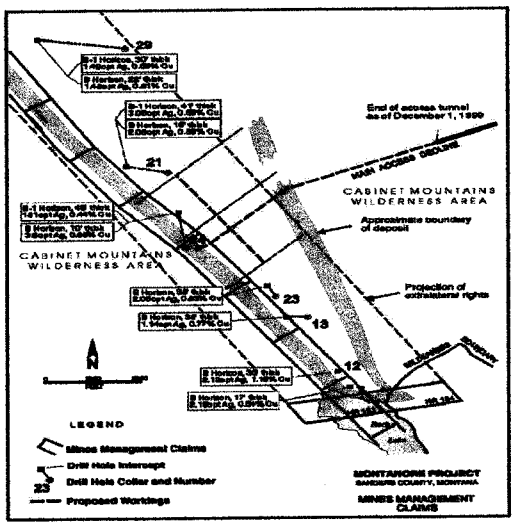
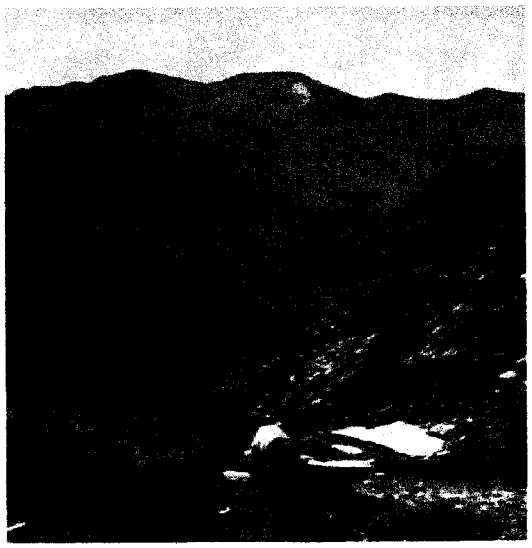
MONTANORE PROJECT

AMENDED APPLICATION

HARD ROCK OPERATING PERMIT

AMENDED PLAN OF OPERATIONS





Appendix B

Water Resources

December 2004

Mines Management, Inc.

WATER RESOURCES

Baseline Data Validation Study Plan

Mines Management, Inc.

Montanore Mine

Libby, Montana

Submitted to:

U.S. Forest Service
Kootenai National Forest
506 Highway 2 West
Libby MT 59923

Montana Department of Environmental Quality
1520 East Sixth Avenue
P.O. Box 200901
Helena MT 59620-0901

September 2004

Introduction

Mines Management, Inc. intends to develop and operate the Montanore silver/copper project near Libby, Montana, as generally outlined in the 1992 Record of Decision and Preferred Alternatives (U.S. Forest Service, et al 1992). The Project is currently undergoing an optimization review to enhance economics and reduce environmental impacts.

The Montanore Project was approved by the US Forest Service (USFS) and State of Montana through the National Environmental Policy Act (NEPA/MEPA) and MEPA processes by the completion of an Environmental Impact Statement. Additional approvals and permits were issued by other regulatory agencies.

Sufficient environmental baseline data was collected by the original proponent (Noranda), the USFS, and other entities in order to comply with the thorough NEPA/MEPA process and to support agency decisions. Following the optimization review, the Project footprint is anticipated to be similar to the alternatives (3-C and 5) selected by the regulatory agencies. Mines Management intends to proceed with securing agency approvals through:

- amending the original project permit applications,
- using the same baseline data sets, and
- acknowledging and following previous agency decisions.

Mines Management Inc. is currently reviewing optimization opportunities associated with the Montanore Project. The review is on-going but has identified that the revised project will be equal to or less than the footprint analyzed by the agencies in 1992. There are no anticipated changes to the project that would require the collection of new baseline data to support agency analyses.

It is Mines Management objective to start a validation of the current baseline data, where appropriate and necessary, to support a NEPA/MEPA review. The Baseline Data Validation Study Plan is intended to initiate that effort. It is further understood that any changes proposed by the formal plan of operations that differ from the current footprint or changes to potential impacts may require additional baseline data collection; however, it is expected that the plan will be similar to the previously reviewed project allowing much of the baseline data to stand as valid.

Project Description

Mines Management, based on the current optimization review, has determined that the footprint planned in the 1992 review will remain relatively consistent with the revised project. At this point, the mill location, mining method, tailings disposal location and method, water management (i.e. land application) and other major aspects of the project will remain consistent. The preferred alternatives (3C and 5) would be incorporated into

the overall design of the project. Because it was the preferred alternative, implementing these changes and mitigation efforts would reduce the environmental impacts associated with the project to an acceptable level.

Only two aspects of the project may vary slightly from the original project and they include the number and location of mine adits to access the project. Trade-off studies to determine the correct combination of mine access is still underway, it is anticipated that the number of adits will be reduced within Libby Creek and Ramsey Creek. Depending on ventilation designs, the adits could all be located in Ramsey Creek, eliminating the need to disturb the Libby Creek Site. Even if a Libby Creek and Ramsey Creek tunnels are required, it would not increase the current footprint.

In addition, development of the ore body will be modified to minimize the amount of workings developed outside the ore zone reducing the amount of development rock produced from the mine. As with the adits review, the footprint required for the project will be situated within the previously reviewed project.

The other outstanding project description is the need for a ventilation raise to patented claims controlled by Mines Management located outside the wilderness boundary. The ventilation design is being developed to provide for smaller tunnels and using this ventilation raise to supplement in-take air to the mine workings. The opening would be quite small and would be developed and accessed from the underground workings.

Production rates anticipated for the project would be at a lower rate and a smaller portion of the total geologic resource would likely be mined. Therefore, the footprint of various facilities (i.e. tailings storage area) may be incrementally less than the past project reviewed. The environmental resources and baseline data would be consistent with past review efforts.

Scope of the Study

As mentioned above, the baseline data sets have been evaluated and found to be generally adequate to support further project analyses under NEPA/MEPA; no new baseline data collection is considered to be required to support a decision by the agencies. The environmental assessment will be revised to update the 1992 decision for any regulatory changes that may have occurred. The 1992 EIS analyzed the following resources in order to develop and select preferred alternatives:

- Meteorology and Climate-meteorology and climate of the Project Area have not changed; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Air Quality-air quality of the Project Area has not changed; there have been no new sources of air pollutants added to the air shed that would cause a change to the air shed classification; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Geology-geology of the Project Area has not changed; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Hydrology – Certain aspects of the baseline data collected for water resources need to be validated under current water quality criteria, laboratory detection levels, and other considerations. Groundwater and surface water resources will be sampled again to validate the water quality characteristics at the site.

- Wetlands and "Waters of the United States"-no changes in wetlands or waters of the United States have occurred in the Project Area. The Project footprint will be less than or equal to the approved footprint; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Aquatics and Fisheries-since it is anticipated that the surface water regime has not changed, the aquatic resources in the Project Area have not changed. It is further that on-going management efforts (by USFS and MFWP) will provide any updated characterizations; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Wildlife-wildlife use of the Project Area has not changed. As with aquatic and fisheries resources, on-going agency management will provide Project Area information required to support a NEPA/MEPA analysis.

- Old Growth Habitat-old growth habitat has not changed in the Project Area. It is anticipated that Forest Plans direct management of old growth areas consistent with the previous NEPA/MEPA analysis; therefore no validation is necessary to support a revised analysis.

- Vegetation-vegetation types in the Project Area have remained the same. No major events (e.g. wildfires) have occurred that would change vegetation in the Project footprint; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Soils-As with vegetation, no major events have occurred that would change soils in the Project Area; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Land Use-land use of the Project Area remains unchanged; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Kootenai National Forest Management Direction-pertinent sections of the Kootenai National Forest Management Plan under which the 1992 EIS was prepared is current.

- Visual Resources-visual resources of the Project Area have not changed; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Recreation-recreation use of the Project Area has not changed. Agency management of recreation in the Project Area will provide any changes in recreation; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Transportation-transportation types and uses remain the same; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Socioeconomics-minor changes have likely occurred in the socioeconomics of the surrounding community, but no validation of baseline data is required. An update analysis will revise the baseline data where necessary for a NEPA/MEPA analysis.

- Cultural Resources-cultural resources of the Project Area remain the same; therefore no validation is necessary to support a NEPA/MEPA analysis.

- Sound-no changes in the background sound have occurred in the Project Area; therefore no validation is necessary to support a NEPA/MEPA analysis.

Validation Study Plan

The baseline data collected for each of the resources to support the 1992 EIS is considered valid. Certain water quality criteria and laboratory analysis techniques have been updated since the water quality analyses were collected for baseline data.

Water quality data collected for the project was intended to provide a reasonable characterization of ground and surface water resources. The current baseline data set contains significant parameters that are below or at detection levels. A validation of the current site water is warranted. It is expected that water quality is the same and that no change has occurred. Unlike other resources, continued monitoring or understanding of the water resources has not occurred over the years and may be necessary to revise the current NEPA/MEPA analysis for a revised project.

The previous project NEPA/MEPA review focused on groundwater and surface water quality for the project. Groundwater analysis primarily focused on two specific areas:

- Land Application Areas
- Tailings Seepage

The USFS indicated that two monitor wells located below the Libby Creek Adit were retained for future agency use. If these monitor wells are available, samples will be collected from these sites as well.

Surface water analyses focused on receiving water in and around the mine area and included:

- Libby Creek
- Ramsey Creek
- Poorman Creek
- L. Cherry Creek

To validate the groundwater within the land application and tailings storage area two groundwater wells are proposed. Figure 1 shows the locations of the groundwater monitoring wells. Both provide down gradient analyses that can be compared to baseline data groundwater monitoring.

Maxim Technologies Inc. (Maxim) will provide a monitor well installation plan for validation of the groundwater in these areas. Quarterly samples will be collected and provide sufficient data (seasonally) to validate the quality of groundwater at these sites. It is expected that no change in groundwater quality has occurred and validation of the groundwater in this area will support all the groundwater samples collected for baseline data at the project.

Figure 1 also shows the surface water samplings sites. The intent is to sample the individual surface systems that drain the project area. It is not intended to be a comprehensive data collection but to validate the water quality from each major stream within the project area. As with groundwater, it is expected that no change will have occurred to the surface water resources within the project boundary.

Surface water sampling will be completed quarterly as well and will provide seasonal validation of the site. Standard sampling procedures and protocols will be followed. The sample parameters will be collected from the surface waters as analyzed in groundwater.

For both groundwater and surface water, the following parameters and field analyses will be completed:

Proposed Water Quality Sample Parameters
Ground and Surface Water Sample Sites

pH
Conductivity
Total Dissolved Solids
Total Suspended Solids *
Nitrate/Nitrite
Aluminum
Arsenic
Copper
Iron
Lead
Manganese
Mercury
Silver
Zinc

* Surface Water Samples Only

Data Use

Data collected in the baseline data validation plan will be compared with the data collected during preparation of the 1992 EIS.

It is expected that the sampling program will not identify any significant changes in water quality. Validation of the data will provide a qualitative data to support the baseline data remains appropriate for project analyses. Water quality criteria, in some instances, have been reduced since the original analyses; however, EPA certified laboratory techniques and detection methods may not be capable of analyzing down to those levels. The NEPA/MEPA analysis will have to employ similar review techniques to assess the potential environment impacts from the mine operation. Conversely, some laboratory detection levels are lower (under standard EPA methodologies) and may quantify previously "undetected" values.

In either case, the baseline and validated data will be used consistent with the 1992 NEPA/MEPA review or revised as appropriate by the agencies to assess the project potential impacts.

Any anomalous results will be identified. All results from the validation plan will be used, along with the 1992 data sets, in the analyses of potential effects of the Montanore Project on the affected environment of the Project Area.

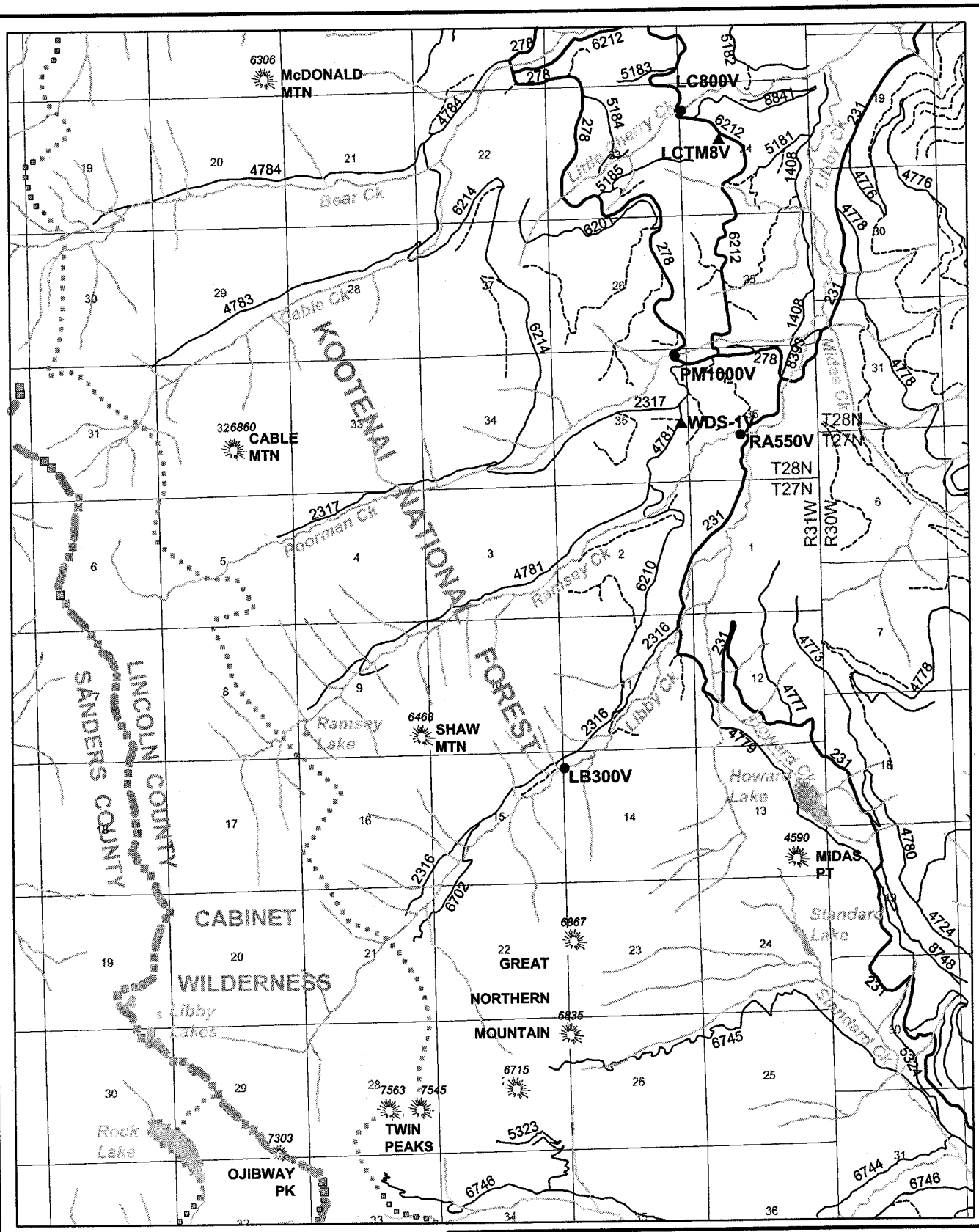
Future Monitoring Plan

Future monitoring required to support the project will be incorporated at the appropriate time and this data collection is not intended to modify the current plan. It is expected that future monitoring plans will be considered as part of the environmental review process.

It is Mines Management's intent to initiate the monitoring plan as outlined in the 1992 Decision.

References

U.S. Forest Service, Montana Department of State lands, Montana Department of Health and Environmental Sciences, Montana Department of Natural Resources and Conservation. 1992. *Final environmental impact statement, Noranda Minerals Corp. Montana Reserves Company Joint Venture, Montanore Project.* October 1992.



N
W E
S

0 5000 FT

0 1 MILE

● SURFACE WATER SAMPLE SITE

▲ GROUND WATER SAMPLE SITE

MINES MANAGEMENT, INC.

FIGURE 1

SCALE: 1"=1 MILE | DATE: SEPT. 2004

DRAWN: JASPER GEOGRAPHICS

MONTANORE PROJECT

DATA VALIDATION STUDY - SAMPLE SITES

LINCOLN COUNTY, MONTANA

Montanore Water Quality
Surface Water Sampling
Validation Study Plan

Constituent	Total	RA 550 V Total Recoverable	Dissolved	Total	LB 300V Total Recoverable	Dissolved	Total	PM 1000V Total Recoverable	Dissolved	Total	LC 800V Total Recoverable	Dissolved
	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*
Date	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004	10/20/2004
Alkalinity	5.4			5.3			12.3			23.3		
CO3, CaCO3	<1.0			<1.0			<1.0			<1.0		
Spec. Cond. (umhos/cm)	12.0			20.0			26.0			38.0		
HCO3, CaCO3	5.4			5.3			12.3			23.3		
Oil & Grease	2.1			<1.0			<1.0			<1.0		
pH	6.72			6.51			7.07			7.22		
TDS	<10			12			16			23		
TSS	<5.0			<5.0			<5.0			<5.0		
Turbidity (NTU)	0.161			0.135			0.163			0.638		
Ammonia as N	0.980			<0.030			1.17			2.74		
NO2+NO3-N	0.080			0.120			0.050			<0.020		
Ortho-Phos. As P	<0.010			<0.010			<0.010			<0.010		
Phosphorus	<0.010			<0.010			<0.010			<0.010		
Nitrogen - TKN	0.21			0.20			0.27			0.20		
Calcium	1.49		1.48	1.61		1.71	3.27		3.28	4.68		4.55
Potassium	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0
Magnesium	0.373		0.364	0.415		0.403	0.819		0.805	1.59		1.56
Sodium	0.69		0.66	0.67		0.67	0.67		0.65	1.51		1.46
Silver		<0.00010	<0.00010		<0.00010	<0.00010		<0.00010	<0.00010		<0.00010	<0.00010
Aluminum		0.028	0.026		<0.020	<0.020		0.021	<0.020		0.029	0.037
Arsenic		<0.0030	<0.0030		<0.0030	<0.0030		<0.0030	<0.0030		<0.0030	<0.0030
Cadmium		<0.00012	<0.00010		<0.00012	<0.00010		<0.00012	<0.00010		<0.00012	<0.00010
Chromium		<0.0060	<0.0060		<0.0060	<0.0060		<0.0060	<0.0060		<0.0060	<0.0060
Copper		<0.0010	<0.0010		<0.0010	<0.0010		<0.0010	<0.0010		<0.0010	0.0020
Iron		<0.020	<0.020		<0.020	<0.020		<0.020	<0.20		0.080	0.051
Mercury		<0.00020	<0.00020		<0.00020	<0.00020		<0.00020	<0.00020		<0.00020	<0.00020
Manganese		<0.0020	<0.0020		<0.0020	<0.0020		<0.0020	<0.0020		0.0084	<0.0020
Lead		<0.0030	<0.0030		<0.0030	<0.0030		<0.0030	<0.0030		<0.0030	<0.0030
Antimony		<0.0050	<0.0050		<0.0050	<0.0050		<0.0050	<0.0050		<0.0050	<0.0050
Selenium		<0.010	<0.010		<0.010	<0.010		<0.010	<0.010		<0.010	<0.010
Zinc		<0.0050	<0.0050		<0.0050	<0.0050		<0.0050	<0.0050		<0.0050	<0.0050
Hardness	3.71			4.03			8.16			11.7		

* Note: mg/l unless noted specifically

RA = Ramsey Creek 800 Validation Site
LB = Libby Creek 300 Validation Site
PM = Poorman Creek 1000 Validation Site
LC = Little Cherry Creek 800 Validation Site

ADDENDUM

TO APPENDIX B
WATER RESOURCES BASELINE TECHNICAL REPORT
MONTANORE PROJECT

This Addendum is prepared to supplement information contained in Appendix B (Water Resources Baseline Investigation Report) for the Montanore Project. Subsequent to the initial baseline monitoring period for water resources (April 1988 through March 1989), additional surface water and groundwater monitoring activities have been completed to continue the collection of baseline data. This period of monitoring from March 1989 through 1998 is known as the "interim" monitoring period. In addition, four surface water monitoring stations were sampled once in October 2004 to verify that water quality has not substantially changed since the previous baseline monitoring period (1988 – 1998). These are known as "verification" samples. Additional verification surface water and groundwater samples will be collected in 2005.

Water Monitoring Reports

The following is a list of reports that contain results of water resources monitoring for the Montanore Project:

Northern Engineering and Testing, Inc., 1988. Montana Silver Venture, Hydrology Investigation Report, Draft Interim Report. September 30, 1988.

Chen-Northern, Inc., 1989. Water Resources Baseline Investigation, Montana Project, Lincoln and Sanders Counties, Montana. in: Application for hard rock operating permit and proposed plan of operation for the Montana Project of Lincoln and Sanders Counties, Montana. Vol. 4. Noranda Minerals Corporation.

Chen-Northern, Inc., 1990. Interim Monitoring Program, Water Resources Summary Report, April 1989 through February 1990. May 14, 1990.

Chen-Northern, Inc., 1991. 1990 Interim Water Resources Monitoring Program, Summary Report, April 1990 through February 1991. April 1991.

Chen-Northern, Inc., 1992. 1991 Interim Water Resources Monitoring Program, Summary Report, April 1991 through February 1992. May 1992.

Chen-Northern, Inc., 1993. 1992 Water Resources Monitoring Program, Summary Report, April 1992 through October 1992. April 1993.

Huntingdon Chen-Northern, Inc., 1994. 1993 Water Resources Monitoring Program, Summary Report, March 1992 through October 1993. February 1994.

Huntingdon Engineering & Environmental, Inc., 1995. 1994 Water Resources Monitoring Program, Summary Report, January through December 1994. January 1995.

Maxim Technologies, Inc., 1996. 1995 Water Resources Monitoring Program, Summary Report, January through December 1995. February 1996.

Maxim Technologies, Inc., 1997. 1996 Water Resources Monitoring Program, Summary Report. February 1997.

Maxim Technologies, Inc., 1998. 1997 Water Resources Monitoring Program, Summary Report. March 1998.

Surface Water Monitoring Stations for Interim Period

The following is a list of surface water monitoring stations according to stream location:

- Libby Creek: LB-200 (above adit at upper bridge); LB-300 (below adit); LB-1000 (below adit near 7-Mile Gate); LB-2000 (below Little Cherry Ck); LB-3000 (at old gage).
- Little Cherry Creek: LC-100 (at Bear Ck road); LC-800 (below proposed tailing impoundment).
- Ramsey Creek: RA-100 (above proposed mill site); RA-200 (below proposed mill site at upper bridge); RA-550/-600 (above mouth of creek).
- Poorman Creek: PM-1000 (at lower Little Cherry Ck loop road).
- Bear Creek: BC-500 (at Bear Ck road).

Table A-1 presents the dates of surface water sampling events completed during the interim period of 1989 through 1997. Also included on this Table are the following four samples that were collected in October 2004 as the verification samples:

- LB-300V: Same location as LB-300 on Libby Creek below adit.
- LC-800V: Same location as LC-800 on Little Cherry Creek below proposed tailing impoundment.
- RA-550V: Same location as RA-550 on Ramsey Creek above mouth of creek.
- PM-1000V: Same location as PM-1000 on Poorman Creek at lower Little Cherry Creek loop road.

TABLE A-1
SUMMARY OF SURFACE WATER SAMPLING
INTERIM MONITORING PERIOD 1989-2004
MONTANORE MINE PROJECT

Sample Period	Number of Surface Water Stations	Sampling Frequency per Year	Station ID and Dates Sampled
1989	1	1 X	RA-200 (Nov)
	2	4 X	LB-200 & LB-300 (Sep through Dec)
	4	8 X	LB-500, LC-100, PM-500 & PM-100 (Apr, May (2), June (2), July, Aug, Sep)
	1	9 X	RA-600 (Apr through Oct)
	2	11 X	LB-800 & LB-3000 (Apr through Nov)
1990	1	1 X	LB-3000 (Feb)
	2	7 X	LB-800 & RA-600 (Feb, Apr, May (2), June (2), Sep)
	1	7 X	LB-2000 (Apr, May (2), June (2), Sep, Nov)
	2	10 X	LB-200 & LB-300 (Jan, Feb, Mar, Apr, May (2), June (2), Sep, Nov)
1991	2	2 X	LB-3000 & PM-1000 (Apr, Aug)
	6	4 X	BC-500, LB-1000, LC-100, LC-800, RA-100, RA-200 & RA-550 (Apr, June, Aug, Oct)
	3	5 X	LB-200, LB-300 & LB-2000 (Feb, Apr, June, Aug, Oct)
1992	5	3 X	LB-200, LB-300, LB-2000, LB-3000 & PM-1000 (Apr, Aug, Oct)
	7	4 X	BC-500, LB-1000, LC-100, LC-800, RA-100, RA-200 & RA-550 (Jan, Apr, Aug, Oct)
1993	1	1 X	RA-600 (Feb)
	13	3 X	BC-500, LB-200, LB-300, LB-1000, LB-2000, LB-3000, LC-100, LC-800, PM-500, PM-1000, RA-100, RA-200 & RA-550 (Mar, Aug, Oct)
	1	10 X	LB-200 (Jan through Oct)
	1	12 X	LB-300 (Jan through Dec)
1994	2	5 X	LB-200 & LB-1000 (June through Oct)
	1	12 X	LB-300 (Jan through Dec)
1995	1	1 X	LB-200 (Oct)
	1	12 X	LB-300 (Jan through Dec)
1996	1	12 X	LB-300 (Jan through Dec)
1997	1	11 X	LB-300 (Jan through Nov)
2004	4	1 X	RA-550V, LB-300V, PM-1000V & LC-800V (Oct)

Groundwater Monitoring Wells for Interim Period

The following is a list of groundwater monitoring wells according to general area:

- Wells near Johnstone Placer and below Libby Adit in Libby Creek drainage (west of SW station LB-300): JPM-1, JPM-2, JPM-3, and JPM-4.

