88		0.007	0.01							6.98			0.025		0.2	ND
STA4	19-Nov-88		0.007	0.002							6.69			0.016		0.2	ND
STA4	19-Dec-88		0.003	0.002							7.33			0.008		ND	
STA4	27-Jan-89																
STA4	24-Feb-89																
STA4	20-Mar-89		0.017	0.006							6.63			0.027		0.3	ND
STA4	14-Apr-89		0.028	0.02							6.89			0.054		1.5	ND
STA4	16-May-89		0.004	0.027							7.21			0.032		0.4	ND
STA4	19-Jun-89		0.006	0.006							6.65			0.019		0.1	ND
STA4	20-Jul-89		0.005	0.001							7.29			0.011		0.4	ND

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Nitrite as Nitrogen, Dissolved (mg/L)	Organic Phosphorus, Total (mg/L)	Ortho Phosphorus (mg/L)	Orthophosphate (mg/L)	Orthophosphate (as P) (mg/L)	Orthophosphate as P, Dissolved (mg/L)	Orthophosphate, Dissolved (mg/L)	Oxygen, Dissolved (%)	Oxygen, Dissolved (mg/L)	pH	Phosphorus as P (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Total (as P) (mg/L)	Potassium, Dissolved (mg/L)	Selenium, Dissolved (mg/L)
STA4	23-Aug-89		0.005	0.003							6.8			0.014		0.5	ND
STA4	27-Sep-89		0.008	0.008							7.25			0.017		0.5	ND
STA4	28-Oct-89		0.009	0.005							7.16			0.021		0.4	ND
STA4	19-Dec-89																ND
STA4	31-Jan-90		0.002	0.008							7			0.033		0.5	ND
STA4	29-Apr-90		0.019	0.008							6.9			0.046		0.6	ND
STA4	27-Jul-90		0.017	0.005							7			0.029		0.5	ND
STA4	16-Nov-08										7.03						ND
STA5	30-Jul-88		0.002	ND							7.43					0.5	ND
STA5	31-Aug-88		0.005	0.002							7.09					0.8	ND
STA5	23-Sep-88		0.002	0.006							7.59			0.01		0.5	ND
STA5	21-Oct-88		0.002	0.01							7.16			0.022		0.4	ND
STA5	19-Nov-88		0.003	ND							7.02			0.007		0.4	
STA5	20-Dec-88		0.008	0.003							7.62			0.008		0.5	
STA5	29-Jan-89		ND	ND							7.58			ND		0.8	ND
STA5	24-Feb-89		0.002	0.001							7.6			0.003		0.6	ND
STA5	22-Mar-89		0.004	0.006							7.72			0.01		0.5	ND
STA5	15-Apr-89										7.67					0.9	ND
STA5	16-Apr-89		0.02	0.012										0.04			
STA5	16-May-89		0.027	0.02							7.61			0.001		0.6	ND
STA5	19-Jun-89		0.005	0.006							6.76			0.02		0.3	ND
STA5	20-Jul-89		0.003	ND							7.52			0.009		0.3	ND
STA5	23-Aug-89		0.006	0.003							6.7			0.014		0.5	ND
STA5	27-Sep-89		0.004	0.005							7.49			0.009		0.5	ND
STA5	28-Oct-89		0.008	0.004							7.53			0.02		0.4	ND
STA5	19-Nov-89																ND
STA5	20-Dec-89																ND
STA5	30-Jan-90		ND	0.007							7.4			0.033		0.8	ND
STA5	29-Apr-90		0.018	0.009							7.4			0.078		0.7	ND
STA5	27-Jul-90		0.003	0.005							7.1			0.013		0.3	ND
STA5	30-Oct-90		0.007	0.007							6.7			0.01		0.5	ND
STA5	13-Nov-08										7.57						ND
STA6	12-May-88																
STA6	30-Jul-88																
STA6	31-Aug-88																
STA6	23-Sep-88																
STA6	22-Oct-88																
STA6	18-Nov-88																
STA6	20-Dec-88																
STA6	29-Jan-89																
STA6	24-Feb-89																
STA6	25-Feb-89																
STA6	20-Mar-89																
STA6	22-Mar-89																
STA6	14-Apr-89																
STA6	12-May-89																
STA6	16-May-89																
STA6	19-Jun-89																
STA6	20-Jul-89																
STA6	23-Aug-89																
STA6	27-Sep-89																
STA6	13-Nov-08										7.63						ND
STA7	30-Jul-88																
STA7	31-Aug-88																
STA7	23-Sep-88																
STA7	22-Oct-88																
STA7	18-Nov-88																

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Nitrite as Nitrogen, Dissolved (mg/L)	Organic Phosphorus, Total (mg/L)	Ortho Phosphorus (mg/L)	Orthophosphate (mg/L)	Orthophosphate (as P) (mg/L)	Orthophosphate as P, Dissolved (mg/L)	Orthophosphate, Dissolved (mg/L)	Oxygen, Dissolved (%)	Oxygen, Dissolved (mg/L)	pH	Phosphorus as P (mg/L)	Phosphorus, Dissolved (mg/L)	Phosphorus, Total (mg/L)	Potassium, Total (as P) (mg/L)	Potassium, Dissolved (mg/L)	Selenium, Dissolved (mg/L)
STA7	19-Dec-88																
STA7	20-Dec-88																
STA7	29-Jan-89																
STA7	24-Feb-89																
STA7	25-Feb-89																
STA7	20-Mar-89																
STA7	22-Mar-89																
STA7	14-Apr-89																
STA7	12-May-89																
STA7	16-May-89																
STA7	19-Jun-89																
STA7	20-Jul-89																
STA7	23-Aug-89																
STA7	26-Sep-89																
STA7	13-Nov-08										7.63						ND
SWEQB	13-Nov-08																ND

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Selenium, Total (mg/L)	Silver, Total (mg/L)	Sodium Adsorption Ratio	Sodium Fraction of Cations (%)	Sodium, Dissolved (mg/L)	Solids, Settleable (mg/L)	Solids, Total Dissolved (mg/L)	Solids, Total Suspended (mg/L)	Sulfate (mg/L)	Sulfate, Dissolved (mg/L)	Turbidity (NTU)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
15283550	18-Mar-99	0.004		0.3		5.01			1	16.2		0.47		0.032
15283550	29-Jun-99	ND		0.1		1.24			0	6.07		1.7		ND
15283550	12-Nov-99	ND		0.2		2.61			ND	11.5		0.49		ND
15283550	05-Apr-00	ND		0.3		4.91			2	15.6		0.3		ND
15283550	28-Jun-00	ND		0.1		0.89				4.27		1.3		ND
15283550	23-Sep-00	ND		0.1		1.05				6.45		1		ND
15283550	27-Mar-01	ND		0.3		4.58			ND	15.6		2.5		ND
15283550	19-Jun-01	ND		0.1		0.83			17	4.56		3.4		ND
15283550	12-Oct-01	ND		0.2		2.35			1	9.44		1.2		ND
15283700	04-Oct-48										8			
15283700	19-Apr-49										11			
15283700	18-Apr-51										8.6			
15283700	05-May-51										5.3			
15283700	14-May-51										2.5			
15283700	21-Nov-51										7.9			
15283700	11-Feb-52										9.7			
15283700	12-Mar-52										10			
15283700	18-Apr-52										8.6			
15283700	07-May-52										10			
15283700	12-Jun-52										6.3			
15283700	16-Jul-52										4.6			
15283700	13-Sep-52			0.1	9	1.8					5.4			
15283700	29-Sep-52			0.1	9	2					6.6			
15283700	12-May-56			0.3	19	4.5					5.4			
15283700	09-Aug-71													
15283700	30-Jun-98			0.1	11	1.71					5.73	0.7		0.04
15283700	18-Mar-99	0.004		0.3	17	5.2					12.9	0.45		
15283700	29-Jun-99			0.2	12	1.97					6.18	1.5		
15283700	12-Nov-99			0.3	18	5.48					10.9	0.41		
15283700	05-Apr-00			0.4	19	6.16					13.2	0.35		
15283700	28-Jun-00			0.1	10	1.31					4.27	2.2		
15283700	23-Sep-00			0.2	14	2.45					6.31	7.9		
15283700	27-Mar-01			0.3	16	5.29					12.5			
15283700	19-Jun-01			0.1	10	1.31					4.74			
15283700	12-Oct-01			0.3	16	3.96					8.36			
STA1	30-Jul-88			0.13		1.6	ND	28	8	5.3		1.6	ND	
STA1	31-Aug-88			0.14		1.8	ND	24	1	5.3			ND	
STA1	23-Sep-88			0.18		2.5	ND	54	2	8.2			ND	
STA1	21-Oct-88												ND	
STA1	22-Oct-88			0.34		5.1	ND	56	ND	9.5				
STA1	18-Nov-88			0.21		3.3	ND	86	2	14			ND	
STA1	20-Dec-88			0.34		5.2	ND	92	ND	14			ND	
STA1	27-Jan-89			0.27		4.4	ND	80	ND	16			ND	
STA1	24-Feb-89			0.38		6.1	ND	76	ND	14			ND	
STA1	22-Mar-89			0.33		5.6	ND	80	ND	17			ND	
STA1	15-Apr-89			0.96		15	ND	82	6	18			ND	
STA1	16-May-89			0.6		9	ND	96	2	12			0.02	
STA1	19-Jun-89			0.12		1.3	ND	34	ND	6			ND	
STA1	20-Jul-89			0.1		1.1	ND	ND	ND	2.5			ND	
STA1	23-Aug-89			0.12		1.7	ND	68	ND	7.4		0.3	0.01	
STA1	27-Sep-89			0.1		1.4	ND	28	2	7.6		0.25	0.05	
STA1	28-Oct-89			0.2		2.7	ND	48	ND	10		8.3	0.02	
STA1	30-Jan-90			0.3		4.8	ND	72	ND	15		0.35	0.01	
STA1	27-Apr-90			0.23		3.4	ND	72	10	7.4		2.5	0.01	
STA1	27-Jul-90			0.13		1.7	ND	41	8	7.4		2	ND	
STA1	30-Oct-90			0.16		2.3	ND	58	ND	12		1.2	ND	
STA1	13-Nov-08	ND					ND	54	ND	15.4		0.4	ND	0.014

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Selenium, Total (mg/L)	Silver, Total (mg/L)	Sodium Adsorption Ratio	Sodium Fraction of Cations (%)	Sodium, Dissolved (mg/L)	Solids, Settleable (mg/L)	Solids, Total Dissolved (mg/L)	Solids, Total Suspended (mg/L)	Sulfate (mg/L)	Sulfate, Dissolved (mg/L)	Turbidity (NTU)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
STA2	30-Jul-88			0.22		3.4	ND	50	6	2.1		1.2	ND	
STA2	31-Aug-88			0.2		3.3	ND	48	4	0.8			0.03	
STA2	23-Sep-88			0.22		3.2	ND	52	9	2.3			ND	
STA2	21-Oct-88			0.21		3.2	ND	58	4	0.8			ND	
STA2	18-Nov-88			0.2		3.3	ND	78	10	2.1				
STA2	19-Nov-88												ND	
STA2	19-Dec-88			0.15		2.6	ND	70	9	0.8			0.01	
STA2	29-Jan-89			0.23		3.7	ND	68	ND	1.2			0.01	
STA2	24-Feb-89			0.27		4.4	ND	66	4	0.6			0.04	
STA2	21-Mar-89			0.21		3.5	ND	70	ND	1.2			ND	
STA2	14-Apr-89			0.23		3.2	0.2	58	10	1			0.01	
STA2	15-May-89			0.24			ND	64	9					
STA2	16-May-89					3.5				1.9			0.02	
STA2	19-Jun-89			0.2		2.9	ND	50	ND	1.2			0.01	
STA2	20-Jul-89			0.19		3	ND	32	ND	1.6			0.02	
STA2	23-Aug-89			0.18		3	ND	86	ND	1.6		0.75	0.03	
STA2	27-Sep-89			0.18		2.9	ND	46	11	ND		0.55	ND	
STA2	28-Oct-89			0.21		3.2	ND	54	70	1.4		0.7	0.01	
STA2	30-Jan-90			0.24		3.9	ND	74	ND	1.5		0.5	0.01	
STA2	29-Apr-90			0.17		2.1	ND	54	139	1		33	0.01	
STA2	27-Jul-90			0.18		3	ND	61	5.6	1.5		0.95	ND	
STA2	30-Oct-90			0.15		2.3	ND	52	3.2	1.4		1.2	ND	
STA2	13-Nov-08	ND					ND	39	ND	2.6		0.7	0.013	0.013
STA3	30-Jul-88			0.3		2.8	0.2	22	46	0.8		17	ND	
STA3	31-Aug-88			0.26		2.5	ND	34	18	0.6		17	ND	
STA3	23-Sep-88							18						
STA3	21-Oct-88			0.25		2.5	ND	18	2	0.4			ND	
STA3	19-Nov-88			0.27		2.7	ND		8	0.6			ND	
STA3	19-Dec-88			0.14		1.4	ND	24	ND	ND			0.03	
STA3	27-Jan-89			0.25		2.5	ND	40	ND	0.6			0.01	
STA3	24-Feb-89			0.29		2.7	ND	38	ND	ND			0.03	
STA3	21-Mar-89			0.31		3	ND	22	2.5	0.4			0.01	
STA3	15-Apr-89			0.25		2.7	ND	30	1	2.7			ND	
STA3	16-May-89			0.28		2.5	ND	32	6	1.4			0.02	
STA3	19-Jun-89			0.23		2.4	ND	32	ND	2.1			0.01	
STA3	20-Jul-89			0.28		2.7	0.2	20	ND	0.6			0.02	
STA3	23-Aug-89			0.27		2.7	ND	50	ND	1.2		0.3	0.05	
STA3	26-Sep-89			0.2		2.1	ND	16	8	ND		0.55	ND	
STA3	28-Oct-89			0.27		2.8	ND	26	30	ND		0.7	0.02	
STA3	31-Jan-90			0.3		3	ND	30	ND	0.6		0.5	0.01	
STA3	27-Apr-90			0.27		2.2	ND	44	3	0.7		1.4	0.01	
STA3	27-Jul-90			0.28		3.1	ND	45	22	0.6		5.8	ND	
STA3	30-Oct-90			2.4		2	ND	30	24	0.7		1.1	ND	
STA3	16-Nov-08	ND					ND	35	ND	0.4		1.6	0.043	0.017
STA4	30-Jul-88			0.27		3.1	ND	30	5	1		0.6	ND	
STA4	31-Aug-88			0.25		3	ND	34	2	0.4			ND	
STA4	23-Sep-88			0.25		2.6	ND	40	7	0.8			ND	
STA4	21-Oct-88			0.25		2.6	ND	28	ND	ND			ND	
STA4	19-Nov-88			0.27		2.8	ND	48	9	1.2			0.04	
STA4	19-Dec-88			0.16		1.9				ND			0.02	
STA4	27-Jan-89							54						
STA4	24-Feb-89							22						
STA4	20-Mar-89			0.35		3.9	ND		1	1.2			ND	
STA4	14-Apr-89			0.24		2.5	ND		1	0.4			0.01	
STA4	16-May-89			0.28		2.5	ND	32	7	0.8			ND	
STA4	19-Jun-89			0.24		2.6	ND	34	ND	1.9			0.02	
STA4	20-Jul-89			0.27		3.2	ND	30	ND	ND			0.08	

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Selenium, Total (mg/L)	Silver, Total (mg/L)	Sodium Adsorption Ratio	Sodium Fraction of Cations (%)	Sodium, Dissolved (mg/L)	Solids, Settleable (mg/L)	Solids, Total Dissolved (mg/L)	Solids, Total Suspended (mg/L)	Sulfate (mg/L)	Sulfate, Dissolved (mg/L)	Turbidity (NTU)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
STA4	23-Aug-89			0.28		3.4	ND	70	ND	1		0.55	0.03	
STA4	27-Sep-89			0.23		2.5	ND	26	9	ND		0.9	ND	
STA4	28-Oct-89			0.27		2.7	ND	28	70	ND		0.4	0.01	
STA4	19-Dec-89						ND	34	ND					
STA4	31-Jan-90			0.29		3.3	ND	44	ND	0.9		0.65	ND	
STA4	29-Apr-90			0.23		1.8	ND	44	17	0.9		3	0.01	
STA4	27-Jul-90			0.28		4	ND	46	4	1.6		1.2	ND	
STA4	16-Nov-08	ND					ND	37	ND	0.7		0.6	0.015	0.025
STA5	30-Jul-88			0.23		3.1	ND	40	4	6		1.2	ND	
STA5	31-Aug-88			0.22		3	ND	42	3	7			ND	
STA5	23-Sep-88			0.47		7	ND	82	3	9.5			ND	
STA5	21-Oct-88			0.37		5.8	ND	76	ND	9.1			ND	
STA5	19-Nov-88			0.32		5.3				12				
STA5	20-Dec-88			0.28		4.5				11			0.02	
STA5	29-Jan-89			0.35		6	ND	60	2	13			0.01	
STA5	24-Feb-89			0.36		6.2	ND	62	1	12			0.01	
STA5	22-Mar-89			0.34		6	ND	96	1	13			ND	
STA5	15-Apr-89					9.7				13			ND	
STA5	16-Apr-89			0.59			ND	68	2					
STA5	16-May-89			0.51		7.8	ND	74	1	9.5			ND	
STA5	19-Jun-89			0.15		1.8	ND	90	ND	5.3			0.01	
STA5	20-Jul-89			0.15		1.8	ND	24	ND	4.5			ND	
STA5	23-Aug-89			0.22		2.9	ND	64	ND	7.4		0.75	0.03	
STA5	27-Sep-89			0.27		4.1	ND	42	6	7.8		0.55	0.01	
STA5	28-Oct-89			0.35		5.5	ND	50	ND	11		0.4	0.02	
STA5	19-Nov-89						ND	90	4				0.02	
STA5	20-Dec-89						ND	74	ND					
STA5	30-Jan-90			0.45		7.9	ND	84	1	14		0.35	0.02	
STA5	29-Apr-90			0.55		7.7	0.1	84	54	7		19	0.01	
STA5	27-Jul-90			0.17		2.2	ND	51	9	7		1.7	ND	
STA5	30-Oct-90			0.28		2	ND	68	ND	0.7		0.65	ND	
STA5	13-Nov-08	ND					ND	47	ND	12.4		0.4	0.017	0.014
STA6	12-May-88													
STA6	30-Jul-88													
STA6	31-Aug-88						ND	38	1					
STA6	23-Sep-88						ND	70	2					
STA6	22-Oct-88						ND	58	1					
STA6	18-Nov-88						ND	94	2					
STA6	20-Dec-88						ND	54	ND					
STA6	29-Jan-89													
STA6	24-Feb-89													
STA6	25-Feb-89						ND	84	2					
STA6	20-Mar-89								ND					
STA6	22-Mar-89						ND	90						
STA6	14-Apr-89						ND	68	3					
STA6	12-May-89						ND	86	8					
STA6	16-May-89													
STA6	19-Jun-89						ND	48	6					
STA6	20-Jul-89						ND	2	3					
STA6	23-Aug-89						ND	72	ND					
STA6	27-Sep-89						ND	32	3					
STA6	13-Nov-08	ND					ND	61	ND	14.3		0.3	0.0009	0.0014
STA7	30-Jul-88													
STA7	31-Aug-88						ND	42	2					
STA7	23-Sep-88						ND	74	3					
STA7	22-Oct-88						ND	66	2					
STA7	18-Nov-88						ND	102	2					

Table 5 Surface Water Analytical Results

Station ID	Date Collected	Selenium, Total (mg/L)	Silver, Total (mg/L)	Sodium Adsorption Ratio	Sodium Fraction of Cations (%)	Sodium, Dissolved (mg/L)	Solids, Settleable (mg/L)	Solids, Total Dissolved (mg/L)	Solids, Total Suspended (mg/L)	Sulfate (mg/L)	Sulfate, Dissolved (mg/L)	Turbidity (NTU)	Zinc, Dissolved (mg/L)	Zinc, Total (mg/L)
STA7	19-Dec-88													
STA7	20-Dec-88						ND	54	ND					
STA7	29-Jan-89													
STA7	24-Feb-89													
STA7	25-Feb-89						ND	52	4					
STA7	20-Mar-89						ND	70	ND					
STA7	22-Mar-89													
STA7	14-Apr-89						ND	70	4					
STA7	12-May-89						ND	90	7					
STA7	16-May-89													
STA7	19-Jun-89						ND	48	4					
STA7	20-Jul-89						ND	20	1					
STA7	23-Aug-89						ND	66	ND					
STA7	26-Sep-89						ND	50	6					
STA7	13-Nov-08	ND					ND	60	ND	13.2		0.4	0.0138	0.0006
SWEQB	13-Nov-08												0.0007	

Note: Blank cells indicate component was not analyzed.

Abbreviations

CaCO3:	Calcium carbonate
meq/L	Milliequivalents per liter
mg/L:	Milligrams per liter
µS/cm:	Microsiemens per centimeter
NTU:	Nephelometric Turbidity Units
ND:	Not detected. If available, reporting limits are provided in the database (Attachment 3).

ADDENDUM 2

STREAM MORPHOLOGY STUDY ON BUFFALO CREEK

Technical Report

Stream Morphology Report
Buffalo Creek
Wishbone Hill Resource Area

Prepared for

Usibelli Coal Mine, Inc.

November 24, 2008

Prepared by

WHPacific, Inc.
9755 S.W. Barnes Road
Portland, Oregon 97225

WHPacific

Prepared for: Usibelli Coal Mine, Inc.
Contact: Jim Helling
Palmer, AK
907-745-6028
E-mail address: jeh3@mtaonline.net

Bartly K. Coiley,
Manager Environmental Affairs
100 Cushman Street, Suite 210
Fairbanks, Alaska 99701
(907) 452-2625
E-mail address: bcoiley@usibelli.com

Title: Buffalo Creek Rosgen Survey Report

Project: Wishbone Hill Resource Area

Prepared by: WHPacific, Inc.
9755 SW Barnes Road, Suite 300
Portland, Oregon 97225

Contact: Casey M. Storey,
Environmental Project Coordinator
(503) 372-3648
FAX: (503) 526-0775
E-mail address: cstorey@whpacific.com

Phil Quarterman
Senior Wetland Scientist and Environmental Project Manager
(503) 372-3562
E-mail address: pquarterman@whpacific.com

TABLE OF CONTENTS

1.0 INTRODUCTION 4

2.0 METHODS 4

3.0 RESULTS 6

3.1 LONGITUDINAL PROFILE 6
3.2 CROSS SECTIONS 9
3.3 SUBSTRATE 13
3.4 SINUOSITY 15
3.5 SUMMARY AND STREAM TYPE DETERMINATION 15

TABLE 1. SURVEY SUMMARY 16

4.0 DISCUSSION 17

APPENDICES

Appendix A: Figures
Appendix B: Photographs

1.0 Introduction

The following report presents stream morphology data gathered during a field effort in October, 2008 by WHPacific. Buffalo Creek, within the Wishbone Hill resource area was the subject of the stream morphology study.

Buffalo Creek is small tributary to Moose Creek and is the main outlet of Wishbone Lake, near Sutton, Alaska. The objective of the Rosgen Level II survey conducted on Buffalo Creek was to characterize the entirety of the stream utilizing reference reaches that represent stream channel types and typical habitats noted during field investigations. Such data can be utilized to quantify fish habitat, to serve as baseline data for potential restoration efforts when development occurs in the study area, and to provide an understanding of the general function and character of the stream. The survey analysis of Buffalo Creek follows recent fisheries and macroinvertebrate sampling efforts conducted by WHPacific on both Moose and Buffalo Creek.

2.0 Methods

To efficiently characterize Buffalo Creek, representative survey reaches were established at the conclusion of a cursory field survey conducted on October 6, 2008. During this survey, 100 foot stations were staked from the mouth of Buffalo Creek to the headwaters of the stream at Wishbone Lake. While staking, visual observations of stream character was made, including general substrate composition, valley form, stream channel slope, and meander characteristics. From these observations, reference reaches were established to focus survey techniques to determine channel type and general habitat character. Within these reaches a longitudinal profile was obtained, representative cross sections were established, and pebble counts were made to characterize substrate.