- Wells in proposed Land Application Discharge (LAD) areas: LAD-1 (south of Poorman Creek), LAD-2 (south of proposed tailing impoundment), LAD-3 (south of Bear Creek), LAD-4 (east of Little Cherry Creek storage pond), and LAD-5 (north of Little Cherry Creek).

- Wells in Little Cherry Creek drainage: DH-15 (geotechnical well at creek on lower loop road inside lower end of proposed tailing impoundment); LCTM-8 and LCM-9 (downgradient of proposed tailing impoundment); LCM-10 and LCM-11 (upgradient of proposed tailing impoundment); and PLCM-6 (dual completion well downgradient of proposed percolation ponds south of tailing impoundment).

- Wells in lower Ramsey Creek drainage near proposed LAD sites: WDS-1 (percolation pond site), WDS-2, WDS-3, WDS-4, WDS-5, and WDS-6.

- Well in upper Ramsey Creek drainage: RCDH-1 (geotechnical well).

Table A-2 presents the dates of groundwater sampling events completed during the interim period of 1989 through 1995. No groundwater samples have been collected from monitoring wells at the project site since 1995.

Two new wells are planned to be completed in early 2005 at the Montanore Project site as verification sites to confirm previous baseline data. These two wells are listed below:

- LCTM-8V: Replaces former well LCTM-8 located in Little Cherry Creek drainage immediately downgradient (east) of proposed tailing impoundment.

- WDS-1V: Replaces former well WDS-1 located in lower Ramsey Creek drainage near proposed LAD site.

TABLE A-2
SUMMARY OF GROUNDWATER SAMPLING
INTERIM MONITORING PERIOD 1989-1995
MONTANORE MINE PROJECT

Sample Period	Number of Monitoring Wells	Sampling Frequency per Year	Well ID and Dates Sampled
1988	1	1 X	LCTM-8 (Aug)
	5	2 X	LCM-9, LCM-10, LCM-11, PLCM-6SH & PLCM-6DP (Aug, Oct)
1989	4	1 X	LCTM-8, LCM-11 & DH-15 (Nov); RCDH-1 (July)
	2	2 X	WDS-1 (Oct, Nov); PLCM-6DP (Mar, Nov)
	5	3 X	LCM-9, LCM-10, LCM-11, LCTM-8 & PLCM-6SH (Jan, Mar, Nov)
	1	4 X	JPM-1 (Sep, Oct, Nov, Dec)
1990	7	1 X	DH-15, LCM-9, LCM-10, LCM-11, LCTM-8, PLCM-6SH & PLCM-6DP (Nov)
	1	2 X	WDS-1 (Feb, Nov)
	1	11 X	JPM-1 (Jan through Nov)
1991	8	1 X	DH-15, LCM-9, LCM-10, LCM-11, LCTM-8, PLCM-6SH, PLCM-6DP & WDS-1 (Aug)
	1	12 X	JPM-1 (Jan through Dec)
1992	1	1 X	PLCM-6DP (Aug)
	9	2 X	DH-15, LCTM-8, LCM-9, LCM-10, LCM-11 & PLCM-6SH (Jan, Aug); WDS-2, WDS-4 & WDS-6 (Feb, Aug)
	2	3 X	WDS-1 & WDS-3 (Jan, Feb, Aug)
	3	11 X	JPM-2, JPM-3 & JPM-4 (Feb through Dec)
	1	12 X	JPM-1 (Jan through Dec)
1993	15	1 X	WDS-1, WDS-2, WDS-3, WDS-4, WDS-6, DH-15, LCTM-8, LCM-9, LCM-10, LCM-11, PLCM-6SH, & PLCM-6DP (Aug); LAD-1, LAD-3 & LAD-4 (Dec)
	4	10 X	JPM-1, JPM-2, JPM-3 & JPM-4 (Jan, Feb (2), Mar, Apr, May, June, July, Aug, Oct)
1994	4	3 X	JPM-1, JPM-2, JPM-3 & JPM-4 (Feb, May, Oct)
	5	4 X	LAD-1, LAD-2, LAD-3, LAD-4 & LAD-5 (Jan, May, Aug, Nov)
1995	9	1 X	JPM-1, JPM-2, JPM-3 & JPM-4 (Aug); LAD-1, LAD-2, LAD-3, LAD-4 & LAD-5 (Oct)

Note: Samples collected after March 1989 are considered "interim" monitoring data. No groundwater samples were collected after 1995.

Libby Adit Discharge Sampling for Interim Period

Water samples have been collected from the Libby Adit between 1990 and 1998. Beginning in 1997, the samples were collected as part of a requirement for a MPDES Permit (No. MT-0030279) issued to Noranda Minerals Corporation. Discharge from adit ceased in October 1998. Three outfalls were included in the MPDES permit: 001 = percolation pond; 002 = infiltration system of buried slotted pipes; and 003 = pipeline outlet. Libby Creek monitoring station LB-200 is located upstream, and station LB-300 is located downstream of the permitted outfalls.

Table A-3 presents the dates of sampling events completed during the interim period of 1993 through 1998 for the Libby Adit discharge.

TABLE A-3
SUMMARY OF LIBBY ADIT DISCHARGE SAMPLING
INTERIM MONITORING PERIOD 1993-1998
MONTANORE MINE PROJECT

Sample Period	Number of Sample Sites	Sampling Frequency per Year	Station ID and Dates Sampled
1993	1	4 X	A2 (Feb, May, June, Oct)
1995	1	4 X	A2 (June, Sept, Oct (2))
1996	1	1 X	Outfall (10/96) collected by MT DEQ
1997	1	9 X	Outfall 001-002 (May through Dec)
1998	1	8 X	Outfall 001-002 (Jan through Aug)

Water Quality Data for Interim Period

Attached are statistical summaries of the surface water and groundwater quality data obtained during the interim monitoring period. For surface water, interim samples were collected from April 1989 through November 1997. Groundwater interim samples were collected from April 1989 through October 1995. The Libby Adit samples were collected from February 1993 through August 1998.

Water Quality Data for Verification Samples

Attached are comparisons of water quality data using samples collected at four representative surface water stations for three general monitoring periods:

- Initial baseline monitoring period: April 1988 through March 1989.
- Interim monitoring period: April 1989 through 1997.
- Verification monitoring period: October 2004 (additional verification samples will be collected in 2005).

The verification sites are located on four separate streams in the project area:

- LB-300V: Same location as LB-300 on Libby Creek below adit.
- LC-800V: Same location as LC-800 on Little Cherry Creek below proposed tailing impoundment.
- RA-550V: Same location as RA-550 on Ramsey Creek above mouth of creek.
- PM-1000V: Same location as PM-1000 on Poorman Creek at lower Little Cherry Creek loop road.

Results of the verification samples collected to date show that surface water quality conditions have not changed substantially in the project area.

ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
A-2	Adit		Period of record:	02/1993 To	10/1995
Flow (cfs)	260.0	260.0	260.0		1
SC (umhos/cm) (lab)	163	261	196	41	5
SC (umhos/cm) (field)	161	250	200	46	3
TSS	246	254	250	6	2
TDS	84	141	114	19	7
Turbidity (NTU)					0
Temperature (C) (field)	13.3	15.0	14.3	0.8	4
pH (s.u) (field)	7.2	8.7	8.0	0.6	5
pH (s.u.) (lab)	7.3	8.0	7.6	0.3	5
Bicarbonate	74	94	86	8	5
Calcium (Total)	15.0	16.0	15.2	0.4	5
Carbonate	0	0	0	0	3
Chloride	1	4	2	2	5
Hydroxide	0.0	0.0	0.0		1
Magnesium (Total)	2.0	4.0	3.6	0.9	5
Potassium (Total)	1.0	2.0	1.4	0.5	5
Sodium (Total)	10.0	21.0	17.2	4.3	5
Sulfate	10.0	15.0	13.6	2.1	5
Total Alkalinity	61	77	70	6	5
Total Hardness					0
Ammonia	0.05	0.12	0.06	0.02	8
Kjeldah Nitrogen	0.20	0.20	0.20	0.00	5
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.005	0.005	0.000	2
Phosphorus	0.027	0.027	0.027		1
Aluminum (Total)	0.10	0.10	0.10		1
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050		1
Barium (Total)					0
Cadmium (Total)	0.0002	0.0002	0.0002		1
Chromium (Total)	0.004	0.004	0.004		1
Copper (Total)	0.001	0.001	0.001		1
Flouride (Total)	0.160	0.160	0.160		1
Iron (Total)	0.10	0.10	0.10		1
Lead (Total)	0.0007	0.0007	0.0007		1
Manganese (Total)	0.02	0.02	0.02		1
Mercury (Total)	0.0002	0.0002	0.0002		1
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002		1
Thallium (Total)					0
Zinc (Total)	0.020	0.050	0.035	0.021	2
Oil + Grease	3.0	3.0	3.0		1

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

Sample population includes below detection data. Below detectable concentrations are set equal to the detection limit value for statistical calculations.

ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
BC-500	Surface Water		Period of record:	**04/1991** To	**10/1993**
Flow (cfs)	2.8	101.2	26.9	32.5	10
SC (umhos/cm) (lab)	36	87	66	18	12
SC (umhos/cm) (field)	34	95	67	18	12
TSS	1	1	1	0	11
TDS	14	48	34	11	12
Turbidity (NTU)	0.05	0.40	0.24	0.10	12
Temperature (C) (field)	0.0	13.0	7.0	4.5	11
pH (s.u) (field)	5.1	7.4	6.8	0.7	11
pH (s.u.) (lab)	5.9	7.6	6.9	0.5	12
Bicarbonate	21	50	39	10	12
Calcium (Total)	0.2	12.1	9.1	3.3	12
Carbonate	0	0	0	0	12
Chloride	1	1	1	0	12
Hydroxide	0.0	0.0	0.0	0.0	10
Magnesium (Total)	0.1	2.6	1.7	0.6	12
Potassium (Total)	0.2	1.0	0.7	0.4	12
Sodium (Total)	0.4	2.0	0.9	0.4	12
Sulfate	1.0	7.0	2.5	1.8	12
Total Alkalinity	17	41	32	8	12
Total Hardness	1	39	30	11	12
Ammonia	0.05	0.22	0.08	0.06	12
Kjeldah Nitrogen	0.20	0.66	0.29	0.17	12
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.015	0.006	0.003	12
Phosphorus	0.005	0.022	0.009	0.006	12
Aluminum (Total)	0.10	0.10	0.10	0.00	12
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	12
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0027	0.0005	0.0008	12
Chromium (Total)	0.004	0.020	0.013	0.008	12
Copper (Total)	0.001	0.010	0.002	0.003	12
Flouride (Total)	0.050	0.050	0.050	0.000	7
Iron (Total)	0.05	0.08	0.05	0.01	12
Lead (Total)	0.0007	0.0013	0.0009	0.0002	12
Manganese (Total)	0.02	0.02	0.02	0.00	12
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	12
Molybdenum (Total)	0.0200	0.0500	0.0457	0.0113	7
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0002	0.0002	0.0000	12
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.020	0.180	0.037	0.046	12
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
DH-15	Groundwater		Period of record:	11/1989 To	08/1993
Flow (cfs)	6.1	6.1	6.1		1
SC (umhos/cm) (lab)	181	340	215	62	6
SC (umhos/cm) (field)	154	199	185	16	6
TSS					0
TDS	86	117	105	11	6
Turbidity (NTU)					0
Temperature (C) (field)	2.0	12.5	8.1	4.0	6
pH (s.u) (field)	7.0	8.0	7.5	0.4	6
pH (s.u.) (lab)	6.0	7.8	7.1	0.7	6
Bicarbonate	15	122	101	42	6
Calcium (Total)	1.0	27.0	21.4	10.1	6
Carbonate	0	0	0	0	6
Chloride	1	3	1	1	6
Hydroxide	0.0	0.0	0.0	0.0	5
Magnesium (Total)	1.5	7.0	5.3	1.9	6
Potassium (Total)	0.3	10.0	2.3	3.8	6
Sodium (Total)	6.0	8.0	6.9	0.8	6
Sulfate	1.0	5.0	3.0	1.5	6
Total Alkalinity	12	100	83	35	6
Total Hardness					0
Ammonia	0.05	0.05	0.05		1
Kjeldah Nitrogen	0.20	0.41	0.31	0.15	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	1.05	0.26	0.39	6
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	6
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0007	0.0005	6
Chromium (Total)	0.004	0.020	0.015	0.008	6
Copper (Total)	0.001	0.020	0.011	0.008	6
Flouride (Total)	0.080	0.100	0.092	0.011	5
Iron (Total)	0.05	0.44	0.12	0.16	6
Lead (Total)	0.0007	0.0100	0.0054	0.0050	6
Manganese (Total)	0.02	0.05	0.03	0.01	6
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	6
Molybdenum (Total)	0.0002	0.0500	0.0400	0.0223	5
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0010	0.0007	0.0004	6
Thallium (Total)					0
Zinc (Total)	0.002	0.120	0.034	0.043	6
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
JPM-1	Groundwater	Period of record:	09/1989	To	08/1995
Flow (cfs)					0
SC (umhos/cm) (lab)	12	1290	90	168	58
SC (umhos/cm) (field)	11	175	66	46	50
TSS					0
TDS	1	174	55	38	59
Turbidity (NTU)					0
Temperature (C) (field)	3.0	15.0	8.4	2.8	56
pH (s.u) (field)	5.1	6.7	6.0	0.4	52
pH (s.u.) (lab)	4.7	6.7	5.6	0.5	57
Bicarbonate	1	12	6	2	60
Calcium (Total)	0.6	17.9	6.1	4.8	60
Carbonate	0	0	0	0	58
Chloride	1	9	1	1	60
Hydroxide	0.0	0.0	0.0	0.0	52
Magnesium (Total)	0.2	4.0	1.4	0.8	60
Potassium (Total)	0.2	11.0	1.3	1.5	60
Sodium (Total)	0.9	10.0	3.6	2.2	60
Sulfate	1.0	11.0	3.7	2.5	59
Total Alkalinity	1	10	5	2	60
Total Hardness					0
Ammonia	0.05	0.68	0.11	0.17	18
Kjeldah Nitrogen	0.20	1.17	0.27	0.24	16
Nitrate + Nitrite					0
Ortho-Phosphate	0.022	0.022	0.022		1
Phosphorus	0.023	0.023	0.023		1
Aluminum (Total)	0.10	0.10	0.10	0.00	59
Antimony (Total)					0
Arsenic (Total)	0.0010	0.0050	0.0047	0.0010	58
Barium (Total)					0
Cadmium (Total)	0.0001	0.0240	0.0015	0.0038	59
Chromium (Total)	0.004	0.200	0.021	0.024	59
Copper (Total)	0.001	0.200	0.013	0.026	59
Flouride (Total)	0.005	0.100	0.048	0.017	47
Iron (Total)	0.01	0.06	0.05	0.01	59
Lead (Total)	0.0007	0.0100	0.0062	0.0045	59
Manganese (Total)	0.01	0.24	0.02	0.03	59
Mercury (Total)	0.0002	0.0005	0.0002	0.0001	59
Molybdenum (Total)	0.0200	0.0500	0.0493	0.0044	46
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0001	0.0500	0.0017	0.0064	59
Thallium (Total)					0
Zinc (Total)	0.002	0.370	0.033	0.060	59
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
JPM-2	Groundwater		Period of record:	**02/1992** To	**08/1995**
Flow (cfs)					0
SC (umhos/cm) (lab)	11	91	40	21	19
SC (umhos/cm) (field)	15	64	40	17	15
TSS					0
TDS	12	62	30	13	19
Turbidity (NTU)					0
Temperature (C) (field)	4.0	14.0	7.5	2.5	22
pH (s.u) (field)	5.0	7.1	5.9	0.5	19
pH (s.u.) (lab)	5.0	6.5	5.6	0.4	18
Bicarbonate	1	10	6	3	20
Calcium (Total)	1.0	6.3	3.3	1.4	20
Carbonate	0	0	0	0	18
Chloride	1	6	2	1	20
Hydroxide	0.0	0.0	0.0	0.0	12
Magnesium (Total)	0.3	3.5	1.1	0.7	20
Potassium (Total)	0.3	3.2	1.0	0.6	20
Sodium (Total)	1.0	7.0	2.6	1.6	20
Sulfate	1.0	9.0	4.1	2.0	20
Total Alkalinity	1	8	5	2	20
Total Hardness					0
Ammonia	0.05	0.11	0.06	0.02	15
Kjeldah Nitrogen	0.20	0.28	0.21	0.03	14
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	19
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	18
Barium (Total)					0
Cadmium (Total)	0.0001	0.0030	0.0007	0.0007	19
Chromium (Total)	0.004	0.020	0.014	0.008	19
Copper (Total)	0.001	0.020	0.009	0.008	19
Flouride (Total)	0.050	0.100	0.058	0.020	6
Iron (Total)	0.05	0.07	0.05	0.00	19
Lead (Total)	0.0007	0.0100	0.0056	0.0047	19
Manganese (Total)	0.02	0.02	0.02	0.00	19
Mercury (Total)	0.0002	0.0007	0.0003	0.0002	19
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	6
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0010	0.0007	0.0004	19
Thallium (Total)					0
Zinc (Total)	0.020	0.360	0.053	0.080	18
Oil + Grease					0

Notes:

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Units are mg/l unless otherwise indicated

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
JPM-3	Groundwater		Period of record:	**02/1992** To	**08/1995**
Flow (cfs)					0
SC (umhos/cm) (lab)	89	187	125	26	19
SC (umhos/cm) (field)	23	220	124	39	16
TSS					0
TDS	50	104	78	15	19
Turbidity (NTU)					0
Temperature (C) (field)	4.0	18.0	10.5	2.7	22
pH (s.u) (field)	5.3	7.2	6.4	0.5	19
pH (s.u.) (lab)	5.5	7.3	6.3	0.4	18
Bicarbonate	9	70	39	18	20
Calcium (Total)	5.7	15.0	9.6	2.3	20
Carbonate	0	0	0	0	18
Chloride	1	6	2	1	20
Hydroxide	0.0	0.0	0.0	0.0	12
Magnesium (Total)	1.0	3.4	1.8	0.6	20
Potassium (Total)	1.0	3.2	1.2	0.5	20
Sodium (Total)	5.2	20.0	12.0	3.3	20
Sulfate	3.0	15.0	11.2	2.9	20
Total Alkalinity	8	57	32	15	20
Total Hardness					0
Ammonia	0.05	0.17	0.07	0.03	15
Kjeldah Nitrogen	0.20	0.42	0.24	0.07	14
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	19
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	19
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0006	0.0004	19
Chromium (Total)	0.004	0.020	0.014	0.008	19
Copper (Total)	0.001	0.020	0.008	0.007	19
Flouride (Total)	0.050	0.140	0.087	0.039	6
Iron (Total)	0.05	0.05	0.05	0.00	19
Lead (Total)	0.0007	0.0100	0.0061	0.0047	19
Manganese (Total)	0.02	0.03	0.02	0.00	19
Mercury (Total)	0.0002	0.0012	0.0003	0.0002	19
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	6
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0010	0.0007	0.0004	19
Thallium (Total)					0
Zinc (Total)	0.020	0.200	0.038	0.042	19
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
JPM-4	Groundwater		Period of record:	**02/1992** To	**08/1995**
Flow (cfs)					0
SC (umhos/cm) (lab)	23	258	72	63	20
SC (umhos/cm) (field)	20	300	73	83	16
TSS					0
TDS	8	154	50	36	20
Turbidity (NTU)					0
Temperature (C) (field)	3.0	14.0	6.9	3.0	23
pH (s.u) (field)	4.8	7.0	5.8	0.6	20
pH (s.u.) (lab)	4.4	6.3	5.4	0.5	19
Bicarbonate	1	28	4	7	21
Calcium (Total)	2.0	25.0	6.9	6.0	21
Carbonate	0	1	0	0	19
Chloride	1	3	1	1	21
Hydroxide	0.0	0.0	0.0	0.0	12
Magnesium (Total)	0.5	3.4	1.4	0.7	21
Potassium (Total)	1.0	46.0	3.4	9.8	21
Sodium (Total)	1.0	14.8	3.8	3.7	21
Sulfate	2.0	24.0	7.9	6.0	20
Total Alkalinity	1	23	3	5	21
Total Hardness					0
Ammonia	0.05	0.13	0.06	0.02	16
Kjeldah Nitrogen	0.20	0.23	0.20	0.01	15
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.70	0.15	0.15	20
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	19
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0005	0.0004	20
Chromium (Total)	0.001	0.020	0.013	0.008	20
Copper (Total)	0.001	0.020	0.009	0.008	20
Flouride (Total)	0.050	0.100	0.062	0.019	6
Iron (Total)	0.01	0.05	0.05	0.01	20
Lead (Total)	0.0007	0.0100	0.0054	0.0047	20
Manganese (Total)	0.02	0.51	0.08	0.12	20
Mercury (Total)	0.0002	0.0014	0.0003	0.0003	20
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	6
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0010	0.0007	0.0004	20
Thallium (Total)					0
Zinc (Total)	0.020	0.150	0.038	0.036	20
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LAD-1	Groundwater		Period of record:	**12/1993** To	**10/1995**
Flow (cfs)					0
SC (umhos/cm) (lab)	62	194	90	51	6
SC (umhos/cm) (field)	54	640	251	337	3
TSS					0
TDS	49	104	75	18	6
Turbidity (NTU)					0
Temperature (C) (field)	5.0	10.0	7.4	2.5	4
pH (s.u) (field)	6.0	7.3	6.4	0.6	4
pH (s.u.) (lab)	5.8	6.6	6.2	0.3	6
Bicarbonate	29	43	37	5	6
Calcium (Total)	4.0	9.0	6.2	1.7	6
Carbonate	0	0	0	0	6
Chloride	1	11	4	4	6
Hydroxide					0
Magnesium (Total)	2.0	14.0	5.2	4.7	6
Potassium (Total)	1.0	4.0	1.8	1.2	6
Sodium (Total)	1.0	6.0	3.5	2.4	6
Sulfate	5.0	9.0	6.5	1.8	6
Total Alkalinity	24	35	30	4	6
Total Hardness					0
Ammonia	0.04	0.12	0.06	0.03	6
Kjeldah Nitrogen	0.20	4.60	1.23	1.70	6
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	6
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	6
Barium (Total)					0
Cadmium (Total)	0.0001	0.0006	0.0002	0.0002	6
Chromium (Total)	0.002	0.004	0.004	0.001	6
Copper (Total)	0.001	0.001	0.001	0.000	6
Flouride (Total)					0
Iron (Total)	0.05	0.05	0.05	0.00	6
Lead (Total)	0.0007	0.0020	0.0010	0.0005	6
Manganese (Total)	0.02	0.05	0.03	0.01	6
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	6
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	6
Thallium (Total)					0
Zinc (Total)	0.020	0.090	0.037	0.027	6
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LAD-2	Groundwater	Period of record:	01/1994	To	10/1995
Flow (cfs)					0
SC (umhos/cm) (lab)	47	191	86	60	5
SC (umhos/cm) (field)	30	520	202	276	3
TSS					0
TDS	71	628	278	226	5
Turbidity (NTU)					0
Temperature (C) (field)	3.4	10.0	7.1	3.4	4
pH (s.u) (field)	5.5	7.0	6.1	0.8	4
pH (s.u.) (lab)	5.9	7.4	6.7	0.5	5
Bicarbonate	15	98	40	34	5
Calcium (Total)	2.0	7.0	5.2	1.9	5
Carbonate	0	0	0	0	5
Chloride	1	15	5	6	5
Hydroxide					0
Magnesium (Total)	1.0	6.0	3.4	2.1	5
Potassium (Total)	1.0	8.0	2.8	3.0	5
Sodium (Total)	1.0	37.0	10.2	15.2	5
Sulfate	5.0	29.0	11.2	10.3	5
Total Alkalinity	12	80	33	28	5
Total Hardness					0
Ammonia	0.05	1.27	0.32	0.53	5
Kjeldah Nitrogen	0.20	1.72	0.71	0.67	5
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	1.50	0.50	0.60	5
Antimony (Total)					0
Arsenic (Total)	0.0005	0.0050	0.0041	0.0020	5
Barium (Total)					0
Cadmium (Total)	0.0001	0.0022	0.0006	0.0009	5
Chromium (Total)	0.002	0.030	0.009	0.012	5
Copper (Total)	0.001	0.008	0.004	0.003	5
Flouride (Total)					0
Iron (Total)	0.05	0.61	0.27	0.23	5
Lead (Total)	0.0007	0.0600	0.0139	0.0259	5
Manganese (Total)	0.02	0.08	0.05	0.03	5
Mercury (Total)	0.0002	0.0080	0.0025	0.0035	5
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	5
Thallium (Total)					0
Zinc (Total)	0.020	0.180	0.056	0.069	5
Oil + Grease					0