Three representative reaches were chosen with the study area. These are referred to as the lower, middle, and upper reaches. The lower reach represents a large percentage of Buffalo Creek and is located within the lower 500 feet of the stream. The middle reach is located approximately 7100 feet upstream of the Moose Creek confluence and represents the second highest percentage of stream channel in Buffalo Creek. Finally, the upper reach is located within a steep section of Buffalo Creek as it cuts through a series of conglomerate and other bedrock bluffs, approximately 8500 feet upstream of the Moose Creek confluence.

The results of each survey components (longitudinal profile, cross sections, substrate, and sinuosity) help place the channel types into a category of stream types and provides a reference for existing channel conditions pending in-stream impacts to stream reaches.

Longitudinal Profile Methods

Following survey techniques established by Dave Rosgen (Rosgen, 1996), longitudinal profiles for three representative reaches were made. The channel distance was measured along the left bank (facing downstream) at 100 foot intervals from the mouth of the stream to the headwaters. The thalweg or deepest and/or primary flow channel and water

surface elevations were measure with the use of a surveyor's rod and hand level. These measurements were taken at a intervals that captured individual habitat types (pool, riffles, and runs or glides) and at a frequency that helped to depict the general longitudinal channel form. The elevation for each longitudinal profile was approximated based on elevations obtained by GPS reading.

Cross Section Methods
Following Rosgen methods (Rosgen, 1996) a total of 7 cross sections were made on Buffalo Creek. Two cross sections were taken within the lower reach, three cross sections were taken on the middle reach, and two cross sections were made of the upper reach. Cross sections were taken of representative habitat features and at least one within each reach was placed in order to effectively obtain flood-prone width and bankfull width measurements. A measuring tape was stretched perpendicular across each cross section from estimated bankfull indicators on each bank. In most instances, bankfull indicators included scour lines, breaks in vegetation, or water stains on substrate. Elevations of the bank and channel bed were taken in generally even frequencies along the tape to provide a bed profile. The edge of water and water surface elevation were also taken at each cross section. Floodprone widths were determined following the equation below:

Max Channel Depth Elevation – Bankfull Stage Elevation = Max Depth Value

Max Depth Value x 2 = Floodprone Elevation

Distance between Floodprone Elevations on each bank = Floodprone Width

Obtaining the floodprone width allows the determination of the entrenchment ratio within the reference reach and provides additional information for the classification of the stream type. The entrenchment ratio is determined by dividing the flood-prone width by the bankfull width.

Bed Sediment Survey (Pebble Count) Methods
A modified Wolman pebble count (Wolman 1954, Rosgen 1993) was used to conduct a substrate analysis within each study reach. Following this method, transects were evenly spaced across the surveyed reach to represent a relatively even proportion of each habitat type. Particles were randomly selected along each transect at a frequency to result in the measurement of 100 particles within each representative reach.

Sinuosity Methods
A basic calculation is used to extrapolate sinuosity. Using stream distance as measured in the field and dividing this by the valley distance as measured from aerial photographs, a sinuosity ratio is calculated.

3.0 Results

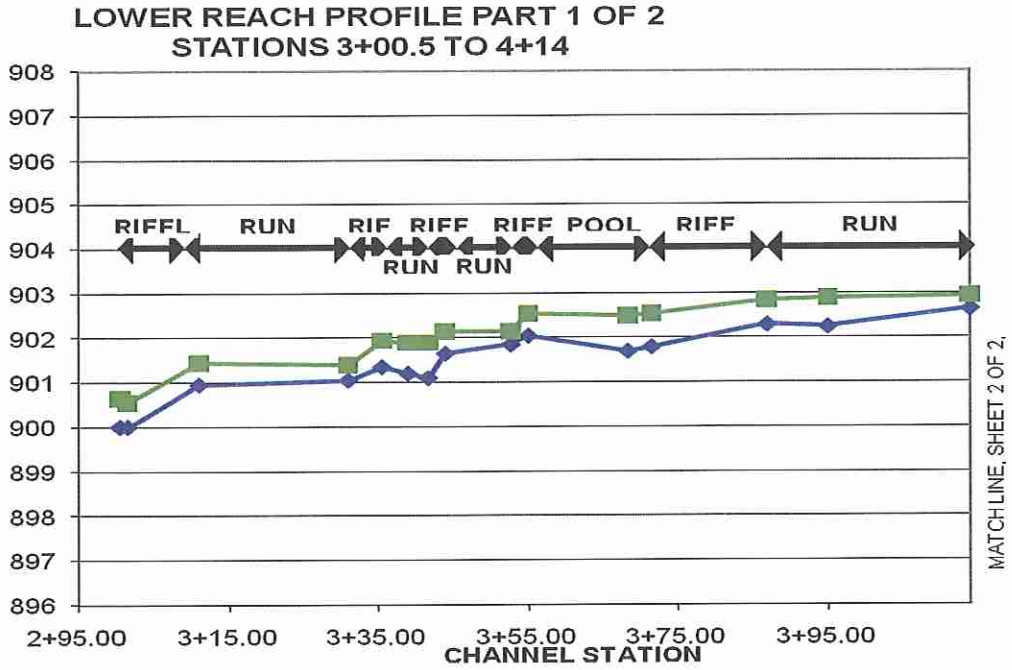
The following lists results for each survey component from each reference reach. An overview of the location of each reference reach can be seen in Figures 1 and 2 in Appendix A.

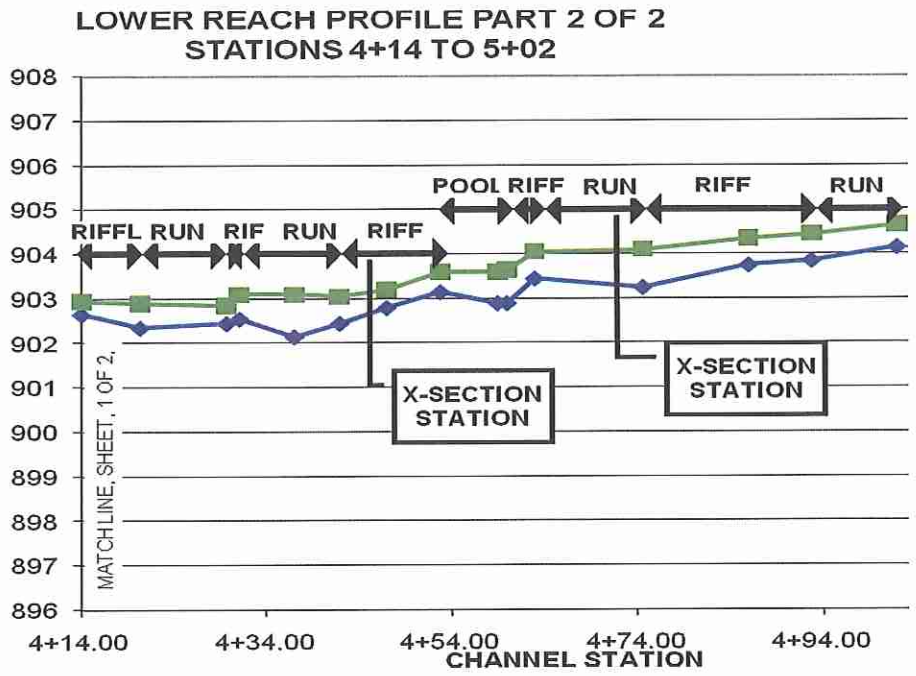
3.1Longitudinal Profile

Lower Reach

The lower reach was measured at 202 feet along the left bank. The profile began at Station 3+00 and extended upstream 5+02. The average water surface slope for the reach was 2.2%. The dominant habitat types within the lower reach are riffles and runs, although several pools were identified. Run habitat is the most abundant at 48%, followed by riffles at 40%, and pools occupying the remaining 12%.

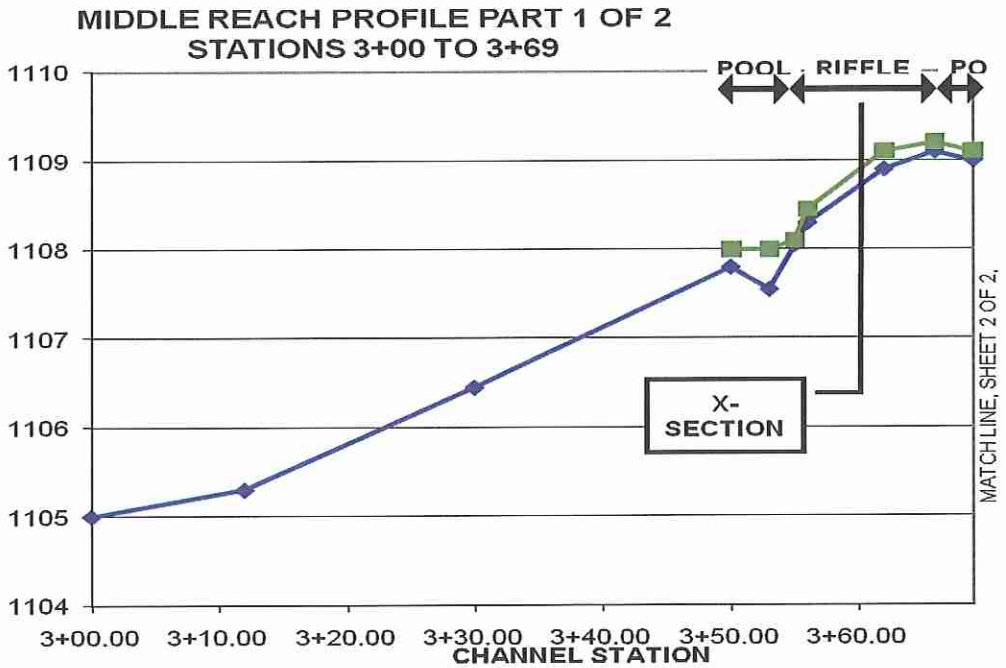
The top line indicates water surface elevation and the bottom line is the thalweg elevation.