Notes:

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NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LAD-3	Groundwater		Period of record:	12/1993 To	10/1995
Flow (cfs)					0
SC (umhos/cm) (lab)	90	116	105	12	6
SC (umhos/cm) (field)	80	180	123	52	3
TSS					0
TDS	64	148	97	30	6
Turbidity (NTU)					0
Temperature (C) (field)	5.0	10.0	7.6	2.3	4
pH (s.u) (field)	6.4	7.1	6.7	0.3	4
pH (s.u.) (lab)	6.8	7.5	7.0	0.3	6
Bicarbonate	55	70	61	7	6
Calcium (Total)	9.0	12.0	10.2	1.2	6
Carbonate	0	0	0	0	6
Chloride	1	6	2	2	6
Hydroxide					0
Magnesium (Total)	3.0	4.0	3.5	0.5	6
Potassium (Total)	1.0	3.0	1.5	0.8	6
Sodium (Total)	1.0	11.0	7.2	3.5	6
Sulfate	5.0	6.0	5.2	0.4	6
Total Alkalinity	45	57	50	5	6
Total Hardness					0
Ammonia	0.03	0.80	0.17	0.28	7
Kjeldah Nitrogen	0.20	0.87	0.40	0.32	7
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.20	0.12	0.04	6
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	6
Barium (Total)					0
Cadmium (Total)	0.0001	0.0168	0.0029	0.0068	6
Chromium (Total)	0.002	0.004	0.004	0.001	6
Copper (Total)	0.001	0.001	0.001	0.000	6
Flouride (Total)					0
Iron (Total)	0.05	0.13	0.06	0.03	6
Lead (Total)	0.0007	0.0020	0.0010	0.0005	6
Manganese (Total)	0.02	0.10	0.04	0.03	6
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	6
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	6
Thallium (Total)					0
Zinc (Total)	0.020	0.090	0.048	0.034	6
Oil + Grease					0

Notes:

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NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LAD-4	Groundwater	Period of record:	**12/1993**	To	**10/1995**
Flow (cfs)					0
SC (umhos/cm) (lab)	148	174	157	9	6
SC (umhos/cm) (field)	24	180	117	82	3
TSS					0
TDS	102	142	121	15	6
Turbidity (NTU)					0
Temperature (C) (field)	5.5	8.0	6.6	1.1	4
pH (s.u) (field)	6.1	7.0	6.5	0.4	4
pH (s.u.) (lab)	6.5	7.4	6.8	0.3	6
Bicarbonate	89	104	97	6	6
Calcium (Total)	5.0	12.0	8.0	2.8	6
Carbonate	0	0	0	0	6
Chloride	1	3	2	1	6
Hydroxide					0
Magnesium (Total)	5.0	6.0	5.2	0.4	6
Potassium (Total)	1.0	1.0	1.0	0.0	6
Sodium (Total)	19.0	22.0	20.0	1.1	6
Sulfate	5.0	9.0	6.8	2.0	6
Total Alkalinity	73	85	80	5	6
Total Hardness					0
Ammonia	0.03	0.05	0.05	0.01	6
Kjeldah Nitrogen	0.12	0.35	0.21	0.07	6
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	6
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	6
Barium (Total)					0
Cadmium (Total)	0.0001	0.0006	0.0003	0.0002	6
Chromium (Total)	0.002	0.004	0.004	0.001	6
Copper (Total)	0.001	0.001	0.001	0.000	6
Flouride (Total)					0
Iron (Total)	0.05	0.09	0.06	0.02	6
Lead (Total)	0.0007	0.0010	0.0008	0.0002	6
Manganese (Total)	0.02	0.54	0.27	0.21	6
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	6
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	6
Thallium (Total)					0
Zinc (Total)	0.020	10.600	3.140	3.888	6
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LAD-5	Groundwater		Period of record:	**01/1994** To	**10/1995**
Flow (cfs)					0
SC (umhos/cm) (lab)	240	618	383	141	5
SC (umhos/cm) (field)	42	450	277	211	3
TSS					0
TDS	206	439	316	101	5
Turbidity (NTU)					0
Temperature (C) (field)	5.0	11.0	8.1	2.9	4
pH (s.u) (field)	6.3	7.9	7.1	0.7	4
pH (s.u.) (lab)	7.8	8.0	7.9	0.1	5
Bicarbonate	116	242	188	55	5
Calcium (Total)	26.0	63.0	41.0	13.5	5
Carbonate	0	0	0	0	5
Chloride	3	11	6	3	5
Hydroxide					0
Magnesium (Total)	7.0	13.0	9.8	2.2	5
Potassium (Total)	5.0	9.0	6.4	1.7	5
Sodium (Total)	21.0	66.0	32.6	18.8	5
Sulfate	10.0	159.0	41.4	65.8	5
Total Alkalinity	95	198	154	45	5
Total Hardness					0
Ammonia	0.07	0.75	0.27	0.28	5
Kjeldah Nitrogen	0.68	41.00	9.37	17.69	5
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	5
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	5
Barium (Total)					0
Cadmium (Total)	0.0001	0.0005	0.0002	0.0002	5
Chromium (Total)	0.002	0.004	0.004	0.001	5
Copper (Total)	0.001	0.001	0.001	0.000	5
Flouride (Total)					0
Iron (Total)	0.05	0.06	0.05	0.00	5
Lead (Total)	0.0007	0.0010	0.0008	0.0001	5
Manganese (Total)	0.02	0.96	0.49	0.44	5
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	5
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	5
Thallium (Total)					0
Zinc (Total)	0.020	0.100	0.056	0.034	5
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-1000	Surface Water		Period of record:	**04/1991** To	**10/1994**
Flow (cfs)	2.9	107.5	29.8	31.6	14
SC (umhos/cm) (lab)	18	78	42	18	12
SC (umhos/cm) (field)	13	78	48	18	15
TSS	1	3	1	1	12
TDS	15	50	29	10	12
Turbidity (NTU)	0.05	0.90	0.36	0.24	12
Temperature (C) (field)	0.5	18.0	10.2	5.6	16
pH (s.u) (field)	6.3	7.8	7.0	0.5	15
pH (s.u.) (lab)	6.0	7.4	6.7	0.4	12
Bicarbonate	8	38	21	8	12
Calcium (Total)	1.8	8.8	4.7	2.1	12
Carbonate	0	0	0	0	11
Chloride	1	1	1	0	12
Hydroxide	0.0	0.0	0.0	0.0	9
Magnesium (Total)	0.5	2.6	1.6	0.7	12
Potassium (Total)	0.2	1.0	0.6	0.4	12
Sodium (Total)	0.5	3.0	1.2	0.7	12
Sulfate	1.0	7.0	2.3	1.9	12
Total Alkalinity	7	31	18	7	12
Total Hardness	7	33	18	8	12
Ammonia	0.05	0.18	0.06	0.04	15
Kjeldah Nitrogen	0.20	0.93	0.28	0.21	12
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.005	0.005	0.000	12
Phosphorus	0.005	0.025	0.008	0.006	12
Aluminum (Total)	0.10	0.10	0.10	0.00	12
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	12
Barium (Total)	0.015	0.015	0.015		1
Cadmium (Total)	0.0001	0.0010	0.0002	0.0003	12
Chromium (Total)	0.004	0.020	0.013	0.008	12
Copper (Total)	0.001	0.010	0.002	0.003	12
Flouride (Total)	0.050	1.000	0.186	0.359	7
Iron (Total)	0.05	0.22	0.07	0.05	12
Lead (Total)	0.0007	0.0040	0.0012	0.0010	12
Manganese (Total)	0.02	0.02	0.02	0.00	12
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	12
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	7
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0028	0.0004	0.0007	12
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.020	0.050	0.023	0.009	12
Oil + Grease					0

Notes:

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NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-200	Surface Water		Period of record:	**09/1989** To	**10/1995**
Flow (cfs)	1.2	113.4	23.8	28.9	31
SC (umhos/cm) (lab)	7	42	14	5	53
SC (umhos/cm) (field)	3	27	14	5	49
TSS	1	5	1	1	56
TDS	1	35	12	7	56
Turbidity (NTU)	0.05	2.90	0.32	0.40	55
Temperature (C) (field)	-0.5	23.0	6.5	5.7	57
pH (s.u) (field)	5.0	8.5	6.6	0.6	53
pH (s.u.) (lab)	5.2	7.6	6.2	0.5	53
Bicarbonate	1	9	4	2	56
Calcium (Total)	0.1	1.4	1.0	0.2	56
Carbonate	0	0	0	0	53
Chloride	1	2	1	0	56
Hydroxide	0.0	0.0	0.0	0.0	46
Magnesium (Total)	0.1	1.0	0.8	0.4	56
Potassium (Total)	0.1	1.0	0.7	0.4	55
Sodium (Total)	0.1	5.0	1.1	0.9	56
Sulfate	1.0	7.0	2.2	1.3	55
Total Alkalinity	1	7	3	2	56
Total Hardness	1	8	6	2	56
Ammonia	0.05	0.15	0.06	0.02	61
Kjeldah Nitrogen	0.05	0.71	0.24	0.10	56
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.010	0.005	0.001	56
Phosphorus	0.005	0.120	0.010	0.016	55
Aluminum (Total)	0.02	1.00	0.11	0.12	56
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0010	0.1000	0.0065	0.0127	56
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0075	0.0003	0.0010	56
Chromium (Total)	0.001	0.020	0.017	0.006	56
Copper (Total)	0.001	0.020	0.003	0.003	56
Flouride (Total)	0.050	0.100	0.052	0.008	41
Iron (Total)	0.01	0.18	0.05	0.02	56
Lead (Total)	0.0003	0.0130	0.0013	0.0017	56
Manganese (Total)	0.00	0.20	0.02	0.02	56
Mercury (Total)	0.0001	0.0017	0.0003	0.0002	56
Molybdenum (Total)	0.0008	0.0500	0.0488	0.0078	40
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0001	0.0035	0.0005	0.0006	56
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.003	0.140	0.026	0.025	56
Oil + Grease	1.0	5.0	2.0	1.7	5

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-2000	Surface Water	Period of record:		**04/1990** To	**10/1993**
Flow (cfs)	8.8	192.8	77.2	65.3	16
SC (umhos/cm) (lab)	17	80	40	18	20
SC (umhos/cm) (field)	18	80	41	19	19
TSS	1	13	2	3	20
TDS	8	54	25	11	20
Turbidity (NTU)	0.05	12.00	1.71	2.86	20
Temperature (C) (field)	0.0	18.0	6.5	4.7	19
pH (s.u) (field)	5.5	7.6	6.7	0.6	17
pH (s.u.) (lab)	5.4	7.6	6.7	0.6	20
Bicarbonate	6	41	22	11	20
Calcium (Total)	1.9	8.8	4.6	2.1	20
Carbonate	0	0	0	0	20
Chloride	1	4	1	1	20
Hydroxide	0.0	0.0	0.0	0.0	17
Magnesium (Total)	0.1	3.1	1.6	0.9	20
Potassium (Total)	0.2	1.0	0.8	0.3	20
Sodium (Total)	0.5	4.0	1.3	0.8	20
Sulfate	1.0	7.0	2.1	1.4	20
Total Alkalinity	5	34	18	9	20
Total Hardness	7	35	18	8	20
Ammonia	0.05	0.24	0.06	0.04	20
Kjeldah Nitrogen	0.20	0.34	0.22	0.04	20
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.017	0.006	0.003	20
Phosphorus	0.005	0.120	0.014	0.026	20
Aluminum (Total)	0.10	2.50	0.23	0.54	20
Antimony (Total)	0.002	0.002	0.002		1
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	20
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0010	0.0002	0.0002	20
Chromium (Total)	0.004	0.020	0.016	0.007	20
Copper (Total)	0.001	0.011	0.002	0.003	20
Flouride (Total)	0.050	0.050	0.050	0.000	15
Iron (Total)	0.05	2.23	0.18	0.48	20
Lead (Total)	0.0007	0.0050	0.0016	0.0012	20
Manganese (Total)	0.02	0.02	0.02	0.00	20
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	20
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	15
Nickel (Total)	0.002	0.002	0.002		1
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0001	0.0032	0.0004	0.0007	20
Thallium (Total)	0.003	0.003	0.003		1
Zinc (Total)	0.010	0.040	0.023	0.007	20
Oil + Grease					0

Notes:

CFS - Cubic feet per second
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-300	Surface Water		Period of record:	**09/1989** To	**11/1997**
Flow (cfs)	1.6	148.1	28.5	33.8	41
SC (umhos/cm) (lab)	2	585	37	69	91
SC (umhos/cm) (field)	9	440	39	50	82
TSS	1	5	1	1	62
TDS	1	86	21	14	63
Turbidity (NTU)	0.05	3.30	0.30	0.43	62
Temperature (C) (field)	0.0	19.5	6.2	4.2	105
pH (s.u) (field)	5.0	8.5	6.6	0.6	87
pH (s.u.) (lab)	5.0	7.6	6.2	0.6	89
Bicarbonate	1	9	5	2	63
Calcium (Total)	1.0	14.0	2.5	2.3	63
Carbonate	0	0	0	0	61
Chloride	1	5	1	1	63
Hydroxide	0.0	0.0	0.0	0.0	52
Magnesium (Total)	0.1	2.0	0.9	0.3	63
Potassium (Total)	0.1	1.0	0.8	0.3	62
Sodium (Total)	0.1	6.0	1.7	1.2	63
Sulfate	1.0	8.0	2.8	1.8	62
Total Alkalinity	1	7	4	2	63
Total Hardness	2	24	9	4	63
Ammonia	0.05	0.63	0.08	0.08	130
Kjeldah Nitrogen	0.07	1.36	0.30	0.23	63
Nitrate + Nitrite	0.05	0.34	0.13	0.08	15
Ortho-Phosphate	0.005	0.030	0.006	0.004	62
Phosphorus	0.005	0.080	0.009	0.010	60
Aluminum (Total)	0.02	0.10	0.10	0.01	63
Antimony (Total)	0.002	0.006	0.004	0.002	3
Arsenic (Total)	0.0010	0.0050	0.0048	0.0008	63
Barium (Total)	0.005	0.015	0.010	0.007	2
Cadmium (Total)	0.0001	0.0012	0.0002	0.0002	63
Chromium (Total)	0.001	0.020	0.017	0.007	63
Copper (Total)	0.001	0.015	0.003	0.003	63
Flouride (Total)	0.050	0.100	0.051	0.007	46
Iron (Total)	0.00	0.26	0.06	0.04	63
Lead (Total)	0.0003	0.0090	0.0012	0.0011	63
Manganese (Total)	0.00	0.03	0.02	0.00	63
Mercury (Total)	0.0001	0.0020	0.0003	0.0003	63
Molybdenum (Total)	0.0008	0.0500	0.0466	0.0114	45
Nickel (Total)	0.002	0.100	0.041	0.052	3
Selenium (Total)	0.001	0.005	0.003	0.003	2
Silver (Total)	0.0001	0.0100	0.0005	0.0014	63
Thallium (Total)	0.002	0.005	0.003	0.002	3
Zinc (Total)	0.002	2.270	0.067	0.284	63
Oil + Grease	1.0	9.0	2.4	2.9	7

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

Sample population includes below detection data. Below detectable concentrations are set equal to the detection limit value for statistical calculations.

ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-3000	Surface Water		Period of record:	**01/1989 To**	**10/1993**
Flow (cfs)	17.2	747.7	148.0	173.6	22
SC (umhos/cm) (lab)	16	142	60	29	25
SC (umhos/cm) (field)	25	112	60	23	24
TSS	1	34	5	9	25
TDS	13	62	38	12	25
Turbidity (NTU)	0.05	21.00	2.94	5.79	25
Temperature (C) (field)	0.0	18.0	6.7	5.7	25
pH (s.u) (field)	5.9	8.5	7.0	0.6	25
pH (s.u.) (lab)	5.7	8.0	7.0	0.5	25
Bicarbonate	15	70	35	14	24
Calcium (Total)	3.0	13.7	7.0	2.9	25
Carbonate	0	0	0	0	25
Chloride	1	6	2	1	25
Hydroxide	0.0	0.0	0.0	0.0	21
Magnesium (Total)	1.0	5.1	2.3	1.2	25
Potassium (Total)	0.3	1.0	0.9	0.2	25
Sodium (Total)	0.9	4.0	1.7	0.9	25
Sulfate	1.0	7.0	2.8	1.7	25
Total Alkalinity	12	57	28	11	25
Total Hardness	8	55	26	13	25
Ammonia	0.05	0.29	0.08	0.06	25
Kjeldah Nitrogen	0.20	0.61	0.26	0.10	25
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.043	0.009	0.010	25
Phosphorus	0.005	0.100	0.016	0.024	25
Aluminum (Total)	0.10	0.70	0.18	0.18	25
Antimony (Total)	0.002	0.006	0.003	0.002	3
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	25
Barium (Total)	0.015	0.015	0.015	0.000	2
Cadmium (Total)	0.0001	0.0031	0.0004	0.0007	25
Chromium (Total)	0.004	0.020	0.016	0.007	24
Copper (Total)	0.001	0.007	0.002	0.001	25
Flouride (Total)	0.010	0.060	0.047	0.011	18
Iron (Total)	0.02	0.74	0.14	0.20	25
Lead (Total)	0.0007	0.0020	0.0011	0.0004	25
Manganese (Total)	0.02	0.02	0.02	0.00	25
Mercury (Total)	0.0002	0.0004	0.0002	0.0000	25
Molybdenum (Total)	0.0200	0.0500	0.0483	0.0071	18
Nickel (Total)	0.002	0.100	0.035	0.057	3
Selenium (Total)	0.005	0.005	0.005	0.000	2
Silver (Total)	0.0001	0.0007	0.0002	0.0001	25
Thallium (Total)	0.003	0.005	0.004	0.001	3
Zinc (Total)	0.020	0.060	0.022	0.008	25
Oil + Grease					0

Notes:

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NTU - Nephelometric Turbidity Unit
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Units are mg/l unless otherwise indicated

Sample population includes below detection data. Below detectable concentrations are set equal to the detection limit value for statistical calculations.

ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-500	Surface Water		Period of record:	**01/1989** To	**04/1992**
Flow (cfs)	3.8	173.6	44.0	51.1	12
SC (umhos/cm) (lab)	11	48	19	9	22
SC (umhos/cm) (field)	6	33	19	7	19
TSS	1	5	1	1	22
TDS	4	51	19	12	22
Turbidity (NTU)	0.12	1.90	0.39	0.38	22
Temperature (C) (field)	0.0	18.0	5.8	4.3	22
pH (s.u) (field)	4.8	8.3	6.5	0.9	22
pH (s.u.) (lab)	5.2	6.9	6.2	0.5	22
Bicarbonate	2	10	5	2	20
Calcium (Total)	1.0	3.8	1.4	0.8	22
Carbonate	0	0	0	0	22
Chloride	1	1	1	0	22
Hydroxide	0.0	0.0	0.0	0.0	16
Magnesium (Total)	0.4	1.0	0.9	0.2	22
Potassium (Total)	0.2	1.0	0.8	0.3	22
Sodium (Total)	1.0	4.0	1.9	1.1	22
Sulfate	1.0	6.0	2.1	1.2	22
Total Alkalinity	2	8	4	2	22
Total Hardness	0	13	5	4	22
Ammonia	0.05	0.19	0.07	0.04	22
Kjeldah Nitrogen	0.15	1.02	0.29	0.22	22
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.013	0.006	0.002	22
Phosphorus	0.005	0.017	0.007	0.003	22
Aluminum (Total)	0.10	0.20	0.10	0.02	22
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	22
Barium (Total)					0
Cadmium (Total)	0.0001	0.0052	0.0009	0.0014	22
Chromium (Total)	0.020	0.020	0.020	0.000	22
Copper (Total)	0.001	0.010	0.003	0.002	22
Flouride (Total)	0.010	0.050	0.041	0.015	22
Iron (Total)	0.05	0.60	0.08	0.12	22
Lead (Total)	0.0010	0.0020	0.0010	0.0002	22
Manganese (Total)	0.02	0.02	0.02	0.00	22
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	22
Molybdenum (Total)	0.0200	0.0500	0.0486	0.0064	22
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0003	0.0002	0.0000	22
Thallium (Total)					0
Zinc (Total)	0.020	0.030	0.021	0.003	22
Oil + Grease					0

Notes:

CFS - Cubic feet per second
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NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LB-800	Surface Water	Period of record:	01/1989	To	09/1990
Flow (cfs)	7.6	250.2	87.2	75.3	18
SC (umhos/cm) (lab)	13	48	24	9	23
SC (umhos/cm) (field)	11	55	26	12	21
TSS	1	30	3	6	23
TDS	6	46	19	10	23
Turbidity (NTU)	0.12	10.00	0.96	2.07	22
Temperature (C) (field)	0.0	18.0	6.1	4.6	23
pH (s.u) (field)	4.6	8.2	6.9	0.8	22
pH (s.u.) (lab)	5.4	7.1	6.2	0.5	22
Bicarbonate	0	22	11	6	22
Calcium (Total)	1.0	5.0	2.2	1.1	23
Carbonate	0	0	0	0	23
Chloride	1	3	1	0	23
Hydroxide	0.0	0.0	0.0	0.0	22
Magnesium (Total)	1.0	2.0	1.0	0.2	23
Potassium (Total)	1.0	1.0	1.0	0.0	23
Sodium (Total)	1.0	4.0	2.0	1.0	23
Sulfate	1.0	4.0	1.5	0.7	23
Total Alkalinity	2	18	9	4	22
Total Hardness	0	21	8	5	23
Ammonia	0.05	0.23	0.07	0.05	23
Kjeldah Nitrogen	0.16	0.70	0.27	0.15	23
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.013	0.005	0.002	23
Phosphorus	0.005	0.088	0.011	0.017	23
Aluminum (Total)	0.10	0.20	0.10	0.02	23
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	23
Barium (Total)					0
Cadmium (Total)	0.0001	0.0028	0.0005	0.0008	23
Chromium (Total)	0.020	0.020	0.020	0.000	23
Copper (Total)	0.001	0.007	0.002	0.002	23
Flouride (Total)	0.010	0.050	0.047	0.010	23
Iron (Total)	0.05	0.45	0.07	0.08	23
Lead (Total)	0.0010	0.0020	0.0010	0.0002	23
Manganese (Total)	0.02	0.02	0.02	0.00	23
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	23
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	23
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0001	0.0100	0.0006	0.0021	23
Thallium (Total)					0
Zinc (Total)	0.010	0.030	0.020	0.004	23
Oil + Grease					0

Notes:

CFS - Cubic feet per second
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LC-100	Surface Water	Period of record:	01/1989	To	10/1993
Flow (cfs)	0.1	50.0	4.5	10.8	21
SC (umhos/cm) (lab)	10	41	23	9	24
SC (umhos/cm) (field)	12	40	23	10	22
TSS	1	1	1	0	24
TDS	8	50	24	11	24
Turbidity (NTU)	0.05	0.68	0.29	0.14	24
Temperature (C) (field)	0.0	15.0	6.7	4.3	22
pH (s.u) (field)	5.2	8.4	6.6	0.7	21
pH (s.u.) (lab)	5.5	7.3	6.5	0.4	24
Bicarbonate	0	21	11	6	23
Calcium (Total)	0.2	4.0	1.9	1.2	24
Carbonate	0	0	0	0	24
Chloride	1	1	1	0	24
Hydroxide	0.0	0.0	0.0	0.0	21
Magnesium (Total)	0.1	1.2	0.9	0.3	24
Potassium (Total)	0.2	1.0	0.8	0.3	24
Sodium (Total)	0.6	6.0	1.9	1.2	24
Sulfate	1.0	7.0	1.8	1.5	24
Total Alkalinity	3	19	10	5	24
Total Hardness	0	15	7	5	24
Ammonia	0.05	0.23	0.06	0.04	24
Kjeldah Nitrogen	0.17	0.67	0.25	0.13	24
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.025	0.007	0.005	24
Phosphorus	0.005	0.049	0.012	0.011	24
Aluminum (Total)	0.10	0.20	0.10	0.02	24
Antimony (Total)	0.002	0.002	0.002		1
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	24
Barium (Total)	0.021	0.021	0.021		1
Cadmium (Total)	0.0001	0.0040	0.0006	0.0010	24
Chromium (Total)	0.004	0.020	0.017	0.007	24
Copper (Total)	0.001	0.012	0.003	0.003	24
Flouride (Total)	0.010	0.050	0.045	0.012	19
Iron (Total)	0.05	0.10	0.06	0.01	24
Lead (Total)	0.0007	0.0020	0.0010	0.0002	24
Manganese (Total)	0.02	0.02	0.02	0.00	24
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	24
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	19
Nickel (Total)	0.002	0.002	0.002		1
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0005	0.0002	0.0001	24
Thallium (Total)	0.003	0.003	0.003		1
Zinc (Total)	0.020	0.200	0.028	0.037	24
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LC-800	Surface Water		Period of record:	04/1991 To	10/1993
Flow (cfs)	0.2	52.0	7.2	16.0	10
SC (umhos/cm) (lab)	20	102	65	27	11
SC (umhos/cm) (field)	25	95	59	24	12
TSS	1	118	15	34	12
TDS	35	73	49	11	11
Turbidity (NTU)	0.05	89.00	12.92	26.90	12
Temperature (C) (field)	3.0	15.5	9.1	4.3	11
pH (s.u) (field)	6.2	8.0	6.9	0.6	12
pH (s.u.) (lab)	6.1	7.9	7.0	0.5	11
Bicarbonate	9	50	35	16	12
Calcium (Total)	1.2	9.9	6.4	3.0	12
Carbonate	0	0	0	0	12
Chloride	1	4	2	1	12
Hydroxide	0.0	0.0	0.0	0.0	9
Magnesium (Total)	0.1	4.0	2.8	1.2	12
Potassium (Total)	0.2	3.0	0.9	0.7	12
Sodium (Total)	0.8	3.0	1.8	0.7	12
Sulfate	1.0	7.0	2.5	2.1	12
Total Alkalinity	7	41	29	13	12
Total Hardness	3	40	27	12	12
Ammonia	0.05	0.16	0.07	0.04	12
Kjeldah Nitrogen	0.20	0.49	0.25	0.09	12
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.048	0.011	0.012	12
Phosphorus	0.005	0.074	0.015	0.019	12
Aluminum (Total)	0.10	10.50	1.07	2.98	12
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	12
Barium (Total)	0.019	0.019	0.019		1
Cadmium (Total)	0.0001	0.0010	0.0003	0.0003	12
Chromium (Total)	0.004	0.020	0.015	0.008	12
Copper (Total)	0.001	0.080	0.009	0.023	12
Flouride (Total)	0.050	0.060	0.053	0.005	7
Iron (Total)	0.05	9.15	1.00	2.58	12
Lead (Total)	0.0007	0.0070	0.0015	0.0018	12
Manganese (Total)	0.02	0.08	0.03	0.02	12
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	12
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	7
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0020	0.0005	0.0006	12
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.020	0.040	0.022	0.006	12
Oil + Grease					0

Notes:

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s.u. - standard units

NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LCM-10	Groundwater		Period of record:	**01/1989** To	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	2	196	147	57	9
SC (umhos/cm) (field)	123	172	151	15	8
TSS					0
TDS	1	150	91	42	9
Turbidity (NTU)					0
Temperature (C) (field)	5.0	11.0	7.5	2.4	9
pH (s.u) (field)	7.0	7.7	7.3	0.3	8
pH (s.u.) (lab)	4.2	8.0	6.9	1.1	9
Bicarbonate	1	107	86	33	9
Calcium (Total)	1.0	21.0	15.5	5.9	9
Carbonate	0	0	0	0	9
Chloride	1	5	2	1	9
Hydroxide	0.0	0.0	0.0	0.0	8
Magnesium (Total)	1.0	14.0	5.7	3.8	9
Potassium (Total)	1.0	18.0	7.4	6.9	9
Sodium (Total)	2.0	12.0	8.4	2.7	9
Sulfate	1.0	18.0	7.0	5.5	9
Total Alkalinity	1	88	71	27	9
Total Hardness					0
Ammonia	0.12	0.19	0.16	0.05	2
Kjeldah Nitrogen	0.20	0.74	0.47	0.38	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.60	0.17	0.17	9
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	9
Barium (Total)					0
Cadmium (Total)	0.0001	0.0050	0.0013	0.0014	9
Chromium (Total)	0.004	0.020	0.018	0.005	9
Copper (Total)	0.001	0.020	0.010	0.007	9
Flouride (Total)	0.050	0.230	0.123	0.059	7
Iron (Total)	0.05	0.42	0.09	0.12	9
Lead (Total)	0.0007	0.0100	0.0080	0.0040	9
Manganese (Total)	0.02	0.87	0.20	0.34	9
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	9
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	7
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0020	0.0009	0.0005	9
Thallium (Total)					0
Zinc (Total)	0.020	0.070	0.027	0.017	9
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LCM-11	Groundwater		Period of record:	**01/1989** To	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	120	206	175	35	8
SC (umhos/cm) (field)	96	215	163	48	7
TSS					0
TDS	64	128	101	22	8
Turbidity (NTU)					0
Temperature (C) (field)	5.0	12.0	8.6	2.8	8
pH (s.u) (field)	7.2	8.4	7.8	0.4	8
pH (s.u.) (lab)	6.7	8.0	7.5	0.4	8
Bicarbonate	66	132	110	25	8
Calcium (Total)	13.0	28.2	23.0	4.8	8
Carbonate	0	0	0	0	8
Chloride	1	3	1	1	8
Hydroxide	0.0	0.0	0.0	0.0	7
Magnesium (Total)	4.0	13.0	7.7	3.1	8
Potassium (Total)	0.9	2.0	1.4	0.5	8
Sodium (Total)	1.0	4.0	2.3	1.0	8
Sulfate	1.0	5.0	3.0	1.5	8
Total Alkalinity	54	108	90	20	8
Total Hardness					0
Ammonia	0.06	0.09	0.08	0.02	2
Kjeldah Nitrogen	0.20	0.31	0.26	0.08	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	1.60	0.30	0.53	8
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	8
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0009	0.0003	8
Chromium (Total)	0.004	0.030	0.019	0.007	8
Copper (Total)	0.001	0.020	0.010	0.007	8
Flouride (Total)	0.050	0.190	0.073	0.057	6
Iron (Total)	0.05	0.86	0.15	0.29	8
Lead (Total)	0.0007	0.0100	0.0077	0.0042	8
Manganese (Total)	0.02	0.03	0.02	0.00	8
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	8
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	6
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0020	0.0010	0.0005	8
Thallium (Total)					0
Zinc (Total)	0.020	0.050	0.024	0.011	8
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LCM-9	Groundwater		Period of record:	01/1989 To	08/1993
Flow (cfs)					0
SC (umhos/cm) (lab)	154	186	171	11	8
SC (umhos/cm) (field)	125	175	155	18	8
TSS					0
TDS	3	101	79	30	9
Turbidity (NTU)					0
Temperature (C) (field)	6.5	20.0	10.0	4.2	9
pH (s.u) (field)	5.6	7.3	6.7	0.5	9
pH (s.u.) (lab)	6.2	7.9	6.8	0.6	8
Bicarbonate	2	112	91	34	9
Calcium (Total)	1.0	19.0	15.3	5.5	9
Carbonate	0	0	0	0	9
Chloride	1	1	1	0	9
Hydroxide	0.0	0.0	0.0	0.0	8
Magnesium (Total)	1.0	9.0	7.4	2.5	9
Potassium (Total)	0.6	1.0	1.0	0.1	9
Sodium (Total)	1.0	6.0	4.4	1.5	9
Sulfate	1.0	9.0	3.0	2.4	9
Total Alkalinity	2	92	75	28	9
Total Hardness					0
Ammonia	0.05	0.05	0.05	0.00	2
Kjeldah Nitrogen	0.20	0.26	0.23	0.04	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	9
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	9
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0009	0.0003	9
Chromium (Total)	0.004	0.020	0.018	0.005	9
Copper (Total)	0.001	0.020	0.012	0.007	9
Flouride (Total)	0.050	0.160	0.120	0.037	7
Iron (Total)	0.05	0.05	0.05	0.00	9
Lead (Total)	0.0007	0.0100	0.0080	0.0040	9
Manganese (Total)	0.02	0.02	0.02	0.00	9
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	9
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	7
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0020	0.0010	0.0005	9
Thallium (Total)					0
Zinc (Total)	0.002	0.020	0.018	0.006	9
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
LCTM-8	Groundwater		Period of record:	**01/1989 To 08/1993**	
Flow (cfs)					0
SC (umhos/cm) (lab)	130	194	178	20	8
SC (umhos/cm) (field)	153	230	176	26	8
TSS					0
TDS	74	111	96	14	8
Turbidity (NTU)					0
Temperature (C) (field)	5.5	10.0	7.9	2.0	8
pH (s.u) (field)	6.6	7.4	7.1	0.3	8
pH (s.u.) (lab)	6.4	7.3	6.8	0.3	8
Bicarbonate	43	117	104	25	8
Calcium (Total)	8.1	21.4	18.0	4.5	8
Carbonate	0	0	0	0	8
Chloride	1	7	2	2	8
Hydroxide	0.0	0.0	0.0	0.0	7
Magnesium (Total)	3.9	9.0	8.2	1.8	8
Potassium (Total)	0.3	4.0	1.3	1.1	8
Sodium (Total)	2.0	8.5	4.7	1.9	8
Sulfate	1.0	14.0	4.0	4.2	8
Total Alkalinity	35	95	85	20	8
Total Hardness					0
Ammonia	0.05	0.18	0.12	0.09	2
Kjeldah Nitrogen	0.20	2.95	1.58	1.94	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.30	0.13	0.07	8
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	8
Barium (Total)					0
Cadmium (Total)	0.0001	0.0120	0.0026	0.0040	8
Chromium (Total)	0.004	0.030	0.017	0.009	8
Copper (Total)	0.001	0.020	0.009	0.008	8
Flouride (Total)	0.070	0.120	0.090	0.018	6
Iron (Total)	0.05	0.94	0.33	0.32	8
Lead (Total)	0.0007	0.0100	0.0066	0.0048	8
Manganese (Total)	0.06	0.24	0.13	0.06	8
Mercury (Total)	0.0002	0.0020	0.0004	0.0006	8
Molybdenum (Total)	0.0002	0.0500	0.0429	0.0188	7
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0020	0.0009	0.0006	8
Thallium (Total)					0
Zinc (Total)	0.020	0.090	0.030	0.024	8
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
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NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
OUTFALL1-2	Adit		Period of record:	**05/1997** To	**08/1998**
Flow (cfs)	3.0	24.3	14.1	6.6	9
SC (umhos/cm) (lab)	202	202	202		1
SC (umhos/cm) (field)	145	254	200	30	16
TSS					0
TDS					0
Turbidity (NTU)					0
Temperature (C) (field)	7.1	15.0	12.0	1.9	16
pH (s.u) (field)	6.6	8.6	7.5	0.5	16
pH (s.u.) (lab)	7.9	7.9	7.9		1
Bicarbonate					0
Calcium (Total)					0
Carbonate					0
Chloride					0
Hydroxide					0
Magnesium (Total)					0
Potassium (Total)					0
Sodium (Total)					0
Sulfate	10.0	23.0	19.5	3.2	15
Total Alkalinity					0
Total Hardness					0
Ammonia	0.05	0.14	0.06	0.02	24
Kjeldah Nitrogen					0
Nitrate + Nitrite	0.02	1.90	0.27	0.54	24
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)					0
Antimony (Total)					0
Arsenic (Total)	0.0030	0.0030	0.0030	0.0000	2
Barium (Total)					0
Cadmium (Total)	0.0001	0.0002	0.0001	0.0000	24
Chromium (Total)	0.001	0.002	0.001	0.000	24
Copper (Total)	0.001	0.001	0.001	0.000	24
Flouride (Total)					0
Iron (Total)	0.01	0.05	0.01	0.01	24
Lead (Total)	0.0010	0.0030	0.0022	0.0010	24
Manganese (Total)	0.01	0.01	0.01	0.00	24
Mercury (Total)	0.0002	0.0007	0.0002	0.0001	24
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	2
Thallium (Total)					0
Zinc (Total)	0.010	0.110	0.028	0.030	24
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
PLCM-6DP	Groundwater		Period of record:	**03/1989** To	**08/1993**
Flow (cfs)	1.9	1.9	1.9	0.0	2
SC (umhos/cm) (lab)	143	200	183	17	8
SC (umhos/cm) (field)	141	191	169	22	8
TSS					0
TDS	85	108	97	9	8
Turbidity (NTU)					0
Temperature (C) (field)	5.5	11.0	7.8	2.0	8
pH (s.u) (field)	7.0	7.9	7.5	0.3	8
pH (s.u.) (lab)	6.8	7.9	7.4	0.4	8
Bicarbonate	110	118	114	3	8
Calcium (Total)	23.2	26.2	25.1	1.1	8
Carbonate	0	0	0	0	8
Chloride	1	1	1	0	8
Hydroxide	0.0	0.0	0.0	0.0	7
Magnesium (Total)	7.3	8.0	7.8	0.3	8
Potassium (Total)	1.0	1.0	1.0	0.0	8
Sodium (Total)	1.0	4.0	2.0	0.9	8
Sulfate	1.0	5.0	2.4	1.5	8
Total Alkalinity	90	97	93	2	8
Total Hardness					0
Ammonia	0.05	0.05	0.05	0.00	3
Kjeldah Nitrogen	0.20	0.50	0.31	0.16	3
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	8
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	8
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0009	0.0003	8
Chromium (Total)	0.004	0.020	0.018	0.006	8
Copper (Total)	0.001	0.020	0.009	0.006	8
Flouride (Total)	0.050	0.050	0.050	0.000	5
Iron (Total)	0.05	0.05	0.05	0.00	8
Lead (Total)	0.0007	0.0100	0.0077	0.0042	8
Manganese (Total)	0.02	0.02	0.02	0.00	8
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	8
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	5
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0020	0.0010	0.0005	8
Thallium (Total)					0
Zinc (Total)	0.020	0.050	0.028	0.014	8
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
PLCM-6SH	Groundwater		Period of record:	**01/1989** To	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	135	215	174	27	8
SC (umhos/cm) (field)	96	210	149	38	8
TSS					0
TDS	75	260	114	60	8
Turbidity (NTU)					0
Temperature (C) (field)	5.0	11.0	7.7	1.9	8
pH (s.u) (field)	6.7	8.2	7.4	0.5	8
pH (s.u.) (lab)	6.6	7.7	7.3	0.3	8
Bicarbonate	93	155	116	20	8
Calcium (Total)	17.0	29.7	21.5	4.7	8
Carbonate	0	0	0	0	8
Chloride	1	5	2	1	8
Hydroxide	0.0	0.0	0.0	0.0	7
Magnesium (Total)	5.0	19.0	9.2	4.7	8
Potassium (Total)	0.5	24.0	7.6	8.4	8
Sodium (Total)	1.0	7.0	3.3	2.5	8
Sulfate	1.0	7.0	3.5	2.1	8
Total Alkalinity	76	127	95	16	8
Total Hardness					0
Ammonia	0.07	0.26	0.17	0.13	2
Kjeldah Nitrogen	0.63	1.64	1.14	0.71	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	1.00	0.24	0.31	8
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	8
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0009	0.0003	8
Chromium (Total)	0.004	0.020	0.018	0.006	8
Copper (Total)	0.001	0.020	0.010	0.007	8
Flouride (Total)	0.050	0.050	0.050	0.000	6
Iron (Total)	0.05	0.92	0.17	0.31	8
Lead (Total)	0.0007	0.0100	0.0088	0.0033	8
Manganese (Total)	0.02	0.03	0.02	0.00	8
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	8
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	6
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0020	0.0010	0.0005	8
Thallium (Total)					0
Zinc (Total)	0.020	0.080	0.036	0.024	8
Oil + Grease					0

Notes:

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NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
PM-1000	Surface Water		Period of record:	01/1989 To	10/1993
Flow (cfs)	1.5	91.2	21.1	25.4	19
SC (umhos/cm) (lab)	16	48	26	8	22
SC (umhos/cm) (field)	14	44	26	8	21
TSS	1	1	1	0	22
TDS	10	50	22	9	22
Turbidity (NTU)	0.05	0.53	0.26	0.12	22
Temperature (C) (field)	0.0	13.5	6.1	4.3	21
pH (s.u) (field)	5.6	8.7	6.7	0.7	20
pH (s.u.) (lab)	5.5	7.7	6.6	0.6	22
Bicarbonate	9	21	14	4	21
Calcium (Total)	1.0	5.1	2.6	1.2	22
Carbonate	0	0	0	0	22
Chloride	1	2	1	0	22
Hydroxide	0.0	0.0	0.0	0.0	19
Magnesium (Total)	0.5	1.3	0.9	0.2	22
Potassium (Total)	0.1	1.0	0.9	0.3	22
Sodium (Total)	0.5	6.0	1.7	1.6	22
Sulfate	1.0	7.0	2.2	1.5	22
Total Alkalinity	7	17	11	3	22
Total Hardness	3	18	9	4	22
Ammonia	0.05	0.21	0.07	0.04	22
Kjeldah Nitrogen	0.16	0.63	0.26	0.11	22
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.010	0.005	0.001	22
Phosphorus	0.005	0.019	0.007	0.003	22
Aluminum (Total)	0.10	0.10	0.10	0.00	22
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	22
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0042	0.0006	0.0010	22
Chromium (Total)	0.004	0.020	0.016	0.007	22
Copper (Total)	0.001	0.006	0.002	0.001	22
Flouride (Total)	0.010	0.090	0.048	0.016	17
Iron (Total)	0.05	0.05	0.05	0.00	22
Lead (Total)	0.0007	0.0010	0.0009	0.0001	22
Manganese (Total)	0.02	0.02	0.02	0.00	22
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	22
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	17
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0002	0.0002	0.0000	22
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.020	0.060	0.026	0.012	22
Oil + Grease	0.1	0.1	0.1		1

Notes:

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s.u. - standard units

NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
PM-500	Surface Water		Period of record:	**01/1989** To	**10/1993**
Flow (cfs)	1.6	85.4	19.3	24.0	14
SC (umhos/cm) (lab)	15	39	25	6	17
SC (umhos/cm) (field)	15	33	25	6	15
TSS	1	1	1	0	17
TDS	5	48	19	11	17
Turbidity (NTU)	0.05	0.35	0.22	0.08	17
Temperature (C) (field)	0.0	12.5	4.9	3.8	16
pH (s.u) (field)	5.3	8.4	6.5	0.8	15
pH (s.u.) (lab)	5.6	7.2	6.5	0.5	17
Bicarbonate	0	18	12	5	16
Calcium (Total)	1.0	4.0	2.4	1.0	17
Carbonate	0	0	0	0	17
Chloride	1	1	1	0	17
Hydroxide	0.0	0.0	0.0	0.0	14
Magnesium (Total)	1.0	1.0	1.0	0.0	17
Potassium (Total)	1.0	1.0	1.0	0.0	17
Sodium (Total)	1.0	5.0	1.8	1.3	17
Sulfate	1.0	7.0	2.2	1.5	17
Total Alkalinity	1	15	10	4	17
Total Hardness	5	14	8	4	17
Ammonia	0.05	0.23	0.07	0.05	17
Kjeldah Nitrogen	0.20	0.54	0.25	0.09	17
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.010	0.005	0.001	17
Phosphorus	0.005	0.018	0.007	0.004	17
Aluminum (Total)	0.10	0.10	0.10	0.00	17
Antimony (Total)	0.002	0.002	0.002		1
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	17
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0046	0.0009	0.0013	17
Chromium (Total)	0.004	0.020	0.017	0.006	17
Copper (Total)	0.001	0.007	0.002	0.002	17
Flouride (Total)	0.020	0.050	0.046	0.009	14
Iron (Total)	0.05	0.05	0.05	0.00	17
Lead (Total)	0.0007	0.0020	0.0010	0.0003	17
Manganese (Total)	0.02	0.02	0.02	0.00	17
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	17
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	14
Nickel (Total)	0.002	0.002	0.002		1
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0014	0.0003	0.0004	17
Thallium (Total)	0.003	0.003	0.003		1
Zinc (Total)	0.020	0.020	0.020	0.000	17
Oil + Grease					0

Notes:

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s.u. - standard units

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
RA-100	Surface Water	Period of record:	04/1991	To	10/1993
Flow (cfs)	0.0	31.2	4.6	9.5	10
SC (umhos/cm) (lab)	7	47	15	12	11
SC (umhos/cm) (field)	7	16	12	3	11
TSS	1	7	2	2	11
TDS	7	54	19	13	11
Turbidity (NTU)	0.05	3.60	0.65	0.99	11
Temperature (C) (field)	1.0	14.0	7.0	4.4	10
pH (s.u) (field)	5.3	7.0	6.1	0.6	11
pH (s.u.) (lab)	5.6	7.1	6.1	0.5	11
Bicarbonate	2	6	5	1	11
Calcium (Total)	0.6	2.0	1.2	0.4	11
Carbonate	0	0	0	0	11
Chloride	1	2	1	0	11
Hydroxide	0.0	0.0	0.0	0.0	9
Magnesium (Total)	0.1	1.0	0.7	0.4	11
Potassium (Total)	0.1	1.0	0.6	0.5	11
Sodium (Total)	0.2	3.0	0.9	0.8	11
Sulfate	1.0	7.0	2.5	2.2	11
Total Alkalinity	2	5	4	1	11
Total Hardness	2	9	5	2	11
Ammonia	0.05	0.09	0.06	0.01	11
Kjeldah Nitrogen	0.20	0.30	0.22	0.03	11
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.010	0.006	0.002	11
Phosphorus	0.005	0.020	0.008	0.005	11
Aluminum (Total)	0.10	0.20	0.11	0.03	11
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	11
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0010	0.0003	0.0003	11
Chromium (Total)	0.004	0.020	0.014	0.008	11
Copper (Total)	0.001	0.010	0.003	0.003	11
Flouride (Total)	0.050	0.100	0.057	0.019	7
Iron (Total)	0.06	0.52	0.16	0.13	11
Lead (Total)	0.0007	0.0020	0.0012	0.0004	11
Manganese (Total)	0.02	0.02	0.02	0.00	11
Mercury (Total)	0.0002	0.0011	0.0003	0.0003	11
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	6
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0230	0.0024	0.0068	11
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.020	0.040	0.023	0.006	11
Oil + Grease	0.1	0.1	0.1		1

Notes:

CFS - Cubic feet per second
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s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
RA-200	Surface Water	Period of record:	**11/1989**	To	**10/1993**
Flow (cfs)	1.3	44.1	11.2	14.6	11
SC (umhos/cm) (lab)	7	26	11	5	14
SC (umhos/cm) (field)	6	24	15	5	13
TSS	1	3	1	1	14
TDS	8	23	13	5	14
Turbidity (NTU)	0.05	0.55	0.33	0.15	14
Temperature (C) (field)	1.0	25.0	7.3	6.6	12
pH (s.u) (field)	5.1	7.3	6.2	0.8	13
pH (s.u.) (lab)	4.8	6.9	6.1	0.5	13
Bicarbonate	2	7	5	1	14
Calcium (Total)	0.6	2.0	1.1	0.4	14
Carbonate	0	0	0	0	14
Chloride	1	2	1	0	14
Hydroxide	0.0	0.0	0.0	0.0	12
Magnesium (Total)	0.1	1.0	0.6	0.4	14
Potassium (Total)	0.1	1.0	0.6	0.5	14
Sodium (Total)	0.1	3.0	0.9	0.7	14
Sulfate	1.0	7.0	2.1	1.7	14
Total Alkalinity	2	6	4	1	14
Total Hardness	2	10	5	2	14
Ammonia	0.05	0.12	0.07	0.03	14
Kjeldah Nitrogen	0.20	0.36	0.22	0.04	14
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.016	0.006	0.003	14
Phosphorus	0.005	0.020	0.008	0.005	14
Aluminum (Total)	0.10	0.10	0.10	0.00	14
Antimony (Total)	0.002	0.006	0.004	0.003	2
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	14
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0010	0.0002	0.0003	14
Chromium (Total)	0.004	0.020	0.015	0.008	14
Copper (Total)	0.001	0.010	0.002	0.002	14
Flouride (Total)	0.050	0.050	0.050	0.000	9
Iron (Total)	0.05	0.18	0.09	0.04	14
Lead (Total)	0.0007	0.0023	0.0011	0.0005	14
Manganese (Total)	0.02	0.02	0.02	0.00	14
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	14
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	9
Nickel (Total)	0.002	0.100	0.051	0.069	2
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0002	0.0020	0.0004	0.0005	14
Thallium (Total)	0.003	0.005	0.004	0.001	2
Zinc (Total)	0.020	0.050	0.023	0.008	14
Oil + Grease	0.1	0.1	0.1		1