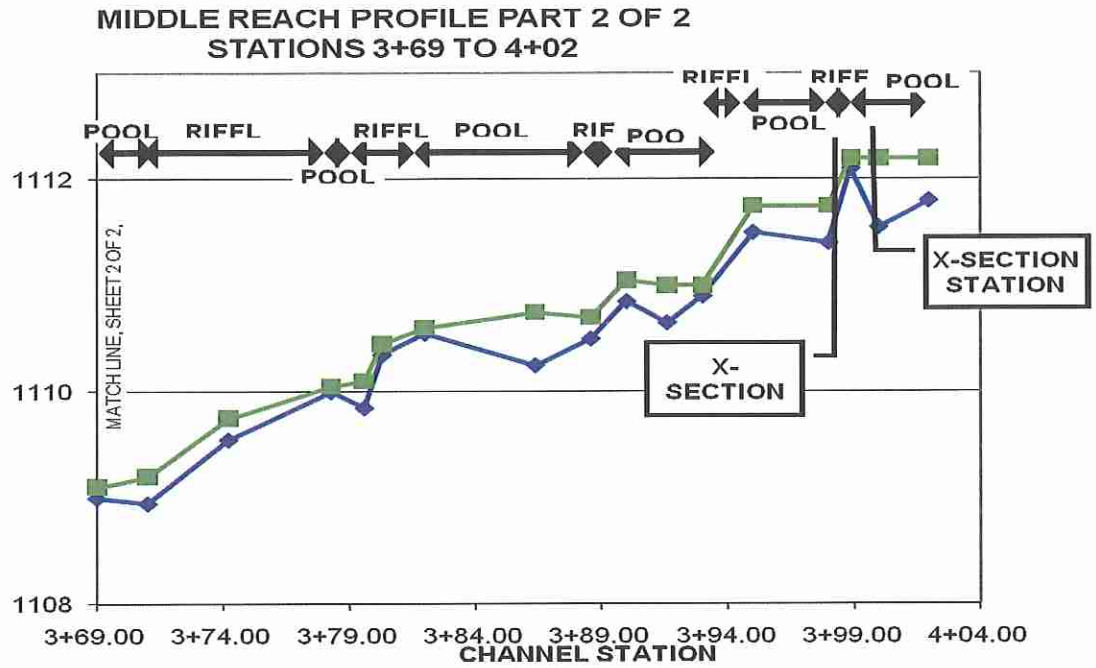




Middle Reach

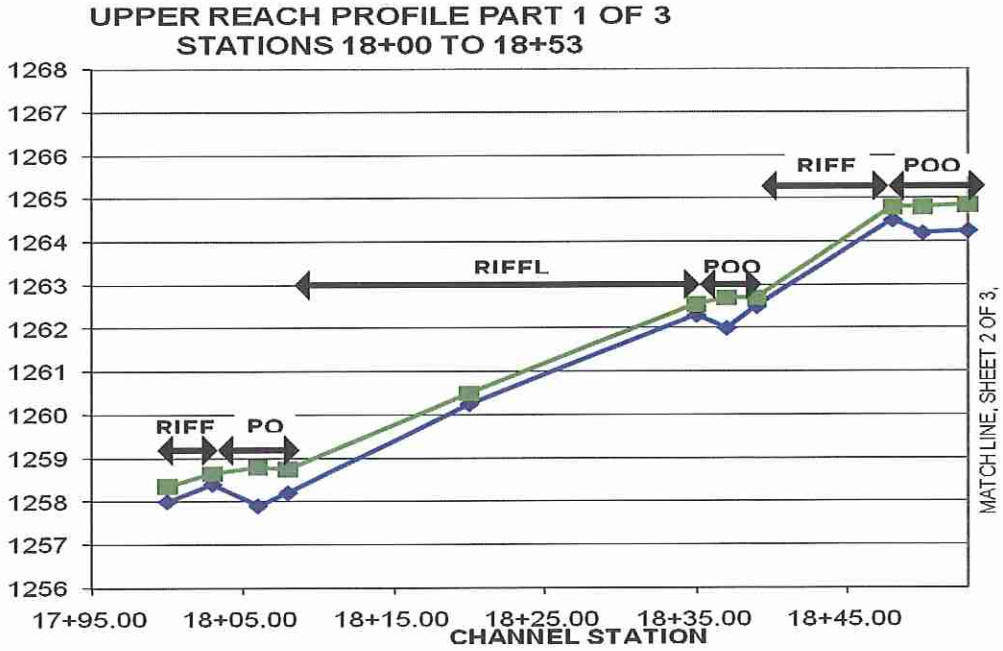
The middle reach was measured at 102 feet along the left bank from station A3+00 (approximately 6600 feet upstream of Moose Creek) to A4+02. The lower 50 feet of the reach was a dry channel, so the water surface slope was averaged over 52 feet and was approximately 8%. Habitat types were evenly split between pools and riffles. This reach is located in a wide depositional slope downstream of system of major bluffs or escarpements.

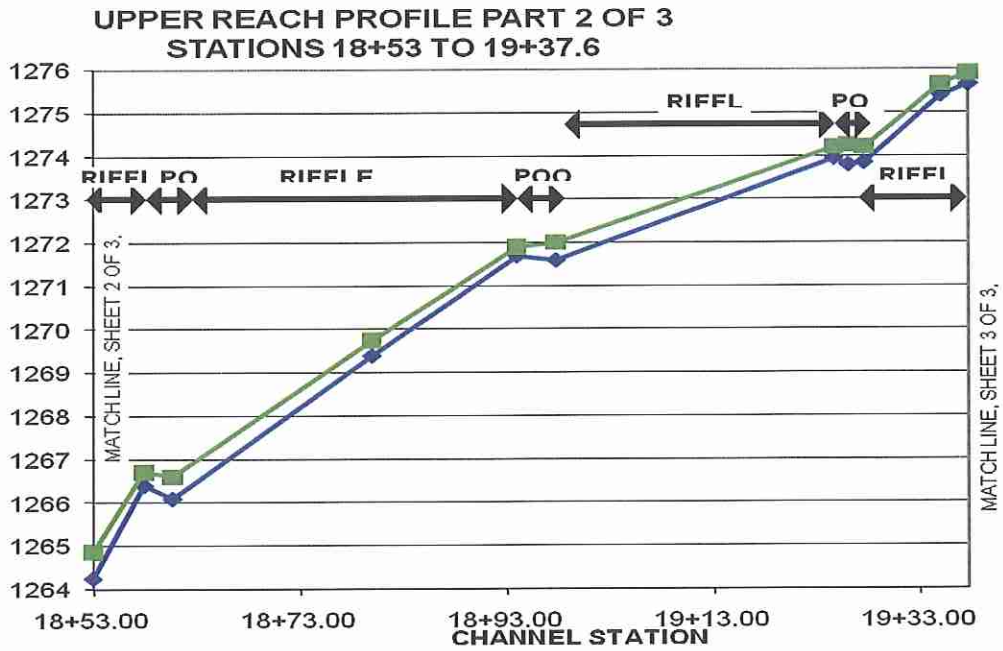


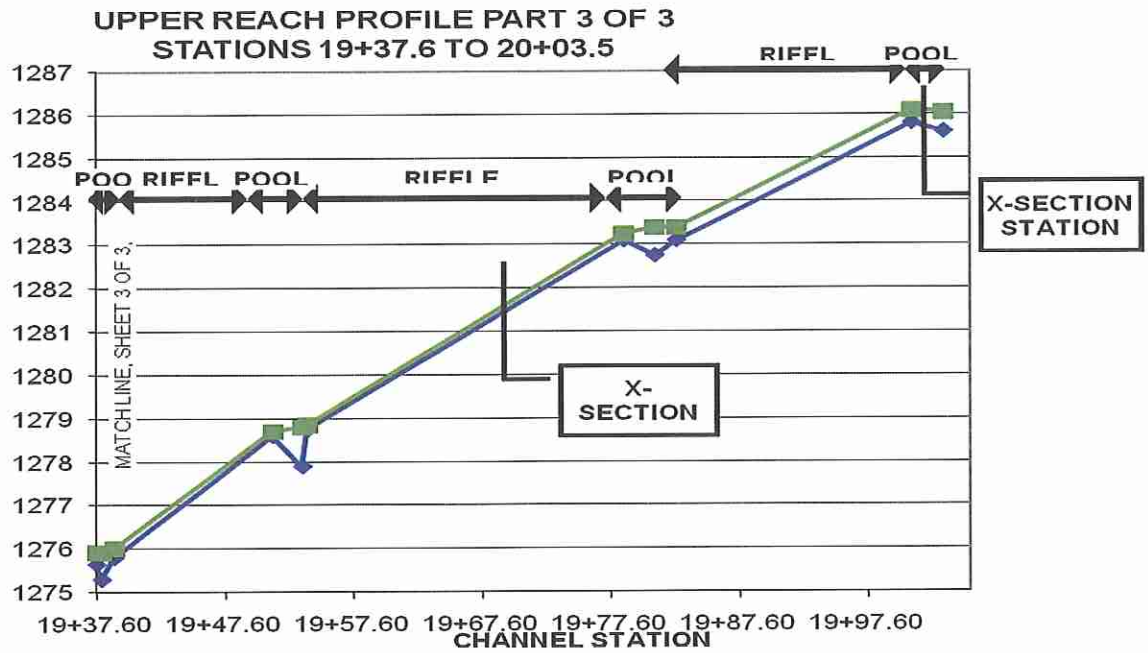


Upper Reach

The upper reach was measured at 203.5 feet along the left bank of the study reach. The profile began at 18+00 and extended upstream to 20+03.5. The upper reach was steep with an average water surface slope of 13.6%. Cascading riffles are the dominant habitat type in the upper reach, occupying 81% of the reach; while pools occupy the remaining 19%.





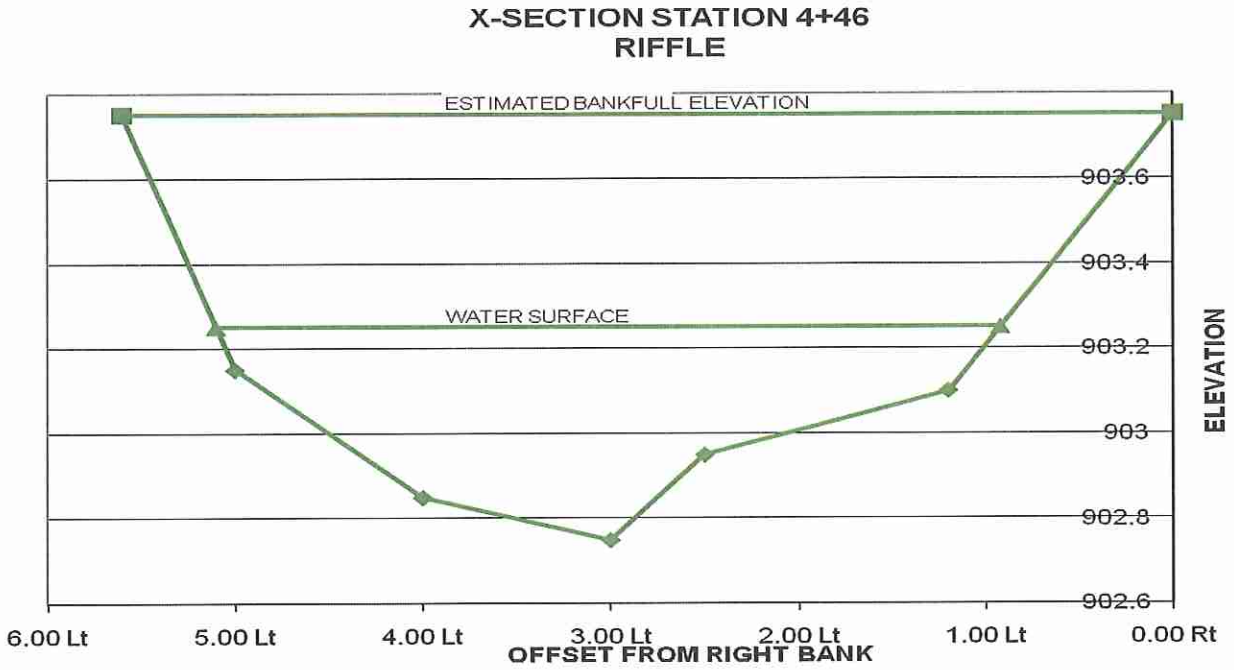


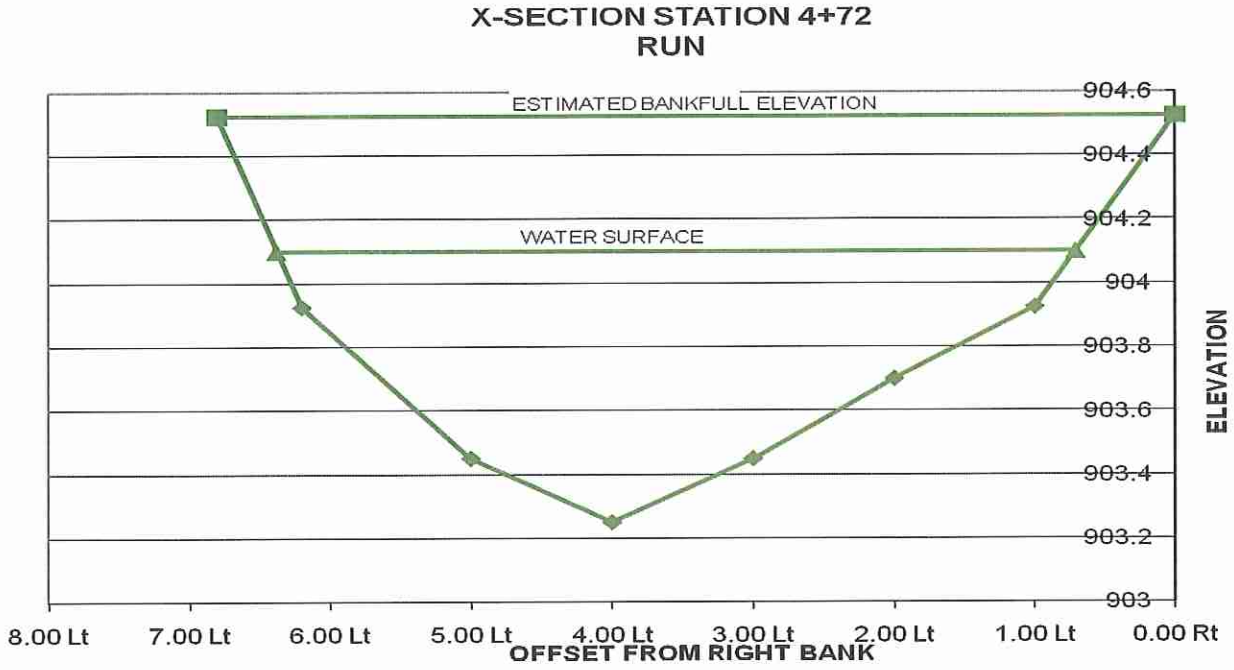
3.2 Cross Sections

Lower Reach

Two cross sections were established within the lower reach. One cross section was placed within a riffle at station 4+46 and one was placed within a run at 4+72. At each cross section a general profile, bankfull width, and wetted width was obtained. At station

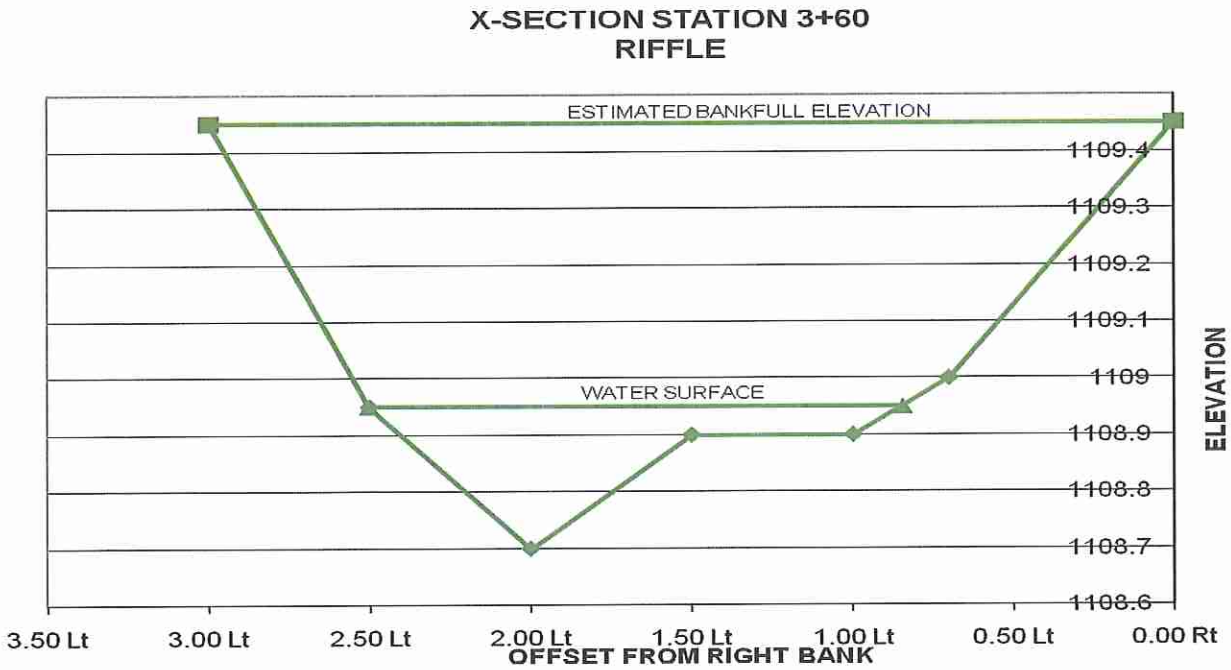
4+72 the floodprone width was measured. The bankfull width at station 4+46 was 5.60 feet and 6.80 feet at station 4+72. The flood-prone width determined at station 4+72 was 13.00 feet. The calculated width depth ratio (bankfull width/average channel depth) was 10.70 and the entrenchment ratio was 1.91. Cross sections are presented below.

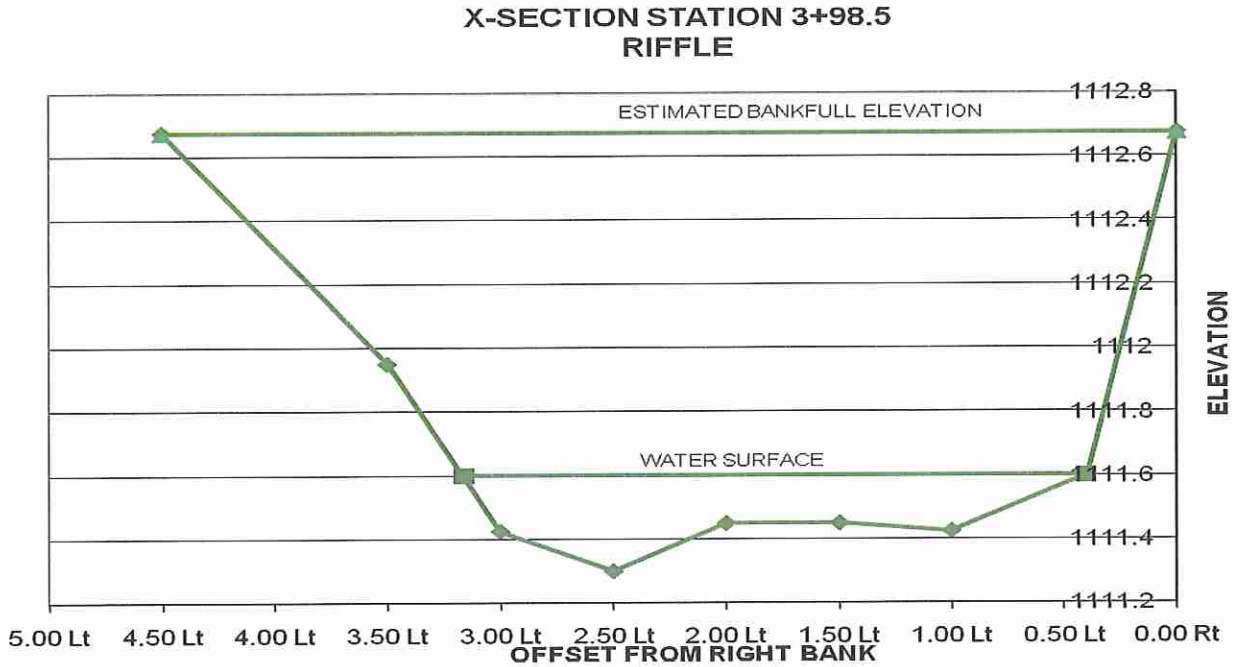


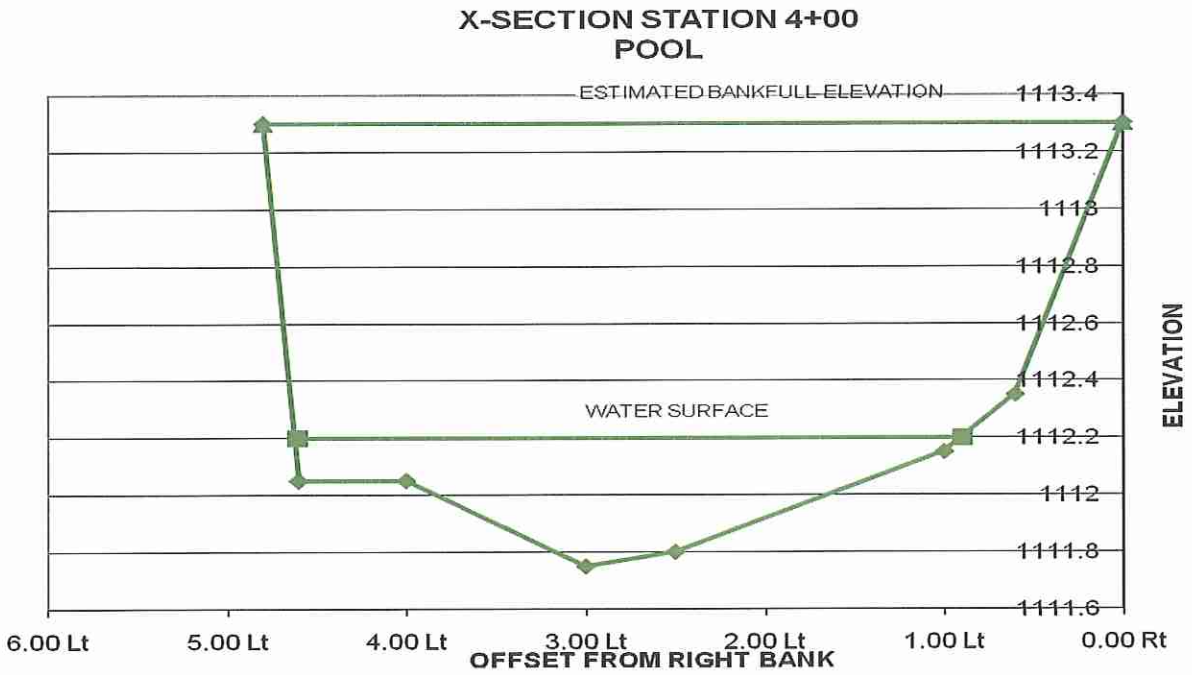


Middle Reach

Three cross sections were established within the middle reference reach. Two cross sections were taken in riffles (stations 3+60 and 3+98.5) and one station (4+00) was taken in a pool. Bankfull widths were determined at all three stations and the floodprone elevation and width/depth ratio was determined at station 4+00. Bankfull widths were 3.00, 4.50, and 4.80 feet at these three stations (progressing upstream). The flood-prone width was calculated at 5.2 feet and the width/depth ratio at 5.35.