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
RA-550	Surface Water		Period of record:	**01/1989** To	**10/1993**
Flow (cfs)	1.2	119.5	28.8	30.9	25
SC (umhos/cm) (lab)	7	21	15	4	31
SC (umhos/cm) (field)	9	31	17	5	28
TSS	1	3	1	1	31
TDS	1	29	14	7	31
Turbidity (NTU)	0.05	0.82	0.30	0.15	31
Temperature (C) (field)	0.0	17.0	5.3	4.5	30
pH (s.u) (field)	5.3	8.0	6.6	0.6	28
pH (s.u.) (lab)	5.2	7.1	6.2	0.5	31
Bicarbonate	1	10	6	2	30
Calcium (Total)	1.0	2.0	1.3	0.4	31
Carbonate	0	0	0	0	31
Chloride	1	3	1	0	31
Hydroxide	0.0	0.0	0.0	0.0	28
Magnesium (Total)	0.3	1.0	0.9	0.2	31
Potassium (Total)	0.1	1.0	0.9	0.3	31
Sodium (Total)	0.6	4.0	1.9	1.1	31
Sulfate	1.0	7.0	2.1	1.5	31
Total Alkalinity	1	8	5	2	31
Total Hardness	0	10	6	3	31
Ammonia	0.05	0.25	0.07	0.05	31
Kjeldah Nitrogen	0.02	0.43	0.22	0.07	31
Nitrate + Nitrite					0
Ortho-Phosphate	0.005	0.009	0.005	0.001	31
Phosphorus	0.005	0.130	0.013	0.026	31
Aluminum (Total)	0.10	0.70	0.12	0.11	31
Antimony (Total)	0.002	0.006	0.005	0.002	3
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	31
Barium (Total)	0.010	0.010	0.010		1
Cadmium (Total)	0.0001	0.0050	0.0006	0.0010	31
Chromium (Total)	0.004	0.020	0.017	0.006	31
Copper (Total)	0.001	0.010	0.002	0.002	31
Flouride (Total)	0.010	0.100	0.048	0.016	25
Iron (Total)	0.05	0.16	0.06	0.02	31
Lead (Total)	0.0007	0.0200	0.0018	0.0034	31
Manganese (Total)	0.02	0.02	0.02	0.00	31
Mercury (Total)	0.0002	0.0003	0.0002	0.0000	31
Molybdenum (Total)	0.0500	0.0500	0.0500	0.0000	24
Nickel (Total)	0.002	0.100	0.067	0.057	3
Selenium (Total)	0.005	0.005	0.005		1
Silver (Total)	0.0001	0.0210	0.0008	0.0037	31
Thallium (Total)	0.002	0.005	0.003	0.002	3
Zinc (Total)	0.002	0.140	0.029	0.029	31
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
WDS-1	Groundwater		Period of record:	**10/1989** To	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	59	77	70	6	9
SC (umhos/cm) (field)	52	79	65	8	10
TSS					0
TDS	41	73	57	11	9
Turbidity (NTU)					0
Temperature (C) (field)	4.0	12.5	9.2	3.3	9
pH (s.u) (field)	6.4	7.3	6.8	0.3	10
pH (s.u.) (lab)	5.4	6.7	6.2	0.4	9
Bicarbonate	37	44	40	3	9
Calcium (Total)	4.8	8.0	6.2	1.0	9
Carbonate	0	0	0	0	9
Chloride	1	1	1	0	9
Hydroxide	0.0	1.0	0.1	0.4	8
Magnesium (Total)	1.0	3.0	1.9	0.6	9
Potassium (Total)	0.5	9.0	3.1	2.9	9
Sodium (Total)	3.0	7.0	5.2	1.4	9
Sulfate	2.0	16.0	5.4	4.4	9
Total Alkalinity	30	36	32	2	9
Total Hardness					0
Ammonia	0.07	0.34	0.21	0.19	2
Kjeldah Nitrogen	0.20	1.84	1.02	1.16	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.50	0.18	0.16	9
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	9
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0009	0.0003	9
Chromium (Total)	0.004	0.020	0.016	0.007	9
Copper (Total)	0.001	0.020	0.013	0.009	9
Flouride (Total)	0.050	0.100	0.070	0.014	8
Iron (Total)	0.05	0.17	0.07	0.04	9
Lead (Total)	0.0007	0.0100	0.0069	0.0046	9
Manganese (Total)	0.02	0.12	0.03	0.03	9
Mercury (Total)	0.0002	0.0005	0.0002	0.0001	9
Molybdenum (Total)	0.0002	0.0500	0.0438	0.0176	8
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0010	0.0008	0.0004	9
Thallium (Total)					0
Zinc (Total)	0.020	0.100	0.033	0.028	9
Oil + Grease					0

Notes:

CFS - Cubic feet per second
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
WDS-2	Groundwater		Period of record:	**02/1992 To**	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	56	64	60	6	2
SC (umhos/cm) (field)	56	70	62	7	3
TSS					0
TDS	62	155	109	66	2
Turbidity (NTU)					0
Temperature (C) (field)	10.0	15.0	12.5	3.5	2
pH (s.u) (field)	5.7	6.5	6.1	0.4	3
pH (s.u.) (lab)	5.3	6.1	5.7	0.6	2
Bicarbonate	10	32	21	16	2
Calcium (Total)	3.0	7.1	5.1	2.9	2
Carbonate	0	0	0	0	2
Chloride	2	2	2	0	2
Hydroxide	0.0	0.0	0.0		1
Magnesium (Total)	1.0	1.6	1.3	0.4	2
Potassium (Total)	2.0	4.0	3.0	1.4	2
Sodium (Total)	5.0	13.2	9.1	5.8	2
Sulfate	5.0	15.0	10.0	7.1	2
Total Alkalinity	8	26	17	13	2
Total Hardness					0
Ammonia	0.05	0.12	0.09	0.05	2
Kjeldah Nitrogen	0.25	0.59	0.42	0.24	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	2
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	2
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0006	0.0006	2
Chromium (Total)	0.004	0.004	0.004	0.000	2
Copper (Total)	0.002	0.003	0.003	0.001	2
Flouride (Total)	0.100	0.100	0.100		1
Iron (Total)	0.05	0.06	0.06	0.01	2
Lead (Total)	0.0007	0.0007	0.0007	0.0000	2
Manganese (Total)	0.02	0.04	0.03	0.01	2
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	2
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	2
Thallium (Total)					0
Zinc (Total)	0.020	0.040	0.030	0.014	2
Oil + Grease					0

Notes:

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umhos/cm - micromhos per centimeter
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Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
WDS-3	Groundwater		Period of record:	01/1992 To	08/1993
Flow (cfs)					0
SC (umhos/cm) (lab)	93	194	143	51	3
SC (umhos/cm) (field)	44	136	94	41	4
TSS					0
TDS	70	117	89	25	3
Turbidity (NTU)					0
Temperature (C) (field)	5.0	10.0	8.0	2.2	4
pH (s.u) (field)	5.7	6.8	6.3	0.5	4
pH (s.u.) (lab)	5.8	7.8	6.7	1.0	3
Bicarbonate	49	112	82	32	3
Calcium (Total)	7.0	26.9	15.9	10.1	3
Carbonate	0	0	0	0	3
Chloride	3	8	6	3	3
Hydroxide	0.0	0.0	0.0	0.0	2
Magnesium (Total)	2.0	5.9	4.5	2.1	3
Potassium (Total)	1.0	3.0	2.0	1.0	3
Sodium (Total)	7.7	15.0	10.4	4.0	3
Sulfate	1.0	6.0	3.7	2.5	3
Total Alkalinity	40	92	67	26	3
Total Hardness					0
Ammonia	0.05	0.05	0.05	0.00	2
Kjeldah Nitrogen	0.20	1.76	0.98	1.10	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	3
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	3
Barium (Total)					0
Cadmium (Total)	0.0001	0.0010	0.0004	0.0005	3
Chromium (Total)	0.004	0.020	0.009	0.009	3
Copper (Total)	0.001	0.020	0.007	0.011	3
Flouride (Total)	0.080	0.080	0.080		1
Iron (Total)	0.05	0.15	0.08	0.06	3
Lead (Total)	0.0007	0.0100	0.0038	0.0054	3
Manganese (Total)	0.02	0.08	0.05	0.03	3
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	3
Molybdenum (Total)	0.0002	0.0500	0.0251	0.0352	2
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0010	0.0005	0.0005	3
Thallium (Total)					0
Zinc (Total)	0.020	0.020	0.020	0.000	3
Oil + Grease					0

Notes:

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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
WDS-4	Groundwater		Period of record:	**02/1992** To	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	140	141	141	1	2
SC (umhos/cm) (field)	108	161	136	27	3
TSS					0
TDS	85	99	92	10	2
Turbidity (NTU)					0
Temperature (C) (field)	9.0	11.0	10.0	1.4	2
pH (s.u) (field)	6.4	7.2	6.8	0.6	2
pH (s.u.) (lab)	6.3	7.1	6.7	0.6	2
Bicarbonate	76	78	77	1	2
Calcium (Total)	15.0	16.5	15.8	1.1	2
Carbonate	0	0	0	0	2
Chloride	1	5	3	3	2
Hydroxide	0.0	0.0	0.0		1
Magnesium (Total)	4.7	5.0	4.9	0.2	2
Potassium (Total)	1.0	1.0	1.0	0.0	2
Sodium (Total)	7.0	12.2	9.6	3.7	2
Sulfate	5.0	7.0	6.0	1.4	2
Total Alkalinity	62	64	63	1	2
Total Hardness					0
Ammonia	0.05	0.07	0.06	0.01	2
Kjeldah Nitrogen	0.20	0.20	0.20	0.00	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	2
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	2
Barium (Total)					0
Cadmium (Total)	0.0001	0.0120	0.0061	0.0084	2
Chromium (Total)	0.004	0.004	0.004	0.000	2
Copper (Total)	0.001	0.002	0.002	0.001	2
Flouride (Total)	0.180	0.180	0.180		1
Iron (Total)	0.05	0.05	0.05	0.00	2
Lead (Total)	0.0007	0.0007	0.0007	0.0000	2
Manganese (Total)	0.02	0.02	0.02	0.00	2
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	2
Molybdenum (Total)					0
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	2
Thallium (Total)					0
Zinc (Total)	0.020	0.020	0.020	0.000	2
Oil + Grease					0

Notes:

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umhos/cm - micromhos per centimeter
s.u. - standard units

NTU - Nephelometric Turbidity Unit
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ADDENDUM

Water Quality Summary Statistics
Montanore Project - Interim Monitoring Period

Sample Location	Range Min	Range Max	Mean	Standard Deviation	Population
WDS-6	Groundwater		Period of record:	**02/1992** To	**08/1993**
Flow (cfs)					0
SC (umhos/cm) (lab)	28	190	109	115	2
SC (umhos/cm) (field)	31	36	34	3	3
TSS					0
TDS	48	126	87	55	2
Turbidity (NTU)					0
Temperature (C) (field)	7.0	10.0	9.0	1.7	3
pH (s.u) (field)	5.9	6.2	6.0	0.2	3
pH (s.u.) (lab)	5.1	7.2	6.2	1.5	2
Bicarbonate	8	111	60	73	2
Calcium (Total)	3.0	19.1	11.1	11.4	2
Carbonate	0	0	0	0	2
Chloride	4	10	7	4	2
Hydroxide	0.0	0.0	0.0		1
Magnesium (Total)	2.0	8.0	5.0	4.2	2
Potassium (Total)	1.0	9.0	5.0	5.7	2
Sodium (Total)	3.0	5.0	4.0	1.4	2
Sulfate	7.0	7.0	7.0	0.0	2
Total Alkalinity	7	93	50	61	2
Total Hardness					0
Ammonia	0.05	0.05	0.05		1
Kjeldah Nitrogen	0.20	0.53	0.37	0.23	2
Nitrate + Nitrite					0
Ortho-Phosphate					0
Phosphorus					0
Aluminum (Total)	0.10	0.10	0.10	0.00	2
Antimony (Total)					0
Arsenic (Total)	0.0050	0.0050	0.0050	0.0000	2
Barium (Total)					0
Cadmium (Total)	0.0001	0.0003	0.0002	0.0001	2
Chromium (Total)	0.004	0.004	0.004	0.000	2
Copper (Total)	0.001	0.003	0.002	0.001	2
Flouride (Total)	0.110	0.110	0.110		1
Iron (Total)	0.05	0.05	0.05	0.00	2
Lead (Total)	0.0007	0.0007	0.0007	0.0000	2
Manganese (Total)	0.02	0.23	0.13	0.15	2
Mercury (Total)	0.0002	0.0002	0.0002	0.0000	2
Molybdenum (Total)	0.0002	0.0002	0.0002		1
Nickel (Total)					0
Selenium (Total)					0
Silver (Total)	0.0002	0.0002	0.0002	0.0000	2
Thallium (Total)					0
Zinc (Total)	0.020	0.020	0.020	0.000	2
Oil + Grease					0

Notes:

CFS - Cubic feet per second
umhos/cm - micromhos per centimeter
s.u. - standard units
NTU - Nephelometric Turbidity Unit
C - Degrees centigrade

Units are mg/l unless otherwise indicated

Sample population includes below detection data. Below detectable concentrations are set equal to the detection limit value for statistical calculations.

Appendix B. Water Resources

Montana Project

Appendix B.

Water Resources Baseline Investigation

WATER RESOURCES BASELINE INVESTIGATION
MONTANA PROJECT

LINCOLN AND SANDERS COUNTIES, MONTANA

NORANDA MINERALS CORPORATION

WATER RESOURCES BASELINE INVESTIGATION
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

Prepared for:

NORANDA MINERALS CORPORATION

Submitted by:

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1610 "B" Street, P.O. Box 4699
Helena, Montana 59604

Revised June 23, 1989

PROJECT DESCRIPTION

This baseline study was initiated by U.S. Borax as part of the licensing requirements for the development and mining of a silver/copper deposit located underneath the Cabinet Mountain Wilderness Area in the Kootenai National Forest, Sanders and Lincoln Counties, Montana. Whereas the State of Montana, Department of State Lands and the Kootenai National Forest have primary responsibility for permitting these activities, the two agencies and U.S. Borax developed a Plan of Study that defined the nature and extent of the baseline work. This work was initiated in the Spring of 1988 and has been conducted in accordance with the terms of the Plan of Study.

A number of alternative sites were identified for portals, processing plant, tailings disposal and ancillary facilities. The area encompassing and adjacent to these sites then became the focus of the baseline work.

In September of 1988, Noranda Minerals Corp. and Montana Reserves formed a venture and purchased the silver/copper deposit from U.S. Borax and continued with project development under the "Montana Project" name. Noranda Minerals Corp. (Noranda) was designated the project manager.

Noranda continued to build from the data and information that had been generated by U.S. Borax and after reviewing the many alternative sites developed the proposed mining program detailed in the Application for a Hard Rock Operating Permit from the Montana Department of State Lands. The application also serves as a proposed Plan of Operation to the Kootenai National Forest. Basically, the application describes a 20,000 ton per day operation accessed from two (twin) portals in Ramsey Creek, a mill site located adjacent to the Ramsey portals, a portal in Libby Creek, two portals in the Rock Creek drainage for ventilation and emergency access, and a tailing impoundment in the Little Cherry Creek drainage. Access to the Ramsey Creek mine site would be over the existing Bear Creek Road. A new transmission line from Pleasant Valley to the mine site would provide electrical energy for the operation. The total labor force is expected to number approximately 400 people. These positions would be filled by hiring locally as much as possible.

WATER RESOURCES SUMMARY

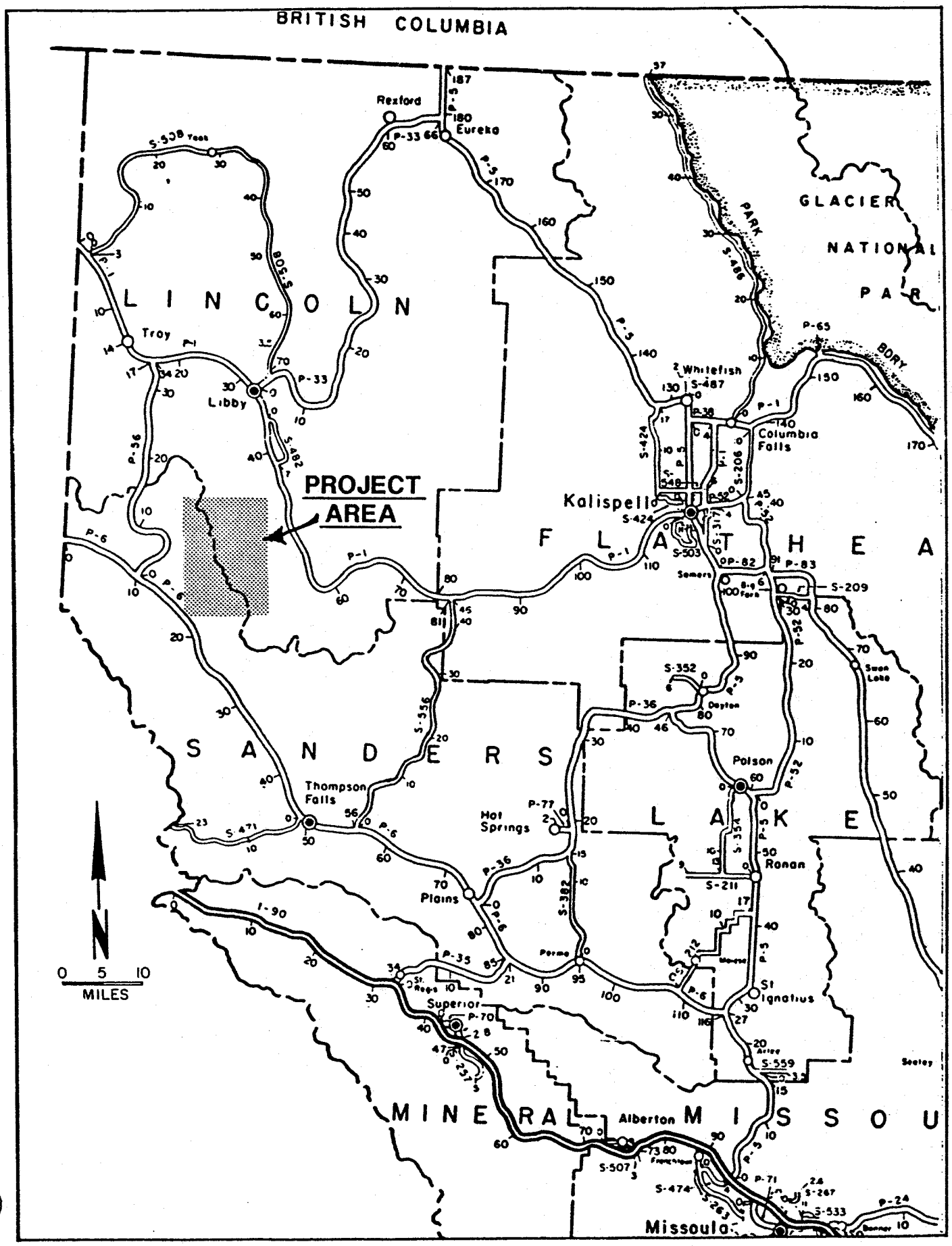
INTRODUCTION

The following is a summary of the Water Resources Baseline Investigation of Noranda Minerals Corporation-Montana Project in Lincoln and Sanders Counties, Montana (Figure i-1). The water resource baseline investigation work plan was developed in conjunction with the Montana Department of State Lands and U.S. Forest Service-Kootenai Forest to obtain information on the quantity and quality of surface and groundwater in the project area. The Water Resources Baseline Investigation augments water quality information previously collected by various agencies and organizations between 1979-1988. Previous information has been collected by the U.S. Forest Service, U.S. Geological Survey, Montana Department of Health and Environmental Sciences, Montana Department of Fish, Wildlife and Parks, ASARCO, U.S. Borax, and Noranda. The Water Resources Baseline Investigation report is contained in Appendix B.

STUDY AREA

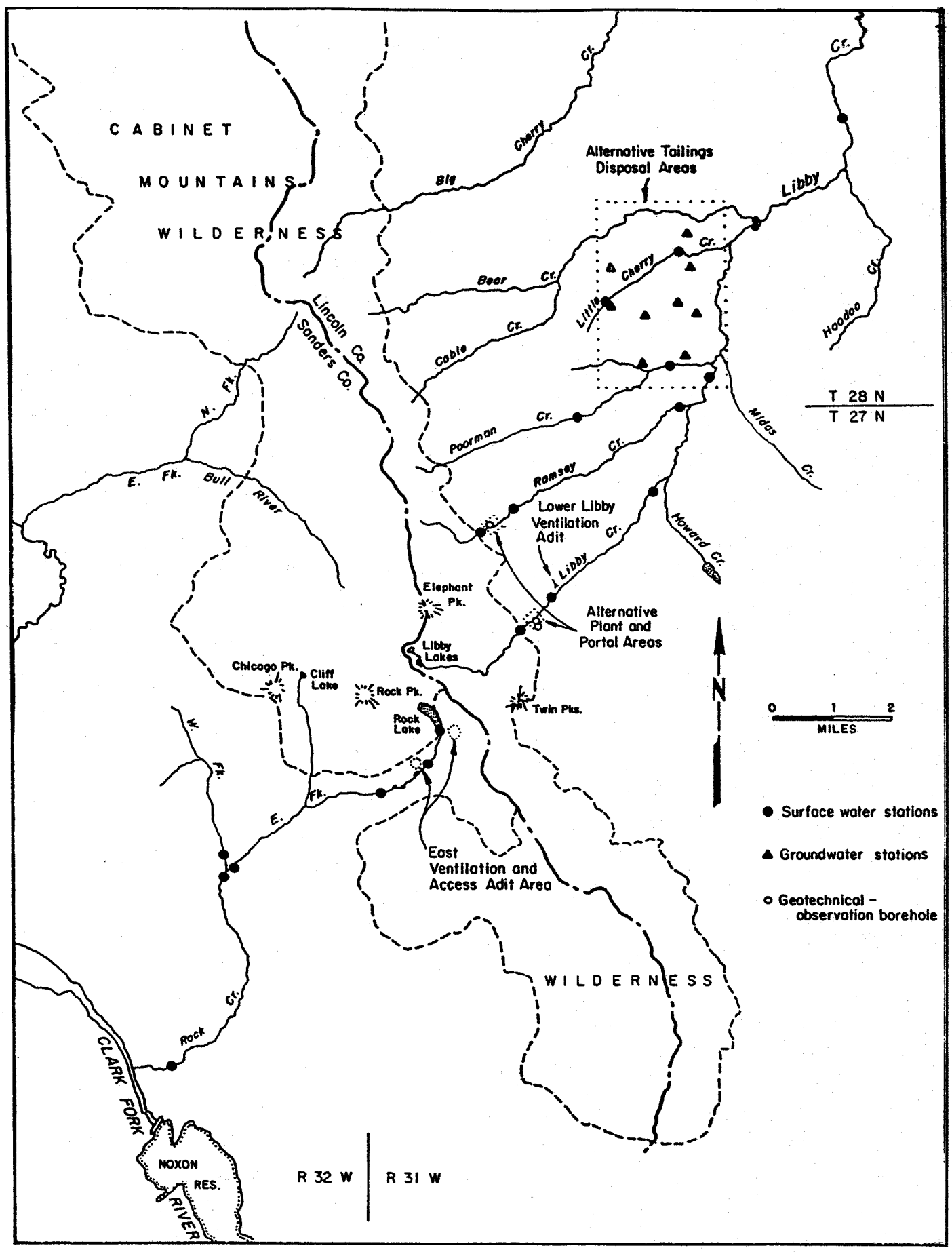
The study area for the Montana Project Water Resource Baseline Investigation is located on the east side of the Cabinet Mountains Wilderness Area, approximately 22 miles south of Libby, Montana, and to the west on Rock Creek, located about 4 miles east of Noxon (Figure i-2). The baseline investigation includes Libby Creek and its tributaries: Ramsey Creek, Poorman Creek, Little Cherry Creek and Bear Creek flowing northeast to the Kootenai River, and Rock Creek flowing west to the Clark Fork River.

Proposed mine facilities lie primarily in the Libby Creek drainage. The proposed production portal and mill site is located in upper Ramsey Creek, tributary to Libby Creek. The proposed tailings disposal site is located in the Little Cherry Creek drainage. Ventilation and mine access adits are proposed for Rock Creek and in the vicinity of the Heidelberg adit in the upper East Fork Rock Creek drainage.



General Site Map
FIGURE i-1

NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana



NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana

Water Resources Map
FIGURE i-2

SURFACE WATER

Watershed Description and Streamflow

Snowmelt and high intensity precipitation are the primary contributors to streamflow in the study area. Groundwater discharge from bedrock and surface deposits account for a small amount of baseflow. Precipitation ranges from 60 inches or more per year in the Cabinet Mountains to about 35 inches per year at the tailings disposal site. Mean monthly temperatures range from 7.3 degrees Fahrenheit in January to 72.1 degrees Fahrenheit in July.

Streamflow was measured at all gaging sites twice monthly from April through June, 1988 and monthly through November. In November, 1988, a winter sampling program was initiated. Sites continued to be sampled which were both accessible and pertinent to mine development.

Libby Creek, draining to the Kootenai River, is the major stream located on the east side of the project area. Libby Creek drains the major mine facility locations. Within this area, tributaries to Libby Creek are Ramsey, Poorman, Little Cherry, and Bear Creeks. Major mine facilities will be located in the Libby, Ramsey, and Little Cherry creeks.