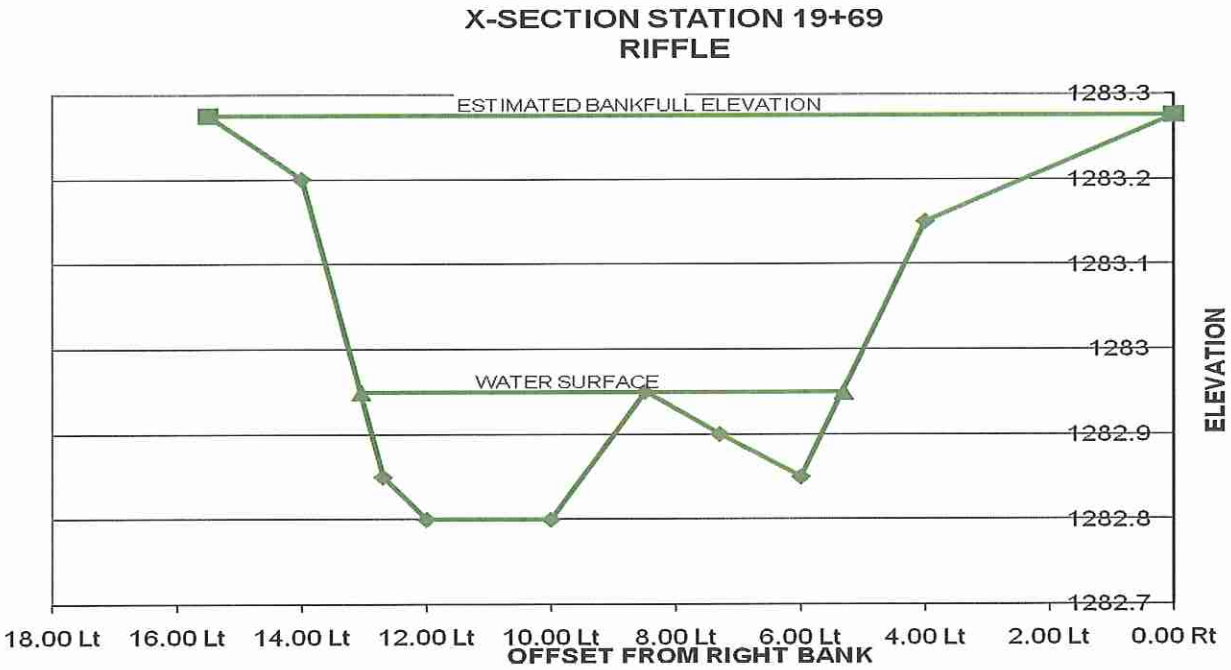


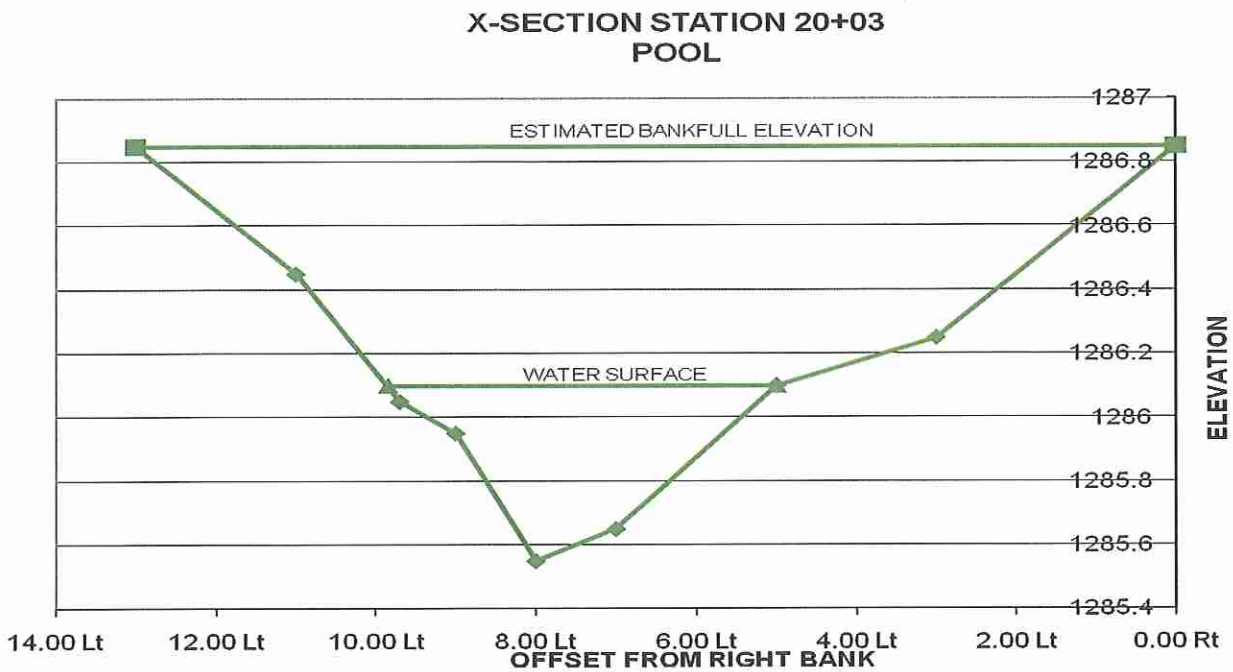




Upper Reach

Two cross sections were established within the uppermost reference reach. A cross section was placed at station 19+69 (riffle) and 20+03 (pool). Bankfull estimates were made at both cross sections and a flood-prone width was determined at station 20+03. Bankfull widths were 15.50 and 13.00 feet at each station. The flood-prone width was calculated at 23.00 feet and the width/depth ratio at 15.29.

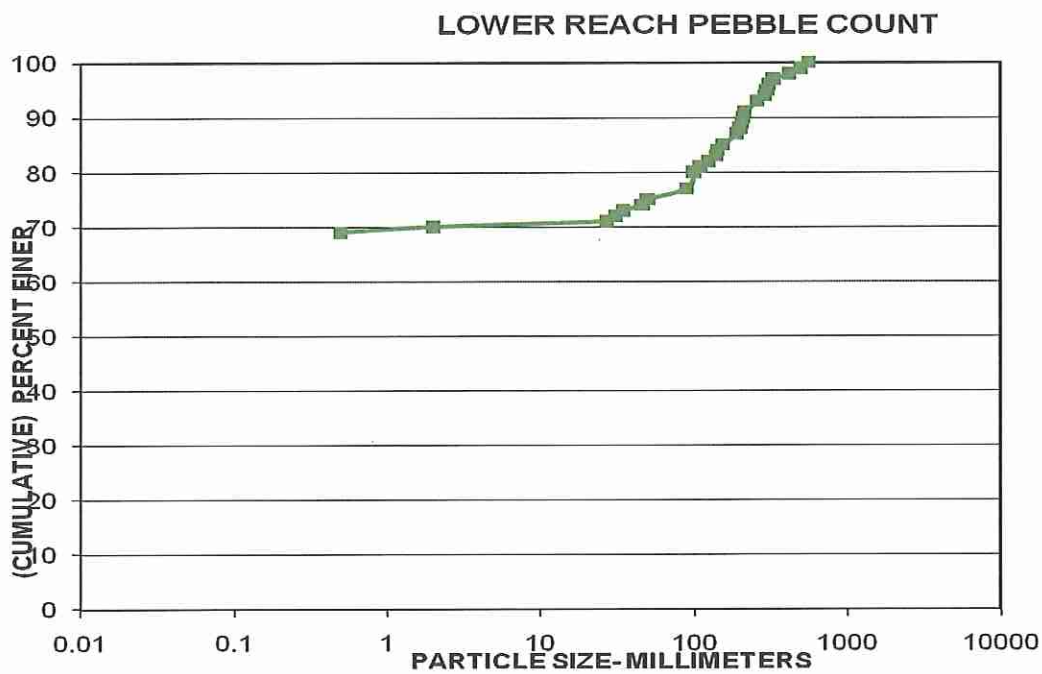




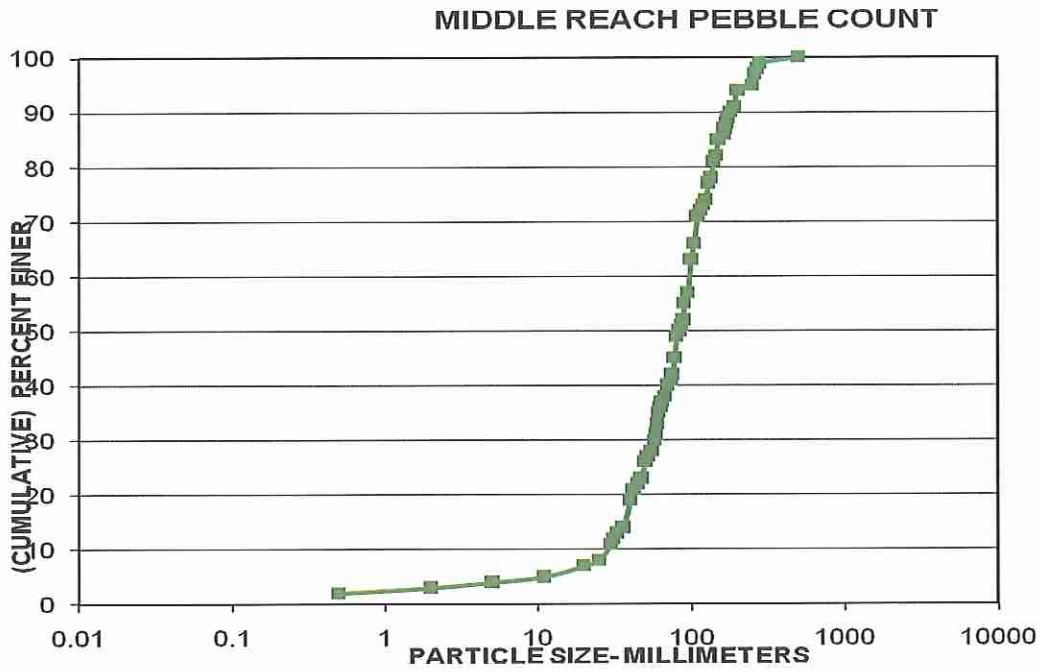
3.3 Substrate

Lower Reach

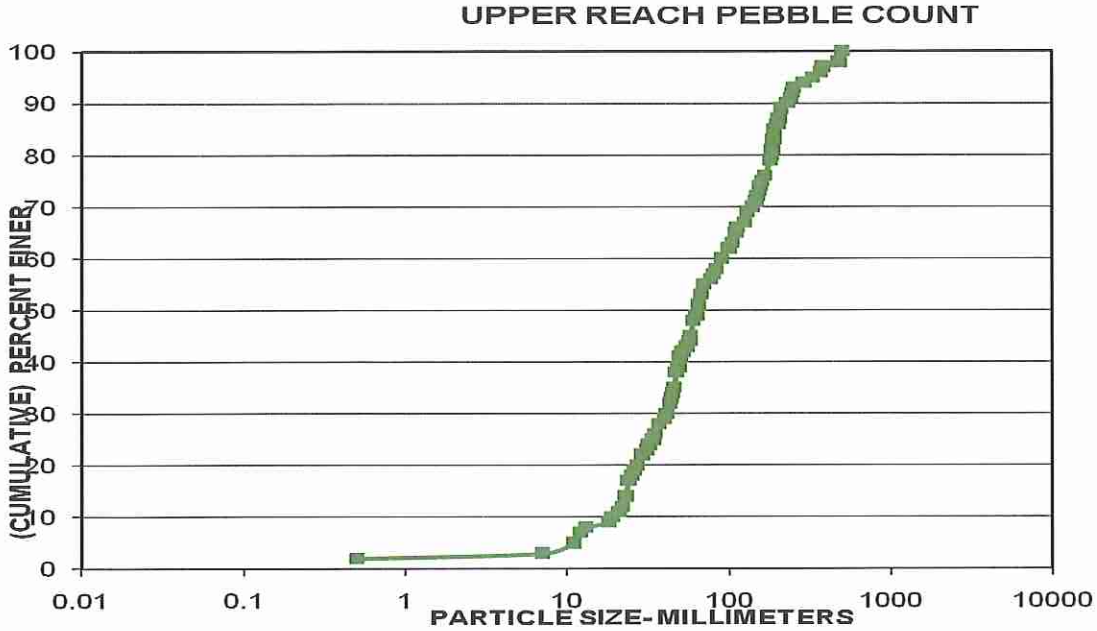
The dominant particle type found in the substrate analysis of the reach is sand (> 2 mm). Gravel (2-64 mm) and cobble (64-256 mm) are represented, with few boulders (256-4096 mm) from high valley rock outcrops also measured. Sand makes up approximately 70 percent of the reference reach substrate.



Middle Reach
Substrate particles were obtained from the entirety of the middle reach, including portions of dry channel. Cobbles comprised over 50 percent of the reference reach substrate with gravel representing the next most common particle class. Sand and boulders comprised less than 10 percent of the channel substrate each.



Upper Reach
The dominant particle size class from the upper reach was nearly evenly divided between cobble and gravel. Boulders and sand each comprise less than 10 percent of the total substrate analyzed. Conglomerate bedrock was a common streambank and valley slope material found within and bracketing the reference reach.



3.4 Sinuosity

Due to the small size of Buffalo Creek, the abundance of overhead vegetation, and limited visibility of field landmarks on aerial photographs, reach level sinuosity was not calculated. However, general sinuosity was calculated for the lower 6600 feet of stream below the middle reach and the upper 4400 feet, including the middle and upper reach.

Lower Reach
The sinuosity of the stream reach including the lower representative reach is 1.33. The estimated sinuosity of the representative reach is expected to approach or exceed 1.5

Middle and Upper Reach
The sinuosity of the upper 4400 feet of Buffalo Creek is 1.07.

3.5 Summary and Stream Type Determination

The following table summarizes the survey results from each representative reach. Each component (except landform) was calculated following methods outlined by Rosgen (1996). A suite of these results is used to place the reference reach into one of eight major stream types and numerous subtypes as outlined by Rosgen (1994, 1996).

Table 1. Survey Summary

Reach	Surrounding Landform	Percent Slope	Width/Depth Ratio	Dominant Substrate	Entrenchment Ratio	Sinuousity
Lower Reach	Moose Creek floodplain bench.	2.1%	10.7	Sand	1.91	1.33 to 1.5+
Middle Reach	Depositional plateau at base of valley	8.0%	5.36	Cobble	1.27	1.07
Upper Reach	Canyon, steep side slopes, exposed bedrock formations	13.6%	15.3	Cobble/Gravel	1.77	1.07

Stream Types
The following describes the determined stream types as based on the survey results.

Lower Reach
The lower representative reach can best be described as an **E5 stream type**. Streams of this type form on gentle slopes in broad riverine or entrenched valleys, as well as meadows and . Sand is the dominant bed material type and the typical slope is < 2%. Entrenchment ratios are typically greater than 2.2, sinuosity is > 1.5, and width depth ratios are less than 12 (Rosgen 1996).