The west side of the project area is drained by the East Fork of Rock Creek to the Clark Fork River. Two ventilation and emergency access adits in the Upper East Fork Rock Creek drainage will be the only surface facilities in this drainage.

Libby Creek is a large, second-order stream (Strahler, 1957) which drains an area of approximately 68 square miles from a point just upstream of its crossing Highway 200 (Figure i-2). Libby Creek originates in a steep, glacial-carved basin at an elevation of 5600 feet and discharges to the Kootenai River 28 miles downstream at an elevation of 2020 feet in Libby, Montana. The stream is primarily restricted to a narrow channel flowing through bedrock canyons; erodible valley fill, composed of glacial, fluvial, and lacustrine sediments; and occasionally on aggraded floodplain surfaces.

A continuous stage recorder was installed on Libby Creek in a downstream reach of the study area and has collected daily stage data since April, 1988. An automatic water quality sampler was installed at the same site for the collection of total suspended solids (TSS) samples. The automatic sampler was removed from the station for the 1988-1989 winter months and will be reinstalled as soon as conditions permit in the spring of 1989.

Six surface water monitoring stations were initially sampled and gaged on Libby Creek. From April through November, 1988, discharge ranged from 1.09 to 50.7 cubic feet per second (cfs) in the upper reach and from 10.6 to 319.2 cfs in the lower reach. The lower reach includes the combined flow from all tributaries in the study area. A perennial spring was located near upper Libby Creek and had a measured flow of approximately 9 gallons per minute (gpm) in August, 1988.

Ramsey Creek is located north of and is tributary to Libby Creek (Figure i-2). It originates in a glacial basin at an elevation of approximately 4440 feet and discharges to Libby Creek 5.3 miles downstream at an elevation 3425 feet. Ramsey Creek drains an area of 6.5 square miles. A marsh, approximately 7 acres in size, exists in the upper drainage at the wilderness boundary. A short distance downstream is Ramsey Lake, which has a surface area of approximately 2 acres. Downstream from Ramsey Lake, Ramsey Creek flows as a high energy stream, similar to Libby Creek, through a series of narrow bedrock canyons and moraine material. Three surface water stations were sampled and gaged on Ramsey Creek during the baseline study. Discharge ranged from 0.9 to 60.9 cfs at the upper site near the wilderness boundary, 1.1 to 62.8 cfs at mid-reach, and 1.4 to 66.0 cfs above the confluence with Libby Creek.

Poorman Creek is a perennial stream located north of Ramsey Creek (Figure i-2). Headwaters originate in a glacial basin at an elevation of approximately 5400 feet. Poorman Creek converges with Libby Creek 5.3 miles downstream at an elevation of 3315 feet and drains an area of approximately 6 square miles. During the baseline study period, discharge ranged from 0.5 to 53.0 cfs at the upstream site and 0.7 to 54.8 cfs at the downstream site. Poorman Creek flows in a constricted channel. Several

small, intermittent tributaries also discharge to Poorman Creek but do not contribute significant flow to the stream. The lower reach of the Poorman Creek drainage was one of the alternative tailings disposal sites which received consideration.

Little Cherry Creek is a perennial stream which originates at an elevation of approximately 4000 feet and discharges 2.8 miles downstream to Libby Creek at an elevation of 3100 feet. Little Cherry Creek drains an area of 1.9 square miles and flows through Kootenai National Forest and Champion International land. Stream banks in the lower reaches are sparsely vegetated and partially collapsed due to recent logging activity in the area. The stream is incised into interfingering glaciolacustrine and glaciofluvial sediments. Flow appears to be maintained by groundwater discharge from a paleo-stream channel trending concordant with Little Cherry Creek. The lower portion of the Little Cherry Creek drainage is the proposed tailings disposal sites.

Bear Creek is the most northern tributary to Libby Creek in the study area. Headwaters originate in a glacial basin at an elevation of 4600 feet. The creek flows 8.5 miles before converging with Libby Creek at an elevation of 3050 feet. Drainage basin size is approximately 15 square miles. Flowing springs were observed in the Bear Creek drainage during the inventory conducted in June, 1988; however, most of the springs were dry by July, 1988. Bear Creek is fed by surface runoff and several small intermittent drainages. The stream is incised into lake bed silts, although small exposed bedrock outcrops occur throughout the reach.

Rock Creek is formed by the convergence of the East and West Forks of Rock Creek (Figure i-2). The two forks drain an area of approximately 33 square miles. Surface topography is steep, and exposed bedrock predominates forested slopes at high elevations. Precipitation averages 80 inches per year in the upper reaches. Temperatures are similar to those reported in the Libby Creek drainage.

The headwaters of the East Fork of Rock Creek include Rock Lake at an elevation of 4958 feet. Rock Lake, with a surface area of 40.4 acres, is enclosed within a steep basin and is fed by snowmelt. A surface water monitoring site was established at the outflow of the lake. Discharge values ranged from 0.0 to 37.8 cfs through October, 1988. The East Fork of Rock Creek receives flow from the lake and from springs. Directly below Rock Lake, East Fork is quite steep, forming a 60 foot high waterfall in a reach near the Heidelberg Mine. A perennial spring, located east of the Heidelberg adit, was gaged at 4.5 gpm in August, 1988.

Stream discharge also was gaged at a surface water monitoring site located downstream from the Heidelberg Mine on the East Fork. Flows at this site ranged from 0.4 to 47.8 cfs. Downstream of this site are a series of small ponds named Rock Creek Meadows. Flow was gaged below the meadows at 1.9 to 149.0 cfs.

Three additional surface water monitoring sites were established near the confluence of East and West Forks of Rock Creek. Flow in the West Fork of Rock Creek is intermittent, and numerous small springs contribute to its flow. Discharges in the West Fork ranged from 0.0 to 21.7 cfs during the baseline study. The East Fork above the confluence could not be safely gaged during spring flow due to high velocities and discharges. Flows measured over the study period ranged between 0.0 and 69.2 cfs. Below the confluence, discharge ranged from 0.0 to 299.0 cfs.

Immediately downstream of the confluence of the East Fork and West Fork of Rock Creek, water is lost to the alluvial groundwater system. The lowest reaches of Rock Creek are typically dry during summer and fall months.

Other surface water features in the study area include Libby Lakes and Isabella Lake. The three Libby Lakes occur at elevations of 6,920, 6,800 and 6,600 feet. Their combined area is approximately 8 acres. Isabella Lake lies at an elevation of 6,800 feet and is approximately 2 acres in surface area. No surface drainage is evident from either Libby Lakes or

Isabella Lake. Saint Paul Lake is at an elevation of 4715 feet. The drainage area above Saint Paul Lake is 1.5 square miles. The drainage area of the unnamed tributary which drains Saint Paul Lake to its confluence with East Fork Bull River is approximately 2.6 square miles.

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Surface Water Quality

A project specific surface water quality sampling program was initiated during the last week of April, 1988. Water quality samples were collected simultaneously with flow measurements at each station (Figure i-2). The frequency of sampling was twice monthly during the spring runoff period (April through June) and monthly during non-runoff flow conditions. Water quality samples were analyzed for parameters presented in Table i-1. Field measurements of specific conductance (SC), pH, and water temperature were also collected at each station at the time of sampling.

Surface water sample collection and preparation were conducted using approved methods and practices described in (but not limited to), the Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA, 1982). Standard Operating Procedures developed by Chen-Northern detail methods and procedures used in the collection of all surface and groundwater baseline data and were followed by all field personnel. Sample collection also incorporated quality assurance/ quality control procedures. Surface water quality data are presented in the Water Resources Baseline Investigation, Appendix B.

Table i-2 presents the range of water quality concentrations from all surface water stations during fifteen sampling episodes (April, 1988 through April, 1989). Minimum values for most parameters are below the method detection limits. Maximum values are generally very near these same detection limits.

Surface water in the Rock Creek and Libby Creek drainages is good quality. Measured total dissolved solids (TDS) concentrations throughout the study area are less than 70 mg/L. Hardness values are low, with approximately one-half of the sampling locations reporting <6.0 mg/L. No hardness values over 50 mg/L are reported for the remaining locations. Specific conductance (SC) field values ranged between 5 and 156 umhos/cm throughout the study area, and field pH ranged between 5.8 and 8.7 standard units. Bicarbonate is the predominant anion.

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TABLE i-1. SURFACE WATER QUALITY PARAMETERS mg/L [a]

FIELD PARAMETERS	COMMON IONS	METALS [b]	OTHERS
pH	Ca	Pb	Nitrite and Nitrate as N
Specific Conductivity (SC)	Mg	Cu	Orthophosphate as P
Temperature (^{o}C)	Na	Cr	F
	K	Zn	TDS
	CO_3	Cd	TSS
	HCO_3	Fe	Turbidity
	Cl	Al	Hardness, as $CaCO_3$
	SO_4	Mn	Alkalinity, as $CaCO_3$
		Hg	Ammonia
		As	Total Kjeldahl Nitrogen as N
		Ag	Total Phosphorous as P
		Mo	

(a) Oil and Grease were analyzed once for each surface water site to establish baseline conditions.

(b) Samples were collected in the field and analyzed in the laboratory for total recoverable metal concentrations. Total recoverable metals were analyzed in the laboratory using procedures described in EPA 600/4-79-020.

TABLE i-2. GENERAL RANGE OF CONCENTRATION FOR ALL SURFACE WATER PARAMETERS WITHIN THE BASELINE STUDY AREA* (APRIL, 1988-APRIL, 1989)

PARAMETER	MINIMUM	MAXIMUM
Aluminum	<0.1	0.5
Arsenic	<0.005	<0.005
Cadmium	0.0004	0.0092
Chromium	<0.02	<0.02
Copper	<0.001	0.022[a]
Iron	<0.05	0.36
Lead	<0.001	0.024[a]
Manganese	<0.02	<0.02
Mercury	<0.0002	0.0004
Molybdenum	<0.05	<0.05
Silver	<0.0002	0.0022
Zinc	<0.02	0.06
Ammonia	<0.05	0.24
Kjeldahl Nitrogen	<0.2	1.43[a]
Nitrate + Nitrite as N	<0.01	2.0
Orthophosphate	<0.005	0.094
Total Phosphorus	<0.005	0.265
Sulfate	<1.0	6
Calcium	<1.0	15
Magnesium	<1.0	4
Sodium	<1.0	6
Potassium	<1.0	2
Chloride	<1.0	<1
Fluoride	<0.05	0.14
Total Alkalinity as $CaCO_3$	<1.0	60
Bicarbonate as HCO_3	<2.0	73
Carbonate as $CaCO_3$	0	0
Total Hardness	<6.0	50
Oil and Grease	<1	2.2
Total Suspended Solids	1	11
Total Dissolved Solids	<1.0	70
Turbidity (NTU)	<0.1	3.0
Field pH	5.8	8.7
Field SC (umhos/cm)	5	156
Temperature (^{o}C)	1	18.0
Lab pH	4.6	8.0
Lab SC (umhos/cm)	6	118

* All values are in mg/L unless noted.

a Anomalous one time values were reported for these parameters: Copper 0.022 mg/L; Lead 0.024 mg/L; and Kjeldahl Nitrogen 1.43 mg/L. These anomalous values were retained for statistical comparison.

< Values are below the established detection limit and the listed value is the detection limit.

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At all sampling locations, concentrations of nitrate + nitrite as N, fluoride, total phosphorous, and orthophosphate were present at higher concentrations in samples collected during spring runoff but declined to near or below detection limits by late summer.

Total recoverable metals occur at very low levels. Arsenic, chromium, manganese, and molybdenum are consistently below their respective detection limits. Copper, iron, lead, mercury, silver, and zinc occurred at detectable concentrations during spring runoff sampling, but were near or below detection limits during summer and fall sampling episodes.

Evaluations of spatial water quality trends were completed using water quality data from sites within the same drainage. Analyses of spatial variation by drainage are presented below.

Rock Creek Drainage Water Quality. The East Fork of Rock Creek drainage contains copper levels at Rock Lake that are slightly above the detection limit; however, concentrations appear to decrease in a downstream direction. Lead was detected in two sampling episodes at downstream sites but exhibits no significant trends. Total dissolved solids (TDS) gradually increase downstream. The West Fork of Rock Creek contributes hardness in the form of calcium and alkalinity as bicarbonate, slightly elevating specific conductivity.

Nitrate + nitrite as N range from 0.01 to 0.49 mg/L on the East Fork of Rock Creek. The higher reported values are suspect due to probable nitrogen contamination during sample handling and preparation. Values for April and May were higher than those reported during summer and fall sampling episodes. No significant trends occur in downstream directions, and values from samples collected below Rock Creek Meadows show no significant increase in nutrients.

Rock Creek downstream from the confluence of the two forks shows continued increases in hardness and alkalinity.

Libby Creek Drainage Water Quality. Libby Creek receives flow from four tributaries. These tributaries account for a fourfold increase in hardness and alkalinity throughout the length of Libby Creek in the study area. The greatest increase appears to occur below Ramsey Creek. Hardness at the most downstream site in the study area averages 17 mg/L, with a maximum of 49 mg/L reported in September, 1988. Alkalinity at this site averages 24 mg/L, with a maximum of 57 mg/L reported in September, 1988.

Concentrations of nitrate + nitrite as N in Libby Creek decrease downstream until the Bear Creek confluence. Concentrations increased downstream from the confluence during higher flows. No increase was evident during low summer flow.

Bear Creek has the highest hardness (50 mg/L) and alkalinity (60 mg/L) values in the study area. An increase in these constituents in Libby Creek occurred downstream of the Bear Creek confluence.

Ramsey Creek has a higher average total suspended solids (TSS) value (2.2 mg/L) due to organic debris contributed by the marsh environment during high flow. A decrease in nitrate + nitrite as N occurs downstream in upper Ramsey Creek similar to a noted decrease on upper Libby Creek. Common ions do not increase measurably in this stream and are not an important source of dissolved solids in Libby Creek.

Poorman Creek contributes hardness and alkalinity to Libby Creek. Average concentrations of hardness (6 mg/L) and alkalinity (12.3 mg/L) are higher than in Libby Creek. Nitrate + nitrite as N decreases downstream. No other significant changes occur in this short reach.

Little Cherry Creek has relatively high average alkalinity (19.7 mg/L) and hardness (11.5 mg/L) values compared to all other creeks in the Libby Creek drainage except Bear Creek. These constituents increase downstream. Fluoride and nitrate + nitrite as N values were slightly above detection limits during spring, as were copper, iron, lead, mercury, and silver concentrations.

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Particular constituents in surface waters are affected by seasonal flow variations. High spring flow is characterized by increased nitrate + nitrite as N, apparently due to leaching of weathered soils during runoff periods. Total phosphorus and orthophosphate also show elevated values during spring runoff; concentrations decreased to near detection limits in late summer.

Values for hardness and total dissolved solids (TSS) increased with a decrease in discharge, concentrating common ions and dissolved solids in the water. Total suspended solids fluctuated during the study period, increasing slightly during runoff and decreasing during the steady flow of early and mid-summer. Slight increases in TSS concentrations were measured during extremely low flows, probably due to sampling difficulties at low flow and increased algal growth with warmer water temperatures. Certain metals, such as silver and copper were detected at higher levels during spring runoff events. These concentrations declined to near or below detection limits during summer and early fall flow conditions. The remaining constituent concentrations do not appear to vary measurably in response to seasonal flow variations.

GROUNDWATER RESOURCES

Groundwater in the proposed mine facility areas was investigated using both monitoring wells and geophysical methods. Nine monitoring wells were installed in the tailings impoundment area between Poorman and Little Cherry creeks; resistivity surveying and seismic refraction also were conducted. Six geotechnical exploration boreholes, 3 of which were completed as observation wells, were installed at the alternative plant and portal sites in Ramsey and Libby creeks. Data from 15 exploration boreholes in the bedrock also were available for use in the ground~~water~~ assessment. In addition, 6 springs were located within the project area; however, only two of the springs exhibited perennial flow during the study per~~iod~~.

The groundwater regime in the Libby Creek drainage may be divided into regional flow within the bedrock fracture system and local flow within surficial deposits. The groundwater aspect of the project in the Rock Creek drainage is limited to the bedrock fracture system intersected by the proposed ventilation adit.

Groundwater flow in both regimes is generally from areas of high elevation to lower elevation. Regional flow is characterized by a low permeability, deep, bedrock system in fractured quartzite and argillite of the Belt Supergroup. Local flow is characterized by a low permeability, shallow system in fine-grained lake bed and poorly sorted outwash deposits, both of glacial origin. The low permeability of the materials results in limited groundwater transmission through the project area.

Groundwater is of good quality. The groundwater is primarily Ca-Mg bicarbonate water with low to moderate hardness, low ion concentration, low total dissolved solids (TDS), low sodium-adsorption ratios (SAR), and low specific conductance (SC). Dissolved metal concentrations are very low; near or below detection limits.

Regional Groundwater Flow

Regional groundwater flow is within the fracture controlled, bedrock system. The bedrock is comprised of metamorphosed sedimentary rock of the of the Wallace, Ravalli, and Pritchard units of the Belt Supergroup. These brittle rocks, quartzite, siltite, and argillite, support a regional fracture system as indicated by well-developed joint patterns visible on aerial photographs. These fractures and the northwest trending faults appear to control regional groundwater flow.

As with most hardrock aquifers, the general rock-mass permeability is expected to be rather low. Fracture information logged during the exploration core drilling indicates a relatively tight rock mass with an estimated permeability of 10^{-4} to 10^{-7} cm/sec.

Depth to regional groundwater in the mine area was evaluated from exploration borehole information. Based on this information, it is possible that a regional water table parallels the existing topography at a depth of approximately 500 feet within this hardrock environment. However, there are no direct measurements of depth to groundwater in this area.

Regional groundwater recharge occurs from the infiltration of precipitation, snowmelt, and streamflow in exposed bedrock of the Cabinet Mountains. Discharge areas for the regional groundwater system are not likely located within the project area. The lack of high flow springs and that relatively low base flow of the major streams indicate the regional flow in the bedrock is either deep or is limited by low permeabilities.

Alternative Portal Sites. Alternative production portal sites are located adjacent to the alternative plant sites in Ramsey and Libby creeks (Figure i-2).

The Libby Creek alternative portal site is located at an elevation of approximately 4300 feet in the upper reaches of Libby Creek. At this alternative site, the production portals would be sited on the northwest side of the creek. The Ramsey Creek alternative portal site is located at an approximate elevation of 4450 feet in the upper reaches of Ramsey Creek. The production portals would be situated on the south side of Ramsey Creek.

A ventilation and access adit will be driven from the lower Libby Creek site. Two mine ventilation adits also will be required in the vicinity of Rock Lake in the Rock Creek drainage.

Production portals and drifts at either alternative site will be driven in bedrock; therefore, underground development will intersect groundwater flow in the bedrock fracture system. More detailed descriptions of the alternative portal and plant sites is provided in the Geotechnical Report (Morrison-Knudsen, 1989).

Local Groundwater Flow

Local groundwater flow is primarily within the glacial deposits along the eastern mountain front. These glacial deposits form a wedge at an approximate elevation of 4,000 feet along the mountain front and thicken away from the mountains. These deposits are dominated by poorly-sorted, glacial outwash and glacial lakebed sediments. The poorly-sorted glacial outwash is deposited directly on ice-scoured bedrock and interfingers with the generally overlying glacial lakebed sediments. Interfingering occurred as the paleo-lakeshore advanced up the mountain front. The uppermost elevation of the paleo-lakeshore in the study area is evidenced by the absence of lakebed silt above approximately 3550 feet. Other local groundwater systems of very limited extent exist within localized morainal, colluvial, and talus deposits within the upper stream valleys. These systems directly discharge to adjacent streams.

Glacial deposits comprise the mountain front hydrogeologic units and exhibit low to very low permeabilities. Thirteen aquifer tests within poorly-sorted glacial outwash material exhibited a range of permeabilities of 2×10^{-6} to 7×10^{-3} cm/sec (0.04-145 gpd/ft^2), with an average value of 2×10^{-3} cm/sec (50 gpd/ft^2). Aquifer tests were not conducted in the lakebed silt because, although saturated, the silts did not yield measurable water to the boreholes. Therefore, the lakebed deposits are estimated to have a horizontal permeability of 10^{-6} cm/sec or less.

The local groundwater system is recharged by infiltration of precipitation, snowmelt, and streamflow, primarily along the mountain front. Groundwater flow is along the bedrock contact to the few springs located in the lower elevations of the project site, directly to local streams, or other locations beyond the study area.

In the vicinity of lower Poorman Creek, an artesian condition exists where lakebed silt caps the underlying glacial outwash material. Farther to the north, near Little Cherry Creek, this artesian condition does not exist, presumably due to breaching of the silt cap by an infilled paleo-channel.

Alternative Tailings Sites. Alternative tailings facility sites are located on Little Cherry Creek and immediately north of lower Poorman Creek (Figure i-2). Both sites are located on a substantial thickness of glacial outwash and lakebed material deposited on bedrock along the eastern mountain front. The thickness of the outwash, lakebed, and local colluvial material in the tailings area ranges from 0 feet at the few exposures of bedrock to over 200 feet at the Poorman site.

An artesian condition exists in the outwash deposits beneath the lakebed silt at the lower portion of the Poorman site. This artesian condition does not occur in the vicinity of Little Cherry Creek because the lakebed deposits are breached by an apparent stream channel that is now infilled with reworked glacial outwash. Although the reworked material is of low permeability, with measured values of 2×10^{-5} to 1×10^{-4} cm/sec (0.5-2.7 gpd/ft^2) in two aquifer tests, the permeability difference, as compared to the silt, is significant.

Measured depth to groundwater at the Poorman site is 13 feet at its deepest, to 12 feet above ground level, in the area of artesian flow.

Measured depth to groundwater at the Little Cherry site ranges from 6 to 11 feet below the surface. The low permeability of both the glacial outwash and the lakebed silt limits groundwater transmission through this area.

Three springs are located within the proposed tailings impoundment areas. One of these is immediately downgradient from the Little Cherry location, while the other two springs are located upgradient. All the springs have relatively low flows and were observed to dry up during the late summer.

Alternative Plant Sites. Alternative plant sites are located in the upper portions of Ramsey Creek and Libby Creek (Figure i-2).

The Ramsey Creek alternative plant site is located in an area of morainal material deposited by alpine glaciation. Geotechnical exploration drilling at the plant site revealed 41 to over 50 feet of silt, sand, and gravel at the site. One borehole intercepted groundwater at 39 feet. Static water

level in this borehole was recorded at 22 feet below the ground surface. The remaining boreholes at the site were dry. This localized groundwater system is apparently flowing on the steeply-dipping bedrock surface within glacial material and is of very limited extent. Groundwater discharges to the stream immediately downhill from the site.

Geotechnical drilling at the Libby Creek alternative plant site encountered 30 to 46 feet of silt, sand, and gravel. Two boreholes recorded water depths of 12 and 16 feet below the surface, and a third borehole was dry. This shallow groundwater system apparently occurs in granular material on the underlying bedrock. It is very localized and discharges to the stream immediately downhill from the site.

Groundwater Quality

Groundwater is of good quality. Analyses show all groundwater to be soft to moderately hard calcium-magnesium bicarbonate type with low concentrations of total dissolved solids and metals. Spring water samples are very similar to surface waters and probably represent local reemergence of infiltrated runoff. Ranges of groundwater quality parameters are given in Table i-3.

Well, Spring, and Adit Inventory

No existing groundwater wells were identified within close proximity to the project study area. Several minor, ephemeral springs and seeps were observed in the Poorman and Little Cherry alternative tailing disposal areas and are associated with surface exposures of lakebed materials.

Four springs were inventoried in the eastern portion of the study area; three of these are in the tailing disposal areas, and one is near the Libby Creek portal site. Those in the tailing disposal areas ranged in flow from 1 to 5 gpm in early summer, but dried up as the season progressed. The Libby Creek spring flowed at approximately 9 gpm.

TABLE i-3. RANGE OF VALUES FOR GROUNDWATER PARAMETERS WITHIN THE BASELINE STUDY AREA* (APRIL AND OCTOBER, 1988)

PARAMETER	MINIMUM	MAXIMUM
Aluminum	<0.1	1.6[a]
Arsenic	<0.005	0.005
Cadmium	<0.001	0.006
Chromium	<0.02	0.03
Copper	<0.02	0.03
Iron	<0.05	0.92
Lead	<0.01	<0.01
Manganese	<0.03	1.09
Mercury	<0.0002	0.0003
Molybdenum	<0.05	<0.05
Silver	<0.001	0.001
Zinc	<0.02	0.23
Nitrate + Nitrite as N	<0.03	3.59[a]
Sulfate	<1.0	18
Calcium	11.0	47
Magnesium	4.0	23
Sodium	2.0	48
Potassium	<1.0	17
Chloride	<1.0	5
Fluoride	<0.05	0.23
Total Alkalinity as $CaCO_3$	58.0	203
Bicarbonate as HCO_3	71.0	242
Carbonate as $CaCO_3$	0	25
Total Hardness	40.0	212
Total Dissolved Solids	70.0	191
Field pH	6.2	9.0
Field SC (umhos/cm)	109.0	335.0
Field Eh	+68	+320
Lab pH	7.0	9.0
Lab SC (umhos/cm)	116.0	349.0
Temperature (^oC)	6.5	11.0

* All values are in mg/L unless noted.
a Anomalous value reported from one analysis.
< Values are below the detection limit, and the listed value is the detection limit.

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Two springs were inventoried along Rock Creek in the western part of the study area. One of these springs is seepage flowing from the Heidelberg adit that was observed to flow in the springtime but by summer only standing water was observed in the adit. The other spring flowed at approximately 5 gpm.

REFERENCES

EPA, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029).

Strahler, A.N., 1957. Qualitative Analysis of Watershed Geomorphology. Trans. Am. Geophysical Union, Vol. 38, pp.91i-920.

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SECTION 1.0

Chen-Northern, Inc.

1.0 INTRODUCTION

In September, 1988, Noranda Minerals Corp. purchased the Montana Silver Venture property from U.S. Borax. The property was subsequently renamed the Montana Project by Noranda. During its ownership, U.S. Borax initiated a hydrology baseline investigation to obtain water resources information in the project area south of Libby, Montana.

U.S. Borax initiated its own water quality sampling program on Rock Creek in June, 1986, and on Libby Creek in September, 1987. In April 1988, U.S. Borax contracted with Northern Engineering and Testing, Inc. (now Chen-Northern, Inc.) to continue the baseline investigation for one additional year and obtain water samples on a bimonthly and monthly basis. The entire baseline investigation incorporates sampling, field measurement, and analysis of groundwater and surface water resources in the project area.

The hydrology baseline investigation provides water quality and quantity data to support a mine operating permit application to the Montana Department of State Lands and the U.S. Forest Service. In addition, water resources data will be utilized to support engineering design of ancillary mine facilities, including a tailing disposal site(s).

The hydrology baseline investigation Plan of Study (POS) was developed in conjunction with U.S. Borax, the Montana Department of State Lands (DSL), the U.S. Forest Service, and Chen-Northern. The plan is designed to satisfy requirements of the Montana Metal Mine Reclamation Act (MMRA), the Montana Environmental Policy Act (MEPA), the National Environmental Policy Act (NEPA), and U.S. Forest Service regulations. The approved U.S. Borax Plan of Study was subsequently adopted by Noranda for use in completion of the study. The approved POS hydrology baseline investigation is included in Appendix A.

1.1 SITE DESCRIPTION

Properties associated with the Montana Project are located on the east side of the Cabinet Mountains Wilderness Area, approximately 22 miles south of Libby, Montana, and on Rock Creek, located 3.4 miles southeast of Noxon, Montana (Figures 1-1 and 1-2).

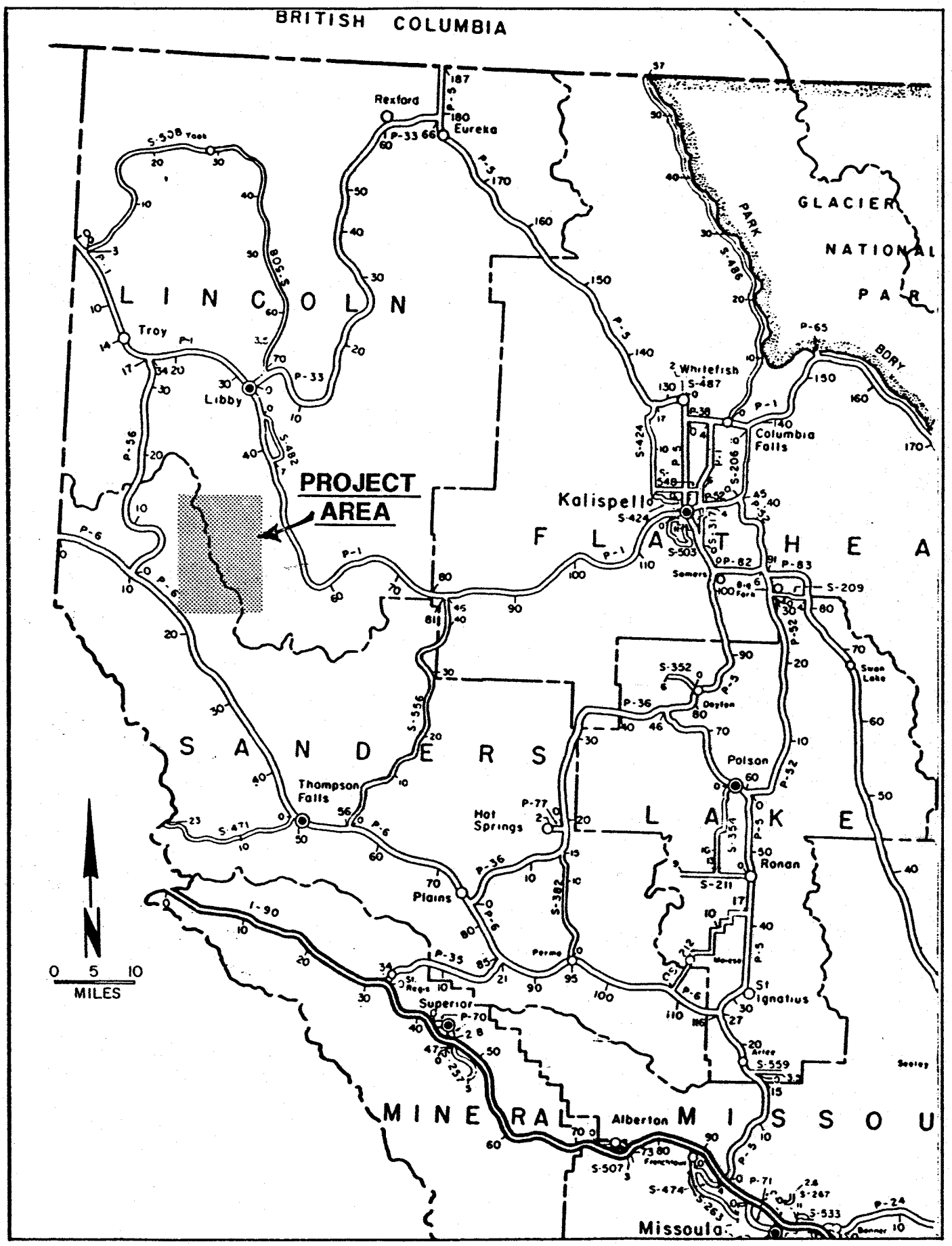
The proposed project involves development of an underground mine and mill complex in Lincoln and Sanders Counties, Montana. The proposed mine is expected to produce a nominal 20,000 tons per day of silver- and copper-bearing ore for a mine life of 16 years. Major features associated with the mine include: mine access and ventilation adits, production adits, a processing plant, tailings disposal site(s), and ancillary mine facilities.

The project site is drained by the East Fork of Rock Creek on the west side of the Cabinet Mountains and by Libby Creek, Ramsey Creek, Poorman Creek, Little Cherry Creek, and Bear Creek on the east side. All creeks on the east side of the project area are tributary to Libby Creek (Figure 1-2).

1.2 PHYSIOGRAPHY/CLIMATOLOGY

The Montana Project area lies within the Northern Rocky Mountain Physiographic Province (Thornbury, 1965). Specifically, the project area is located in a series of north-south trending mountain ranges separated by linear valleys. The mountain ranges are structural in origin and display imbricate thrust faulting.

Previous reconnaissance-level geologic mapping of the region (Alden, 1953; Johns, 1970) depicted regional glaciation. However, recent mapping and photogeologic work indicate that glacial scouring was limited to elevations above 5000 feet in the project area. Ice scoured debris became the source for valley bottom deposits consisting of glaciofluvial, fluvial, colluvial, and glacial lake sediments. Stratigraphic units in the Cabinet Mountains consist of rocks of the Belt Supergroup, including units of the Ravalli Group.



NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana

General Site Map
FIGURE 1-1

Major river systems draining the region include the Kootenai River to the north and the Clark Fork of the Columbia River to the south. Tributary streams in the proposed project area include Ramsey Creek, Poorman Creek, Little Cherry Creek, and Bear Creek, all of which are tributary to Libby Creek. Libby Creek flows northward and is tributary to the Kootenai River at Libby, Montana. The project area also extends to the East Fork Rock Creek, tributary to Rock Creek, which flows southward to Clark Fork of the Columbia River near Noxon, Montana (Figure 1-2).

Elevations in the project area on the west side ranges from 7938 feet at Elephant Peak to approximately 2175 feet at the mouth of Rock Creek near Noxon Rapids Dam, and to approximately 2835 feet at the lowest Libby Creek gaging and sampling site (LB-3000) 12 miles southeast of Libby, Montana. Higher elevations in the area are dominated by glacial cirques and small hanging valleys. Rock Lake is located at 4958 feet at the headwaters of the East Fork of Rock Creek. Terminal moraines were formed by the most recent glaciation in the upper reaches of the tributaries to Libby Creek.

The climate of the region is influenced by Pacific weather systems modified by continental air masses. Precipitation is predominantly in the form of snow during November through March, and rain during April through June. Climate data for the project area are tabulated as outlined in Table 1-1 in Appendix B.

TABLE 1-1

PROJECT AREA CLIMATE DATA CONTAINED IN APPENDIX B FOR LOCATIONS IN LINCOLN AND SANDERS COUNTIES, MONTANA

Data Type	Figure Table No.	Station No.	Location
Station Location Map	Figure B-1	N/A	Project Area
Average Monthly Precipitation	Table B-1	MX12	Poorman Creek
Average Monthly Precipitation	Table B-2	2W/Ranger Station	Trout Creek Ranger Station
Average Monthly Precipitation	Table B-3	Libby 1 NE	Libby Ranger Station
Average Monthly Precipitation	Table B-4	Libby 32 SSE	3 1/2 Mi. S.E. of Project Area
Snow Course Survey	Table B-5	15A12	Upper Poorman Creek
	Table B-6	15A13	Cedar Grove (Lower Poorman Creek)
Evaporation Pan	Table B-7	N/A	Trout Creek Ranger Station
Average Monthly Temperatures	Table B-8	Libby 1 NE	Libby Ranger Station
Potential Evaporation	Table B-9	N/A	Project Area

SECTION 2.0

Chen-Northern, Inc.

2.0 PLAN OF STUDY

2.1 OBJECTIVES

Specific objectives for the hydrologic baseline investigation for the proposed Montana Project are as follows:

- Provide necessary hydrologic information for mine planning, engineering design, operational monitoring program development, and reclamation plan development.

- Collect hydrologic data under an appropriate quality control/quality assurance program such that data collected during the investigation are of known reliability, precision, and accuracy.

- Provide sufficient information for regulatory agencies to prepare an environmental impact statement (EIS). The water resources database must be adequate to make reasonable predictions of the effects of mining in the project area, assess the cumulative effects of the operation in the region, and provide for an assessment of alternative sites for mine facilities, process plants, and ancillary facilities.

- Collect hydrologic baseline data such that a water quality monitoring program can be developed and implemented to adequately detect effects of the mine operations on water quality.

Detailed descriptions of the scope of the baseline investigation are contained in the approved Plan of Study, Collection of Environmental Baseline Data, Montana Silver Venture Project, Lincoln and Sanders Counties, Montana, June, 1988 (Fletcher Associates and U.S. Borax, 1988; Appendix A).

2.2 PROJECT COMPONENTS AND INVESTIGATIVE METHODS

A comprehensive and detailed study has addressed both surface and groundwater resources within the study area. This section of the report contains a brief discussion of methods used in the investigations. Major components of the surface water study include: a literature search for all existing and available historical data pertaining to the study area; establishment of a database to analyze flow and water quality data; calculation of flood peaks for several stream sites using methods developed by Omang and others (1986), including a check of the method by Log-Pearson analysis; floodplain mapping using aerial photography; stilling well construction on a downstream site on Libby Creek for continuous stream gaging; and routine flow measurement at 21 selected sites. Surface water quality sampling procedures, analyzed parameters, and specific detection limits are identified, and techniques for analyzing water quality data are also presented.

Major components of the groundwater investigation also include a literature search and database development for field and groundwater quality data. In addition, an inventory was conducted for wells, springs, and adits within the study area. Methods for geophysical reconnaissance work and details of monitoring well construction are described. Methods for collection of groundwater samples and measurement of static water levels, analyzed parameters, and specific detection limits are also presented. Particular aquifer tests performed on various wells within the study area are described.

2.2.1 Surface Water Methods

2.2.1.1 Literature Review and Data Search

A search and review of existing hydrologic data for the Montana Project study area began with initiation of the baseline study. From this study a

project file of pertinent data and information concerning surface water resources was constructed.

The U.S. Forest Service provided streamflow and water quality data for several streams, including: Rock Creek, Little Cherry Creek, Bear Creek, Libby Creek, Cliff Creek, and outflow from Cliff Lake (Figure 1-2, Appendix D-1).

Baseline data files provided by U.S. Borax and ASARCO were also reviewed for accuracy and relevance. Useful data, including water quality data and surface water station locations, were included. Surface water data provided by the U.S. Forest Service and U.S. Borax, as well as that obtained from ASARCO, contains information on streamflows and water quality in both the Rock Creek (west side) and Libby Creek (east side) drainages.

Streamflow gaging in the project area began as long ago as 1960, although apparently no sites have been gaged continuously over this time span. Most extensive and intensive surface water data have been collected in the area since about 1985 by consultants for ASARCO.

Streamflow measurements and water quality sampling initiated by U.S. Borax, and continued by Chen-Northern for the Montana Project, cover a time span of between 21 months (Libby Creek drainage) and 36 months (Rock Creek drainage).

2.2.1.2 Surface Water Database

A computerized database management system was developed to analyze the surface water quality sampling and flow measurement data. The software "Knowledgeman" facilitates data entry into a customized spreadsheet for presenting raw data. IBM-PC compatible computers were used to enter field data and conditions after each sampling episode, as well as laboratory results upon their receipt. Surface water data were edited for accuracy subsequent to entry into the database. Milliequivalent calculations for

the common cations and anions were generated by the database and compared with those from the laboratory to insure no errors in data transcription had occurred.

Customized "Knowledgeman" software was also used to run the computerized quality assurance/quality control program for both the surface and groundwater sampling data. The quality assurance/quality control program for the investigation is contained in Appendix C.

2.2.1.3 Streamflow and Flood Calculations

Flood calculations were completed for at least one point in each drainage of the study area. The drainages included were: Bear Creek, Little Cherry Creek, Poorman Creek, Ramsey Creek, Libby Creek and Rock Creek (Figure 1-2). Flood peaks were calculated using methods developed by Omang and others (1986). Streamflow characteristics were evaluated for statistical flood peak flows with recurrence intervals of 25, 50, and 100 years. U.S. Geological Survey flow data from gaging sites near or similar to the study area were used in a Log-Pearson frequency analysis (Chow, 1964) as a check on the accuracy of the Omang method.

2.2.1.4 Floodplain Mapping

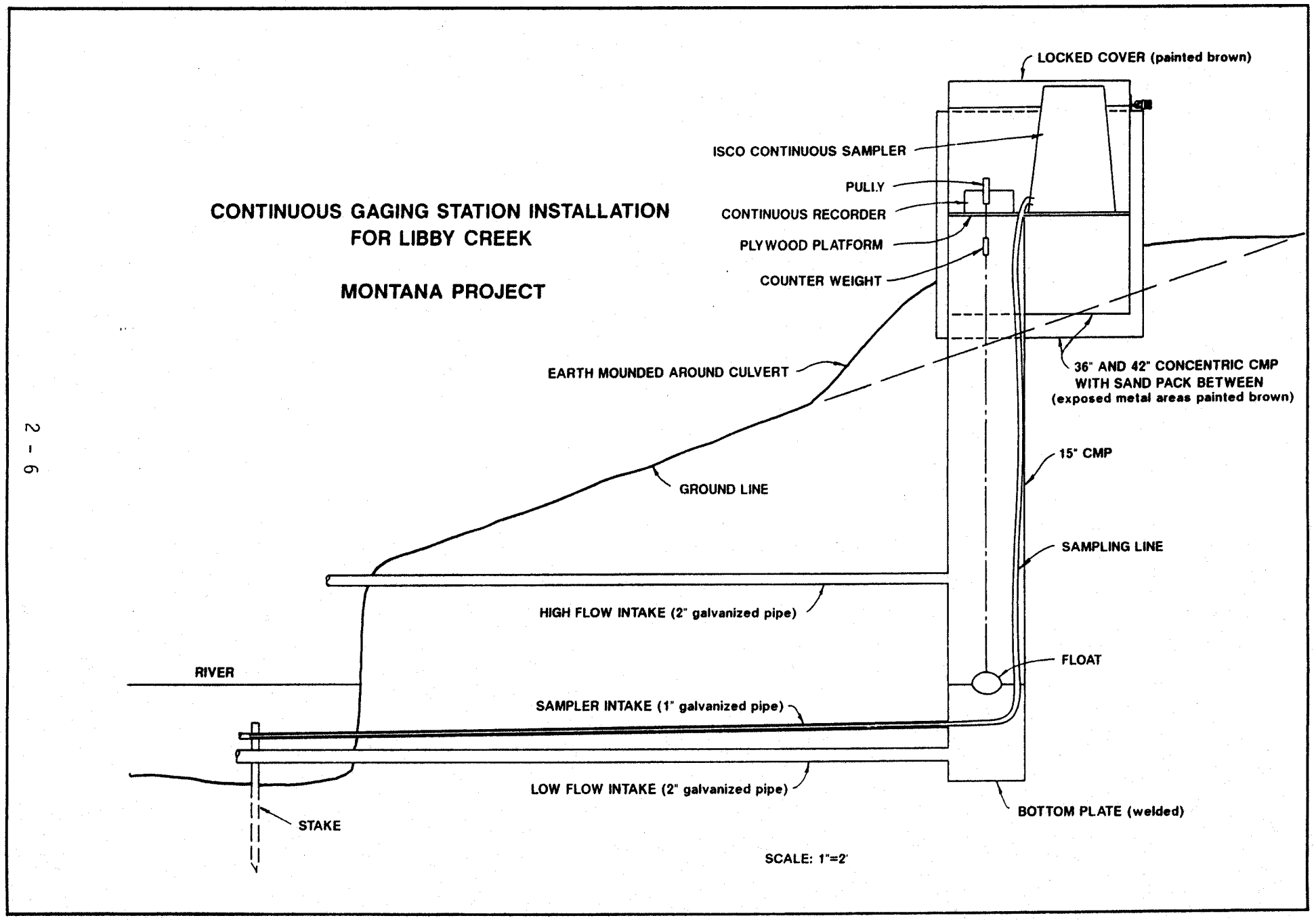
Aerial photography provided by U.S. Borax was used for preliminary hydrogeologic mapping of study area. This was U.S. Department of Agriculture color photography flown in late July and August, 1982, at an approximate scale of 1:12,000 (1 inch = 1000 ft.). Major emphasis was placed on floodplain evaluation and structural or stratigraphic elements having groundwater implications for alternative mill and tailings disposal sites. Areas evaluated by this method are described in Section 3.4 of this report.

2.2.1.5 Gaging Station Construction and Streamflow Measurement

A permanent stream gaging and sampling station was constructed on Libby Creek during June, 1988, in cooperation with the U.S. Forest Service. The station was constructed at sampling site LB-3000, located near the downstream end of the study area (Exhibit I).

A schematic drawing of a typical gaging station installation is presented in Figure 2-1. Water flowing past sampling site LB-3000 is the combined flow from several smaller upstream tributaries. These tributaries were gaged separately to account for the flow at this station. A float and pulley system installed in the stilling well accurately measures changes in stream stage, and stage data are recorded on an OMNIDATA data storage module (dsm). Flow measurements are then compared to stage measurements to create a stage-discharge relationship for the gaging station. In addition, an ISCO continuous sampler was installed at the gaging station and programmed to collect daily sediment (TSS) samples. Construction characteristics of the gaging station (Figure 2-1) generally followed accepted industry norms as adopted from U.S. Geological Survey practices.

Flow measurements were made by Chen-Northern at 21 sites between April and October, 1988, at eight sites for the winter program between November, 1988 and April, 1989, and by U.S. Borax in September, 1987 and July, 1986. As many of U.S. Borax's original streamflow monitoring sites as possible were retained for the present baseline study to correlate data. Streamflow measurements were made by current meter methods consistent with those described by the U.S. Geological Survey.



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MONTANA PROJECT
Lincoln and Sanders Counties, Montana

Continuous Gaging Station Installation
FIGURE 2-1

2.2.1.6 Surface Water Quality Sampling

U.S. Borax initiated water quality sampling on Rock Creek in June, 1986. Surface water sampling was expanded to the Libby Creek drainage with sampling episodes in September, 1987 and February, 1988. In April, 1988, U.S. Borax contracted with Chen-Northern to continue the baseline investigation for surface water quality sampling.

A description of surface water sampling station locations is presented in Table 2-1; these stations are also shown on Exhibit 1. A table of dates of sampling episodes is presented in Table 2-2.

Water quality samples were collected simultaneously with flow measurements at each station. The frequency of sampling was semimonthly during the spring runoff period (April-June, 1988), and monthly during non-runoff flow (July, 1988-April, 1989). Water quality samples were analyzed for parameters presented in Table 2-3. Field measurements of specific conductance (SC), pH, and water temperature were also collected at each site at the time of sampling.

Surface water sample collection and preparation were conducted using methods and practices described in the Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA, 1982).

Chen-Northern has developed a series of Standard Operating Procedures, referred to as NETSOPs. NETSOPs detail specific procedures and methods used in the collection of surface and groundwater baseline data and are followed by all field personnel. These methods are described in detail in Appendix C.

TABLE 2-1
SURFACE WATER SAMPLING LOCATIONS[a]
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

STATION NO.	GAGING STATION LOCATIONS
UPPER ROCK CREEK	
EF 200	Rock Creek Outlet Located at headwaters of Rock Creek at Rock Lake.
EF 300	East Fork of Rock Creek at Third Bridge Located upstream of the third bridge on Rock Creek past the gate, above Rock Creek Meadows.
EF 400	East Fork of Rock Creek at Second Bridge Located at the bridge crossing the East Fork of Rock Creek just below Rock Creek Meadows.
EF 800	East Fork of Rock Creek above Confluence East Fork of Rock Creek about 200 yards above confluence with West Fork (off of USFS RD #2285).
WEST FORK ROCK CREEK	
WF 20	West Fork Rock Creek above Confluence Located upstream of the bridge crossing the West Fork of Rock Creek, on Rock Creek road; the same vicinity as the ASARCO gaging station.
ROCK CREEK (mainstream)	
RC 850	Rock Creek at Bridge below Confluence Located upstream of the bridge on Rock Creek road, just below the confluence of the East Fork and West Fork of Rock Creek.
RC 2000	Rock Creek at Highway 200 Located upstream from the Highway 200 crossing on Rock Creek.
POORMAN CREEK	
PM 500	Poorman Creek at Poorman Road Located at the bridge on Poorman Creek Road. Samples were collected upstream of bridge and flow measurements were taken approximately 70' below bridge at optimum section.
PM 1000	Poorman Creek at USFS Road #6212 Located upstream of culvert, approximately 0.1 mile north of Bear Creek Road junction.

(a) Surface water sampling locations are located on Exhibit I.

TABLE 2-1
SURFACE WATER SAMPLING LOCATIONS
(continued)

STATION NO.	GAGING STATION LOCATIONS
LIBBY CREEK	
LB 100	Libby Creek at Wilderness Boundary Located 1/4 mile past the end of Libby Creek Road, near the wilderness boundary.
LB 200	Libby Creek at Fourth Bridge Located at the bridge crossing Libby Creek on the lower, left ford road approximately 1/3 mile past USFS gate. Samples are collected upstream of bridge and flow measurements are taken downstream at an optimum section.
LB 500	Libby Creek at Howard Lake Bridge Located on Libby Creek at the turnoff to Howard Lake. Samples are collected upstream of bridge and flow measurements are taken downstream at an optimum section.
LB 800	Libby Creek at Second Bridge Located where Libby Creek road crosses Libby Creek at high, concrete decked bridge. Samples are collected upstream of bridge and flow measurements are taken downstream at an optimum section.
LB 2000	Libby Creek above Bear Creek Confluence Directly south of Bear Creek sampling station on Libby Creek. The best access to this site is by wading Bear Creek across to Libby Creek.
LB 3000	Libby Creek at Gage The continuous recorder is located on the west bank of Libby Creek, 0.4 mile up the dirt road turnoff, before the first concrete bridge over Libby Creek.
LITTLE CHERRY CREEK	
LC 100	Little Cherry Creek at Bear Creek Road Located approximately 15 yards upstream from the Bear Creek Road at Little Cherry Creek.
LC 600	Lower Little Cherry Creek From Bear Creek Road, turn onto USFS road #6212, at the north end of Lower Cherry Creek Loop road. Drive 2.6 miles; about 1000' south of Little Cherry Creek culvert, turn east onto logging road, continue 0.4 mile, and turn down on to path, drive approximately 100 yards, sample downstream of old bridge.