While the entrenchment ratio of the stream reach is below that typically exhibited for E channel types, the absence of point bars, the stability of banks in the reach, and a low width/depth ratio preclude the channel from being classed as a C type.

Middle Reach
The middle representative reach can best be classified as an **A3 stream type**. Streams of this type form in colluvial deposits in steep landforms. Average slopes range from 4-10% , entrenchments ratios are less than 1.4, width/depth ratios are less than 12, and sinuosity is typically less than 1.2.

The middle reach is located at the base of deep colluvial deposit at a break in the valley slope and at the junction of several short valleys. Flows cease at the downstream end of the reference reach and do not reappear for approximately 600 feet downstream of this point. Upstream of the reference reach, flows increase and the scale of channel, bank, and floodplain all increase, while the channel type remains until shifting to the channel type represented in the Upper Reach.

Upper Reach
The upper reach can best be classified as an **A2a+ stream type**, although it shares characteristics with the A3 type, most notably substrate. Streams of this type occur within steep, confined slopes, including canyons. Substrate is dominated by boulders with cobble, gravel, and sand occurring in lesser amounts. Slopes range from 4-10% and the a+ designation exceeds 10% slopes. Width/depth ratios are typically less than 12, entrenchment ratios are < 1.4, and sinuosity is less than 1.2.

The upper reach is an intermediate fit for this stream type based on the criteria outlined above. However, the stream and geologic characteristics of this area are relatively unique and the prevalence of error in calculating the width/depth ratio and the associated entrenchment ratio. First, the dominant substrate associated with the upper reach is evenly split between gravel and cobble, but the reach is bounded by large bedrock shelves and is narrowly confined to a steep slope. Secondly, gravel and cobble deposition from conglomerate formations within the narrow channel and the absence of clear bankfull indicators in the reference reach likely resulted in bankfull and flood-prone widths that exceeded the true dimensions. Characterizing the stream type as A2a+ best represents the high energy, confined channel type found within this reach and adjacent habitats.

4.0 Discussion

The reference reaches characterized above can be used as surrogates to approximate the channel types found adjacent to these reaches and throughout the entire stream reach based on field observations. Following the stream course from its mouth to the headwaters at Wishbone Lake, a general picture of stream types can be drawn for significant segments of the stream using these surrogate reaches. A description of these segments follows below. Segments are also depicted in Figure 1.

Segment 1: Station 1+00 to 36+00
This segment includes the lower reference reach and occupies a large bench that parallels Moose Creek. Based on survey results, the reach is best characterized as an **E5 stream type**. The stream channel is stable with few point bars, heavily vegetated banks, and moderate to high degree of meander. Deposition of course substrate materials (gravel and larger) from conglomerate cliffs above the left bank of this stream reach are obvious. Woody debris is a common habitat element.

Segment 2: Station 36+00 to 41+00
This segment is located within a moderately steep, but short notch in an escarpment at the edge of a plateau/meadow area. Habitat is most closely comparative to the middle reference reach (**A3 type**). The slope is generally steep, sinuosity is low, substrate is dominated by cobble and gravel, and the banks are highly mobile and steep.

Segment 3: Station 41+00 to 62+00
This segment is located in a moderately entrenched meadow dominated plateau above the Moose Creek bench. The stream type is best characterized as an **E5 type**. Bed sediment/substrate is dominated by sand, with a high meander rate. Slopes are slight and point bars are generally absent. Banks are heavily vegetated and stable. The upstream extent of this segment becomes dewatered and a discernable channel is absent past 66+00.

Segment 4: Station 62+00 to A1+00
A discernable channel is absent in the valley. The length between the two stations is approximately 300 feet. Large gravel and cobble deposits are evident.

Segment 5: Station A1+00 to A17+00
This segment includes the middle reference reach and is best characterized as an **A3 channel type**. Stream slopes are steep, substrate is cobble and gravel dominated, and habitat is a series of cascading riffles. Sinuosity is generally low throughout the reach.

Segment 6: Station A17 to A30+00
This segment includes the upper reference reach and flows through a steep and narrow canyon bracketed by conglomerate bedrock outcrops. The stream is best characterized as an **A2a+ type**, but could also be characterized as an A3a+ type due to large areas of gravel and cobble deposits. This reach contains a number of waterfalls, many cascades, undercut alcoves, and chutes. Slopes are high, sinuosity is low, and pools are common, but small.

Segment 7: Station A30+00 to A33+00
This segment is slightly less steep than segment 6, but generally exhibits the same character. This stream reach loses the a+ designation, but most other physical features remain constant with the downstream habitat.

Segment 8: Station A33+00 to A41+00
This segment occupies a shallow valley at the outlet end of Wishbone Lake. The stream reach is best characterized as an **E5 stream type**. The channel is highly sinuous, banks are stable, the substrate is dominated by sand, and the slopes are low. Vegetation along the banks consists of a mix of hardwood trees and shrubs, conifers, and grass.

Segment 9: Station A41+00 to A45+00 (Wishbone Lake)
This segment occupies a short, moderately steep valley leading west from Wishbone Lake. The stream type is most likely represented as an **A3 type**. Cobble and gravel are common substrate types, slopes are steep, and meanders are moderate.

References

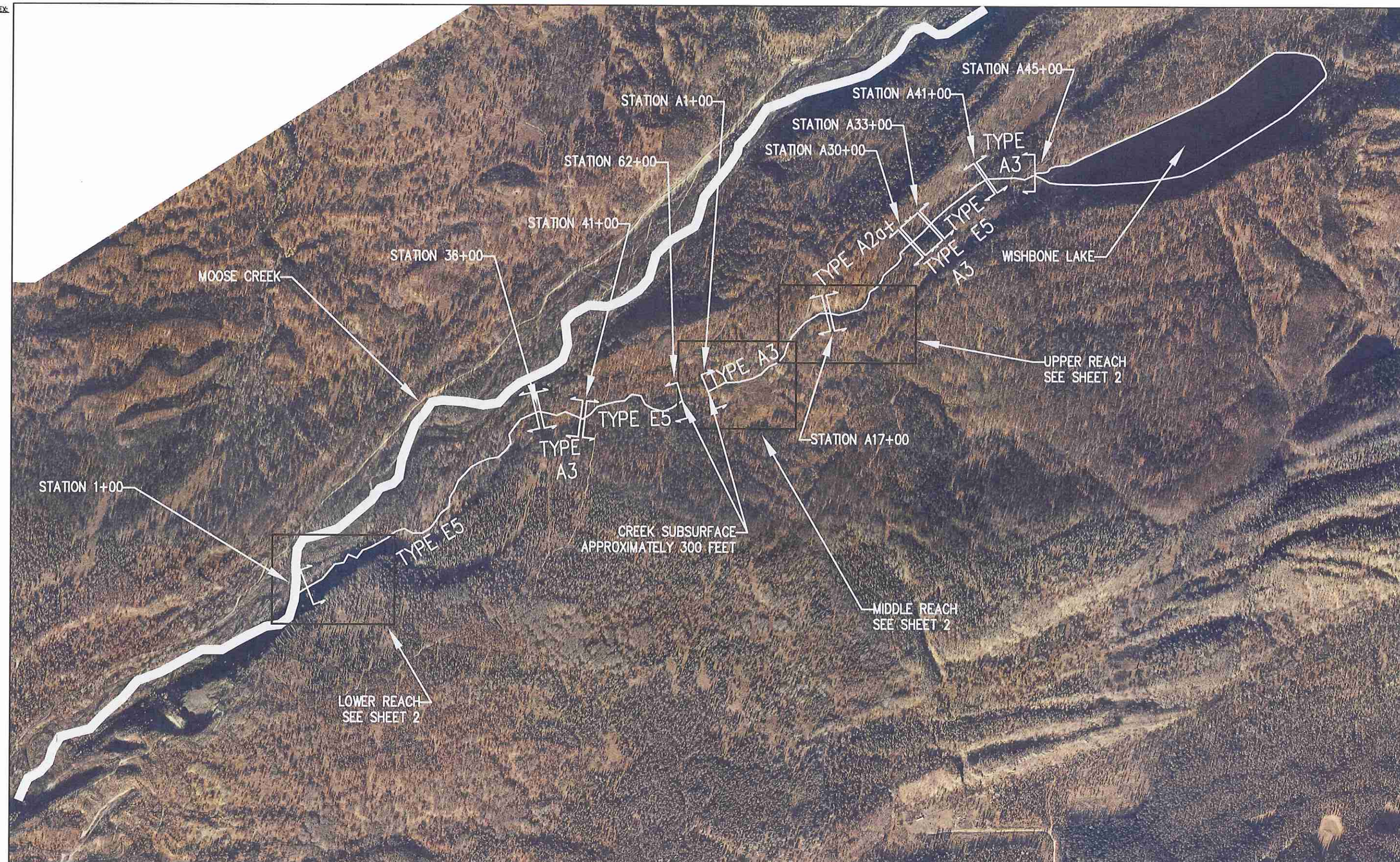
Rosgen, D., 1994 A classification of Natural Rivers. Catena, Vol 22: 169-199. Elsevier Science, B.V. Amsterdam

Rosgen, D., 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Wolman, M.G., 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union 35: 951-956

Appendix A – Figures

XREF INDEX:



SCALE

1000 0 500 1000 2000

(FEET)

1 INCH = 1000 FT.

NOTE: STATION 1+00 TO 62+00, THIS GRAPHIC IS AN APPROXIMATE REPRESENTATION OF THE CHANNEL. THE ACTUAL CHANNEL REACH IS COMPOSED OF MEANDERS THAT ARE NOT CLEARLY VISIBLE IN THE SCALE OF THIS FIGURE.

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

REVISIONS			
NO.	BY	DATE	REMARKS

SHEET INFO	
DRAWN	JCO
CHECKED	
APPROVED	
LAST EDIT	11/12/2008
PLOT DATE	11/14/2008
SUBMITTAL	

REPRESENTATIVE REACHES
USIBELLI COAL MINE
BUFFALO CREEK
GEOMORPHOLOGICAL STUDY

PROJECT NUMBER 34272

DRAWING FILE NAME BUFFALO TOPO

SCALE 1=1000

SHEET NUMBER 1

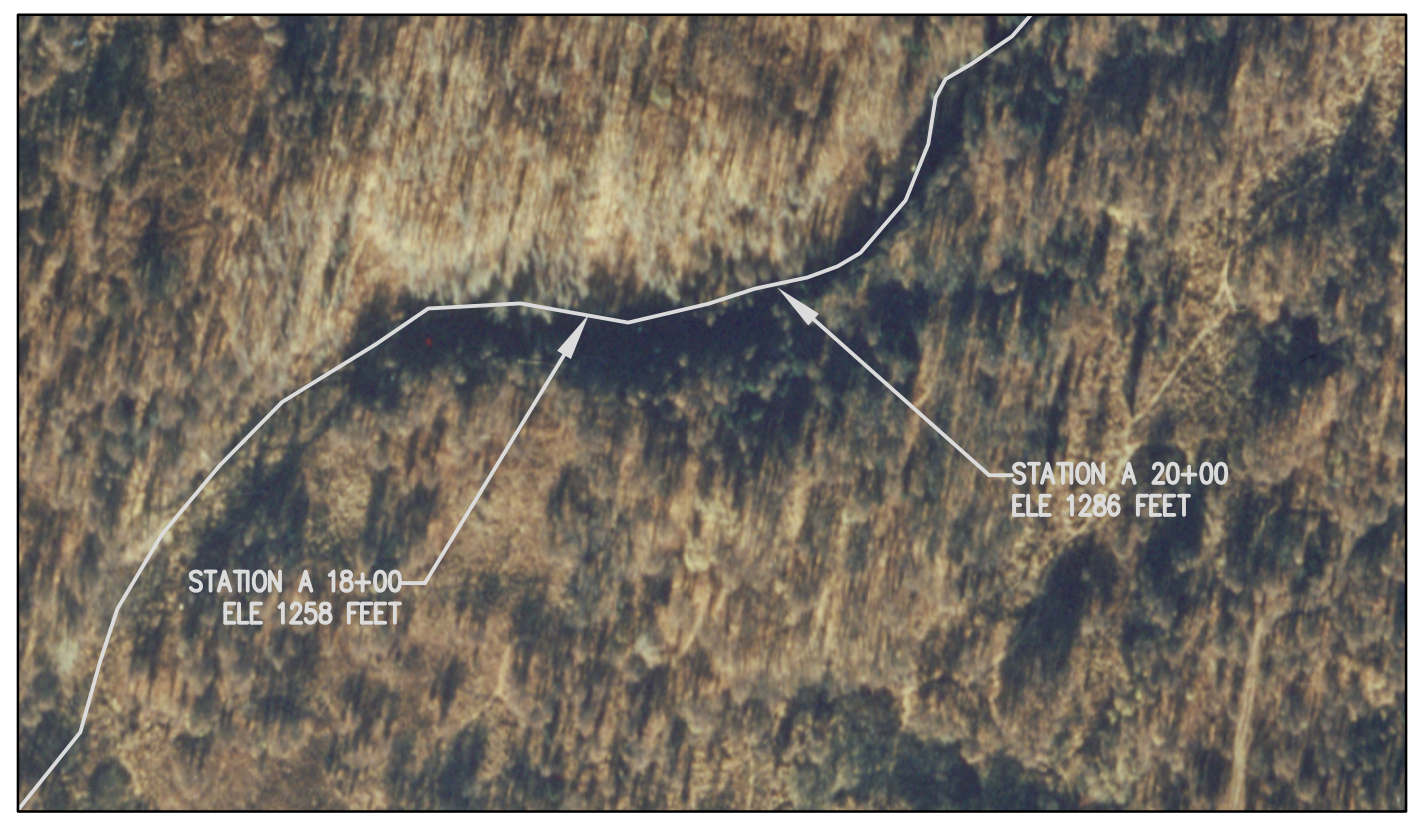
1 of 2

C:\Documents and Settings\jorganek\Desktop\usebelli\Buffalo Creek Rosgen Survey\figures\BUFFALO TOPO.dwg, A, 11/14/2008 12:33:23 PM, jorganek, CutePDF Writer, Tabloid, 1:1

XREF INDEX:

LOWER REACH
STATIONS 3+00 TO 5+02

MIDDLE REACH
STATIONS A 3+00 TO A 4+02



UPPER REACH
STATIONS A 18+00 TO A 20+00

SCALE

200 0 100 200 400

(FEET)
1 INCH = 200 FT.

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

REVISIONS			
NO.	BY	DATE	REMARKS

SHEET INFO	
DRAWN	JCO
CHECKED	
APPROVED	
LAST EDIT	11/12/2008
PLOT DATE	11/14/2008
SUBMITTAL	

REPRESENTATIVE REACHES
USIBELLI COAL MINE
BUFFALO CREEK
GEOMORPHOLOGICAL STUDY

SCALE 1=200

PROJECT NUMBER 34272

DRAWING FILE NAME BUFFALO TOPO

SHEET NUMBER
2
2 of 2

C:\Documents and Settings\jorganek\Desktop\usebelli\Buffalo Creek Rosgen Survey\figures\BUFFALO TOPO.dwg, B, 11/14/2008 12:36:05 PM, jorganek, CutePDF Writer, Tabloid, 1:1

Appendix B - Photographs

Photo 1: Buffalo Mine Creek, typical stream reach downstream of first bluff and near Moose Creek (lower reference reach)

Photo 2: Buffalo Mine Creek, middle reference reach.

Photo 3. Waterfall near upstream end of upper reference reach.

Photo 4. Conglomerate bluffs upstream of upper reference reach.

Photo 5. Upper reference reach habitat between cascades.

Photo 6. Buffalo Mine Creek immediately downstream of Wishbone Lake.

Photo 7. Wishbone Lake near outlet (Buffalo Mine Creek).

ADDENDUM 3

COMPARATIVE ANALYSIS OF HISTORICAL SURFACE WATER MONITORING DATA FROM MWH REPORT DATED MAY 03, 2013

Table A3-1 Wishbone Hill Surface Water Monitoring Data[1]

Year	Data Type	Moose Creek				Buffalo Creek		Premier Creek
		Station 1/15283550	Station 6	Station 7	Station 5/15283700[2]	Station 3	Station 4	Station 2
1948-1956	Flow							
	Water Quality				Discrete – spring to fall			
1971	Flow							
	Water Quality				August			
1988-1990	Flow	Monthly			Monthly		Seasonal	
	Water Quality	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	X
1990	Flow					Fall		X
	Water Quality							
1991-1992	Flow					Daily		
	Water Quality							
1998	Flow				Daily			
	Water Quality				June			
1999-2001	Flow				Daily			
	Water Quality	Seasonal			Seasonal			
2008	Flow	November			November			
	Water Quality	November	November	November	November	November	November	X
2007-2009	Flow				Daily[2]			
	Water Quality							
2012	Flow					July	July	
	Water Quality							

Key:
1 – Table is intended as a quick reference; dates shown for some sites are approximate.
2 – U.S. Geological Survey gage is still active; current data is available.

Table A3-2 Water Quality Analysis for Surface Water

		Baseline (1988-1990 and early data starting 1948)					2008 and 1998-2001			
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**	**STD.DEV**
pH (Lab)		8.3	7.2	6.3	0.4	6.8 to 7.6	7.9	7.6	6.7	0.2
pH (Field)		8.2	7.04	5.2	0.57	6.47 to 7.61	8.09	6.94	5.45	0.78
Specific Conductance (Lab)	µS/cm	155	84.9	35	30.3	54.6 to 115.2	144	95.2	48	34.4
Specific Conductance (Field)	µS/cm	241	97.3	35	41.1	56.2 to 138.4	2076	**304**	67	538
Temperature	°C	20	4.35	-2	4.02	0.33 to 8.37	1.1	**0.32**	0.01	0.38
Dissolved Oxygen (Lab)	mg/L	NA		NA			14.1	12.4	10.8	1.15
Dissolved Oxygen (Field)	mg/L	15	11.74	4.7	1.95	9.79 to 13.69	14.11	11.3	5.07	2.82
Turbidity (Lab)	NTU	33	3.29	0.25	6.6	0 to 9.89	7.9	1.32	0.3	1.6
Turbidity (Field)	NTU	46	2.97	0.2	5.81	0 to 8.78	7.01	2.85	0.53	1.93
Alkalinity (total, Lab)	mg/L	59	34.8	16	11.9	22.9 to 46.7	45	35.6	20	8.9
Alkalinity (Field)	mg/L	119	34	5	17.5	16.5 to 51.5	NA		NA	
Aluminum (diss.)	mg/L	0.2	0.135	0.1	0.05	0.085 to 0.185	0.0175	**0.007**	0.002	0.005
Arsenic (diss.)	mg/L	ND		ND			0.0012	0.00098	0.0008	0.00015
Barium (diss.)	mg/L	ND		ND			0.39	0.068	0.0019	0.123
Cadmium (diss.)	mg/L	ND		ND			0.00004	0.00004	0.00004	0
Copper (diss.)	mg/L	0.02	0.014	0.01	0.005	0.009 to 0.019	0.7	**0.186**	0.0006	0.295
Lead (diss.)	mg/L	0.09	0.06	0.02	0.03	0.03 to 0.09	0.00006	**0.000032**	0.00002	0.000015
Mercury (diss.)	mg/L	ND		ND			0.000007	0.000007	0.000007	0
Selenium	mg/L	ND		ND			ND		ND	
Zinc (diss.)	mg/L	0.08	0.02	0.01	0.014	0.006 to 0.034	0.043	0.015	0.0007	0.013
Chromium (total)	mg/L	ND		ND			0.00128	0.0006	0.0002	0.0004
Chromium (diss.)	mg/L	ND		ND			ND		ND	
Iron (total)	mg/L	6.24	0.42	0.05	0.99	0 to 1.41	0.478	0.091	0.007	0.119
Iron (diss.)	mg/L	0.24	0.09	0.05	0.04	0.05 to 0.13	0.037	**0.023**	0.013	0.008
Manganese (total)	mg/L	0.8	0.1	0.02	0.2	0 to 0.3	0.0138	0.0063	0.0025	0.0044
Manganese (diss.)	mg/L	0.05	0.03	0.02	0.01	0.02 to 0.04	0.0027	0.002	0.0012	0.0008

Table A3-2 (Cont.) Water Quality Analysis for Surface Water

		Baseline (1988-1990 and early data starting 1948)					2008 and 1998-2001			
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**	**STD.DEV**
Ammonia (as N)	mg/L	0.42	0.073	0.01	0.09	0 to 0.163	0.014	0.006	0.002	0.004
Total Kjeldahl Nitrogen (as N)	mg/L	1.9	0.4	0.1	0.4	0 to 0.8	NA		NA	
Ortho Phosphorus	mg/L	0.027	0.007	0.001	0.005	0.002 to 0.012	NA		NA	
Total Organic Phosphorus	mg/L	0.077	0.01	0.001	0.013	0 to 0.023	NA		NA	
Total Phosphorus	mg/L	0.191	0.023	0.001	0.024	0 to 0.047	NA		NA	
Hardness as CaCO3	mg/L	59	35.6	12	12.9	22.7 to 48.5	60	38.6	15.8	12.9
Total Acidity	mg/L	ND		ND			ND		ND	
Sodium Adsorption Ratio		2.4	0.28	0.1	0.24	0.04 to 0.52	0.4	0.21	0.1	0.097
Total Suspended Solids	mg/L	139	10.05	1	19.7	0 to 29.75	17	4.2	0	6.43
Total Dissolved Solids	mg/L	102	53.7	2	22.1	31.6 to 75.8	61	47.6	35	10.14
Settleable Solids	mg/L	0.2	0.18	0.1	0.04	0.14 to 0.22	ND		ND	
Boron	mg/L	0.46	0.16	0.01	0.13	0.03 to 0.29	NA		NA	
Fluoride	mg/L	0.1	0.05	0.02	0.02	0.03 to 0.07	0.097	0.042	0.023	0.03
Bicarbonate HCO3	mg/L	71	42.3	19	14.6	27.7 to 56.9	42	33.4	23	6.4
Carbonate CO3	mg/L	0	0	0	0		NA		NA	
Chloride	mg/L	9	1.99	0.4	1.86	0.13 to 3.85	7.95	2.42	0.39	2.4
Nitrate (as N)	mg/L	1.59	0.37	0.01	0.32	0.05 to 0.69	1.45	0.56	0.1	0.5
Nitrite (as N)	mg/L	ND		ND			0.003	0.003	0.003	0
Sulfate SO4	mg/L	18	5.12	0.4	5.07	0.05 to 10.19	16.2	9.3	0.4	5.5
Calcium (diss.)	mg/L	19	10.46	1.1	4.7	5.76 to 15.16	19.4	12.94	7.42	3.99
Magnesium (diss.)	mg/L	8.8	2.27	0.1	1.6	0.67 to 3.87	2.83	1.68	0.721	0.7
Potassium (diss.)	mg/L	1.5	0.49	0.1	0.23	0.26 to 0.72	0.58	0.43	0.28	0.09
Sodium (diss.)	mg/L	15	3.5	1.1	2.03	1.47 to 5.53	6.16	3.07	0.83	1.82

Table A3-2 (Cont.) Water Quality Analysis for Surface Water

		Baseline (1988-1990 and early data starting 1948)					2008 and 1998-2001			
CONSTITUENT	**UNITS**	**MAX**	**MEAN**	**MIN**	**STD.DEV.**	**mean ± std.dev.**	**MAX**	**MEAN**	**MIN**	**STD.DEV**
Anions	meq/L	1.61	0.86	0.37	0.33	0.53 to 1.19	NA		NA	
Cations	meq/L	1.6	0.85	0.36	0.3	0.55 to 1.15	NA		NA	
Cation/Anion Difference	%	5.15	1.12	0	1	0.12 to 2.12	NA		NA	

Key:
% – percent
µS/cm - microSiemens per centimeter
°C – degrees Celsius
Max – maximum
mg/L – milligrams per liter
Min – minimum
NA – not available
ND – non-detect
NTU – Nephelometric Turbidity Units
Std. Dev. – standard deviation

Bold indicates value is above or below the mean ± std.dev. value.