TABLE 2-1
SURFACE WATER SAMPLING LOCATIONS
(continued)

STATION NO.	GAGING STATION LOCATIONS
RAMSEY CREEK	
RA 100	Ramsey Creek at Wilderness Boundary Located 1/4 mile past the end of Ramsey Creek road, near the wilderness boundary in swampy, beaver pond area.
RA 200	Ramsey Creek at Upper Bridge Located at the bridge on the lower, left fork road (approximately 3 miles past Poorman Creek road turnoff). Samples are collected upstream of bridge and flow measurements are taken downstream at an optimum section.
RA 600	Ramsey Creek at Libby Creek Road Samples are collected approximately 10 yards upstream of Libby Creek road crossing
BEAR CREEK	
BC 100	Bear Creek Above Libby Creek Located on Bear Creek at mouth, approximately 50 yards above confluence with Libby Creek.

TABLE 2-2

SURFACE WATER QUALITY SAMPLING SCHEDULE

LOCATIONS[a] DRAINAGE	SITE NO.	WATER QUALITY SAMPLING FREQUENCY[b] APRIL-JUNE	JULY-OCTOBER[a]	DECEMBER-APRIL[c]
Upper Rock Creek	EF 200	5	5	
	EF 300	5	5	
	EF 400	5	5	
	EF 800	5	5	
West Fork Rock Creek	WF 20	5	5	
Rock Creek (mainstream)	RC 850	5	5	
	RC 2000	5	5	
Libby Creek	LB 100	5	5	
	LB 200	5	5	
	LB 500	5	5	5
	LB 800	5	5	5
	LB 2000	5	5	
	LB 3000	5	5	5
Ramsey Creek	RA 100	5	5	
	RA 200	5	5	
	RA 600	5	5	5
Poorman Creek	PM 500	5	5	5
	PM 1000	5	5	5
Little Cherry Creek	LC 100	5	5	5
	LC 600	5	5	5
Bear Creek	BC 100	5	5	

(a) Water quality sampling locations shown on Exhibit I.

(b) Actual water quality sampling dates

Chen-Northern, all 1988	
April 27-29	July 18-21
May 9-13	August 15-19
May 23-27	September 12-16
June 6-10	October 17-21
June 20-24	November 28-30

(c) Winter Sampling Program
December 14-16
January 24-27
February 22-23
March 28-31
April 11-14

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TABLE 2-3

SURFACE-WATER QUALITY PARAMETERS [a]
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

FIELD PARAMETERS	COMMON IONS	METALS[b]	OTHERS
	Cations		
pH (standard units)	Ca	Pb	Nitrite and Nitrate as N
Specific Conductivity (SC)	Mg	Cu	Orthophosphate as P
Temperature (^{o}C)	Na	Cr	F
	K	Zn	TDS
	Anions	Cd	TSS
	CO_3	Fe	Turbidity
	HCO_3	Al	Hardness, as $CaCO_3$[c]
	Cl	Mn	Alkalinity, as $CaCO_3$
	SO_4	Hg	Ammonia
		As	Total Kjeldahl Nitrogen as N
		Ag	Total Phosphorous as P
		Mo	

(a) All units are in mg/L unless specified. Oil and Grease were analyzed once for each surface water site to establish baseline conditions.

(b) Samples were collected in the field and analyzed in the laboratory for total recoverable metal concentrations. Total recoverable metals were analyzed in the laboratory using procedures described in EPA 600/4-79-020.

(c) Hardness is calculated from the concentrations of calcium and magnesium in the in the samples by the equation:

$$(Ca\ mg/L)(2.497) + (Mg\ mg/L)\ (4.118) = mg/L\ Hardness\ as\ CaCo_3.$$

Therefore the contribution of calcium to hardness is 2.497 and contribution of magnesium to hardness is 4.118 the sum of the contributions is hardness as $CaCo_3$. If the measurable concentrations of either or both concentrations of calcium or magnesium are less than detection, the value for hardness will also be less than the calculated value. If both Ca and Mg are <1 mg/L, the calculated value for hardness <6.

Because of changing field conditions, problems encountered with low target detection limits, and contamination associated with field blanks, slight modifications to the decontamination procedures in selected NETSOPs (Appendix C) were made. The following changes to standard procedures were implemented:

1. Low flow conditions associated with late-summer flow made it difficult to use the DH-48 sampler as described in NETSOP-03 (Appendix C). Low flows inhibit use of the DH-48 sampler as designed. Because of this, a decontaminated glass sample bottle (the same bottle used in the DH-48 sampling device) was used to collect samples directly from the stream. Both equal discharge interval (EDI) and grab samples were collected using this technique. The advantage in using this technique over the DH-48 was that samples could be collected in much shallower water and under much lower velocities.

2. Contamination problems in blank samples may have occurred for nitrate + nitrite as N from rinses done with nitric acid for metals. Nitric acid was used to rinse polyethylene sample collection containers between sites (NETSOP-11; Appendix C). To eliminate possible contamination in the form of increased levels of nitrogen, separate poly bottles are now used to collect metals and nutrients samples. Sample bottles for total recoverable metals are rinsed once with nitric acid, three times with deionized water, and three times with stream water before the sample is collected in that bottle. Nutrients, common ions, and total suspended solids are collected from a larger bottle that has been rinsed three times with deionized water and three times with stream water before the sample is collected.

3. Because of recurring problems with cadmium contamination in bottle and cross-contamination blanks, a substitute for

laboratory quality deionized water was added to the sample train in the September and October field episodes. Ultra-pure grade deionized water was purchased through Northwest Scientific in Billings, Montana. Ultra-pure is higher grade deionized water used to determine if contamination was coming from carboys, bottles, or the water source itself. Experiments indicate that cadmium is, and will be, detected at concentrations of 0.0002 to 0.0008 mg/L as background noise. These amounts are probably due to a combination of factors, including sample bottles, deionized water, and carboys.

4. The ISCO automated sampler installed at LB-3000 (Figure 2-1) has collected daily samples for total suspended solids (TSS) since late May, 1988. Low TSS values were reported during early and mid-July. During early September, 1988, the arm of the ISCO sampler used to collect the TSS sample was only partially submerged. Because of this, samples were being collected in water which was too shallow for proper operation of the device, and sample containers were partially filled with stream bottom material rather than suspended sediment. After September 9, 1988, streamflows were too low to collect any sample suitable for analysis. The sampler was removed in mid-October because operation is not possible in freezing temperatures.

2.2.1.7 Data Analysis

Throughout the surface water investigation, data collected from field activities and generated from other tasks were evaluated, checked for accuracy and completeness, and entered into the computerized database.

Water quality analytical data received from the laboratory were reviewed prior to entry into the project database. Once entered, data were again edited for accuracy and then analyzed by the QA/QC computer program for each sampling episode. The QA/QC program utilized on this project is described in Appendix C and is summarized below.

Sample documentation and control procedures used for tracking samples from time of collection through laboratory reporting of analytical results are specified in the QA/QC plan (Appendix C). Also included are examples of chain-of-custody and analysis request forms, types of information to be entered on standardized field forms, sample custody responsibilities, and sample shipping procedures.

Data validation, reduction and reporting procedures are also detailed in the QA/QC plan (Appendix C). The main points addressed are: comparabillity of baseline water quality samples to existing data; completeness of samples collected as a calculated percent value; representativeness of actual site conditions using field blanks; accuracy statements generated from blind field standards; and precision statements based on relative percent differences for each pair of replicate samples. The final data summary report includes these data validation statements. Results of data validation are reported in Appendix G4 for surface water.

A customized computer program was created to analyze surface and groundwater quality data. The program was used to evaluate water quality data by comparing values for bottle blanks and cross-contamination blanks

to detection limits for each parameter, and blind field standard with predetermined values set by the manufacturer. Those natural sample values failing to meet predetermined criteria are "flagged" by the QA/QC computer program.

Reported natural sample values are flagged by code for each parameter when either a cross-contamination blank or bottle blank analysis exceeds a particular parameter's detection limit, or when a blind field standard falls outside of the predicted range set by the manufacturer. Field duplicate values are flagged when the calculated range is not met. Ranges for field duplicate sample values were determined by Chen-Northern's laboratory; and are contained in the QA/QC plan (Appendix C).

Comparison of data are made only between natural samples and QA/QC samples from the same sampling episode. In order to submit a true blind field standard, blind field standard concentrations and compositions vary for each sampling episode; values for each specific blind field standard are entered into the database prior to running the QA/QC program for that particular sampling episode.

Flagged data are again reviewed and checked against laboratory results. The computer program enables early recognition of suspect data, at which time samples may be reanalyzed by the laboratory if they have not passed their expiration dates. Less than four percent of the natural samples submitted to the laboratory necessitated reanalysis.

The QA/QC computer program also calculated the mean and standard deviation for all parameters at each sampling location. A thorough review of all data allowed selection of those data used in the statistical analysis. The following criteria were used to determine data eligibility for use in the statistics program:

1. All "unflagged" data were used in the statistical analysis. Questionable ("flagged") data are not used in these statistical analyses, but remain in the database.

2. If the blind field standard was out of agreement with the predetermined range set by the manufacturer, data for that sampling run and parameter are not used.

3. If values for either the bottle-blank or cross-contamination blank are above detection limits, natural sample data are "flagged" for that particular parameter. Flagged data are then considered for use on an individual basis. If natural sample values are at least one and one-half times the reported blank value, and above the detection limit, the natural sample value was used in statistical analysis. If the reported natural sample value is near the detection limit, however, the sample value is not used.

4. Samples with reported values below the detection limit for a particular parameter, and which have no other "flags" associated with it, are calculated statistically using the value of that detection limit.

5. Duplicate samples are not included in statistical calculations.

6. The total number of samples used to statistically analyze each parameter is dependent on the results of QA/QC review and is contained in Appendices G4 and J2.

2.2.2 Groundwater Methods

Groundwater investigative methods for some tasks are similar to those of the surface water investigation. Reference is made to the surface water section (2.2.1) when appropriate.

2.2.2.1 Literature Review and Data Search

The search and review of existing groundwater hydrologic data was performed using methods and sources described in Section 2.2.1.1. Relatively little existing groundwater information is available for the project area.

2.2.2.2 Groundwater Database

Customized "Knowledgeman" software was used to construct both the surface water and groundwater database, and similar quality control/quality assurance procedures were developed for automatic checking of data.

2.2.2.3 Aerial Photogeologic Mapping

The mapping used for the photogeologic interpretation is described under Floodplain Mapping (Section 2.2.1.4). A geomorphic landform analysis was conducted as part of the aerial photogeologic mapping task. The photogeologic work was supported by checks of interpretations against observed geologic conditions in the field.

2.2.2.4 Well, Spring and Adit Inventory

An inventory of wells, springs and adits in the vicinity of proposed mine production and alternative tailing impoundment sites was conducted during early summer, 1988. Well locations were determined from information obtained from Montana Department of Natural Resources and Conservation.

The spring and adit inventory on the Rock Creek drainage was restricted to a one mile distance downstream from Rock Lake (Exhibit 1). Potential locations for springs were identified on U.S. Geological Survey maps and then field checked.

2.2.2.5 Geophysical Reconnaissance

A near-surface geophysical reconnaissance of the Poorman and Little Cherry alternative tailing impoundment sites was conducted for the dual purpose of characterizing subsurface hydrologic conditions and to provide information pertaining to lithologic variation prior to the installation of monitoring wells. The direct current resistivity method was selected to determine water table and bedrock configurations. Due to excessive topographic irregularities and the presence of thick timber, the resistivity survey was carried out through electrical soundings. Forty locations were selected that permitted straight field arrays over flat terrain. Random orientations resulted in arrays being set both parallel and perpendicular to suspected hydrogeological features.

The geophysical survey was made using a Bison Model 2390 signal enhancement earth resistivity system, coupled with a Wenner "A" spacing kit out to 300 meters (984 ft.). Sounding curves were plotted from observed readings and interpreted qualitatively on the basis of inflections in apparent resistivities thought to coincide with depth to bedrock or to saturated conditions (water table) in unconsolidated materials.

2.2.2.6 Monitoring Well Construction

Eight groundwater monitoring wells were constructed for the investigation, one of which is a dual-completion monitoring well. Four other wells were planned (Appendix A), but were not constructed in accordance with the field hydrogeologist's decision that they would provide redundant information.

Groundwater monitoring wells were drilled using an air rotary drill rig. Wells were completed using threaded, factory-slotted PVC casing installed to the desired depth with clean 10/20 mesh silica sand surrounding the slotted interval. Bentonite pellet seals were installed above the sandpack and volclay bentonite grout tremmied into the well anulus until grout reached several feet below the ground surface. Steel casing was withdrawn from the bore as the sand pack and bentonite seals were installed. Steel

surface casing was installed around all wells after completion, and a locking well cap and lock were placed on the steel casing. Figure 2-2 shows construction details typical of the monitoring wells installed.

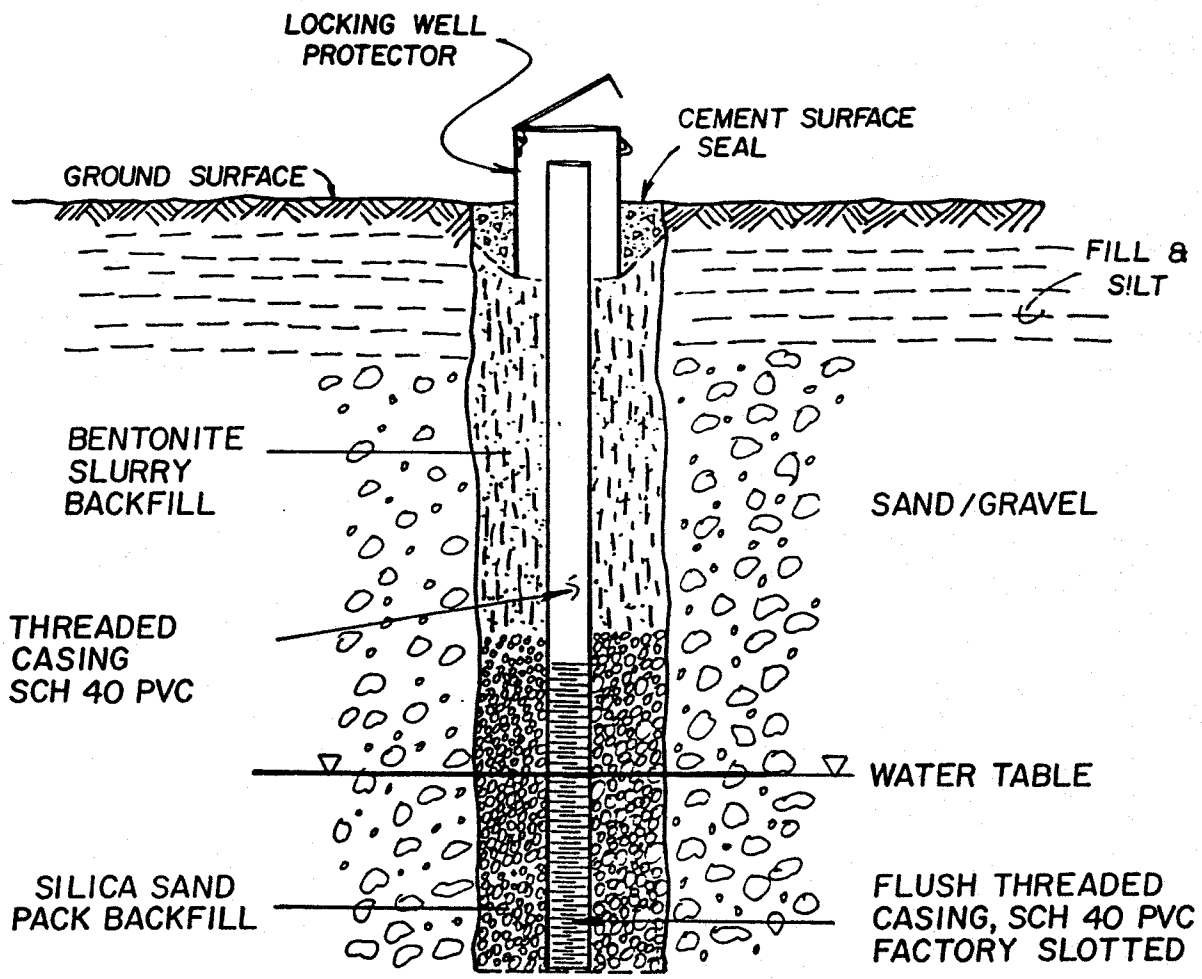
2.2.2.7 Static Water Level Monitoring

Static water levels in all wells were measured shortly after well drilling and completion. Subsequent measurements were scheduled quarterly over a year's time in order to determine seasonal fluctuations. These measurements were made in August and October, 1988 and in January and March, 1989. Static water levels were measured using M-Scope electrical tapes, as described in NETSOP-16 (Appendix C).

2.2.2.8 Groundwater Quality Sampling

Groundwater quality sampling was undertaken in August and October, 1988, and January and March, 1989 at the same time as the quarterly groundwater level measurements. Groundwater sampling locations, Exhibit I, are presented in Table 2-4, and the sampling schedule is presented in Table 2-5. Field measurements included pH, specific conductance (SC), temperature, and redox potential (Eh). Water quality parameters are listed in Table 2-6.

Sample collection methods are detailed in NETSOP-15 (Appendix C). Sample preparation was conducted according to the methods of the Handbook for Sampling and Sample Preservation of Water and Waste water (EPA,1982).



Schematic Showing Typical Monitoring Well Construction

FIGURE 2-2

NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana

TABLE 2-4

GROUNDWATER WELL AND SPRING SAMPLING LOCATIONS [a]
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

WELL NO.	WELL LOCATION
PM-2	Located on USFS Road #278V, 0.3 miles off Bear Creek Road
PM-3	Located off south end of Little Cherry Creek Loop Road, 0.3 miles on unmarked road, south of USFS Road #6212M, at west end of gravel pit.
PM-5	Located off Little Cherry Creek Loop Road on USFS Road #6212H. Well is located 0.6 miles past locked gate across from the weather station.
PLCM-6	On Little Cherry Creek Loop Road approximately 100 yards south of turnoff to USFS Road #6212H (Dual Completed Well).
LCTM-8	From Bear Creek Road, turn onto north end of Little Cherry Creek Loop Road Drive 2.6 miles, turn onto logging road. Well is located .55 miles from turn-off, approximately 200 yards beyond path to LC-600.
LCM-9	Off Bear Creek Road onto the north end of Little Cherry Loop Road, travel 1.2 miles turn onto dirt road. The well is located approximately 1 mile in old clear-cut past the excavated pit area.
LCM-10	Located 100 yards south of Little Cherry Creek on Bear Creek Road.
LCM-11	Located about one-half mile north of Little Cherry Creek on Bear Creek Road.
SP-04	Located one-quarter mile west of surface water station LB-200, along logging road.
SP-05	Located 200 yards southeast of the Old Heidelberg Mine Adit along the mining trail to Rock Lake
(a)	Well and spring locations on shown on Exhibit I.

TABLE 2-5

GROUNDWATER QUALITY SAMPLING SCHEDULE
MONTANA PROJECT
SAMPLING LOCATIONS IN LINCOLN
AND SANDERS COUNTIES, MONTANA

Locations[a]	Sampling Frequency and Dates			
	August 1988	October 1988	January 1989	March 1989
Poorman Drainage				
Well No. PM-2	1	1	1	1
PM-3	1	1	1	1
PM-5	1	1	0(c)	1
PLCM-6 (dual)	2	2	1(c)	2
Little Cherry Drainage				
Well No. LCTM-8	1	0(b)	1	1
LCM-9	1	1	1	1
LCM-10	1	1	1	1
LCM-11	1	1	1	1
Springs and Adits				
Spring No. SP-04	1	1	No spring samples collected	
SP-05	1	1		
Quality Control				
Bottle Blank	1	1	1	1
Cross-contamination Blank	1	1	1	1
Blind Field Standard	1	1	1	1
Duplicate	1	1	1	1
TOTAL SAMPLES COLLECTED	15	14	11	13

(a) Well and spring locations are shown on Exhibit 1.

(b) Pump failure. No sample collected.

(c) Artesian well plugs frozen. No sample collected.

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TABLE 2-6

GROUNDWATER QUALITY PARAMETERS[a]
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

FIELD PARAMETERS	COMMON IONS	METALS[b]	OTHERS
	Cations	Pb	F
pH (s.u.)	Ca	Cu	TDS
Specific Conductivity(SC)	Mg	Cr	Hardness, as $CaCO_3$[c]
Temperature(^oC)	Na	Zn	Alkalinity, as $CaCO_3$
Eh	K	Cd	Nitrite and Nitrate as N
	Anions	Fe	
	CO_3	Al	
	HCO_3	Mn	
	Cl	Hg	
	SO_4	As	
		Ag	
		Mo	

(a) All units are in mg/L unless otherwise specified

(b) Dissolved metals were analyzed in the laboratory using procedures described in EPA 600/4-79-020.

(c) Hardness is calculated from the concentrations of calcium and magnesium in samples by the equation:

$$(Ca\ mg/L)(2.497) + mg\ mg/L)\ (4.118) = mg/L\ Hardness\ as\ CaCo_3.$$

Therefore the contribution of calcium to hardness is 2.497 and contribution of magnesium to hardness is 4.118 the sum of the contributions is hardness as $CaCo_3$. If the measurable concentrations of either or both concentrations of calcium or magnesium are less than detection, the value for hardness will also be less than the calculated value. If both Ca + mg are <1 mg/L, the calculated value for hardness <6.

2.2.2.9 Aquifer Testing

All groundwater monitoring wells in the Poorman and Little Cherry alternative tailing impoundment areas were used for aquifer tests. The two wells completed with 4-inch PVC (PM-2, with its observation well, and LCTM-8; Exhibits I and III), were pump tested. Well PM-5 and the deep completion of well PLCM-6 (Exhibits I and III) were flow and/or shut-in tested, because the wells flow at the surface. All other wells were slug tested. Hydraulic characteristics were determined from the different types of tests. As a result, aquifer characterization is considered to be representative of conditions present at both sites. General procedures for aquifer testing are described in NETSOP-18 (Appendix C).

2.2.2.10 Data Analysis

Data entry and quality assurance/quality control procedures were conducted in a manner similar to the surface water quality analysis (Section 2.2.1.7). Statistical analysis of the natural and quality control sample results have not been performed because of the very limited size of the current data set. Qualitative precision and accuracy statements and data representativeness, completeness, and comparability are presented in Appendix J-2. Trilinear diagrams were plotted for the analytical results to allow comparison of water types.

SECTION 3.0

Chen-Northern, Inc.

3.0 SURFACE WATER: RESULTS AND ANALYSIS

3.1 WATERSHED DESCRIPTIONS AND SIZES

The Montana Project hydrologic baseline study is being conducted in the Kaniksu and Kootenai National Forests, in northwest Montana (Figure 1-2). The baseline study area is located in the Rock Creek drainage on the west flank of the Cabinet Mountain range and in the Libby Creek drainage on the eastern flank of the mountains. The headwaters of these two drainages lie in steep, rocky terrain. On the divide separating these two drainages, Elephant Peak rises to an elevation of 7938 feet above sea level. Rock Creek discharges into the Clark Fork River downstream of Noxon Rapids Dam after falling to an elevation of 2175 feet. Libby Creek discharges into the Kootenai River at Libby at an elevation of 2066 feet.

Snowmelt is the main source of water for area streams. Snowmelt recharges ponds, lakes, and springs in the headwaters of many of the streams, as well as creates significant runoff. High streamflow events have historically occurred during spring snowmelt and during winter months when warming conditions, combined with a precipitation event, produce melting snow and runoff.

3.1.1 Libby Creek Drainage

Libby Creek is a large, second-order stream (Strahler, 1957) which drains an area of approximately 68 square miles from a point just upstream of where it crosses Highway 2 (Figure 1-2). Four tributaries flow into Libby Creek and are included as part of the baseline study: Ramsey Creek, Poorman Creek, Little Cherry Creek, and Bear Creek (Exhibit 1-A).

Libby Creek is a perennial stream with headwaters in a steep, glacially carved basin. Its total length from headwaters to the Kootenai River is approximately 28 miles. Streambed material consists of boulders, cobbles, and pebbles comprised of Precambrian Belt argillite. The stream is primarily restricted to a narrow channel flowing intermittently through

bedrock canyons and erodible valley fill, and glacio-fluvial and lacustrine sediments with occasional aggraded floodplains. Bar material primarily composed of cobbles and boulders is deposited several feet above the present channel upstream of its confluence with Bear Creek. The banks are lined with a variety of conifers and shrubs; several avalanche runout paths cross the stream. Libby Creek generally gains water from its small alluvial groundwater system, and streamflow increases downstream.

Ramsey Creek is located north of and is tributary to Libby Creek (Exhibit 1-A). Dividing these two drainages is a bedrock ridge. Ramsey Creek originates in a steep, glacial basin at an elevation of 4440 feet and travels 5.3 miles to its confluence with Libby Creek at 3425 feet. Ramsey Creek drains an area of approximately 6.5 square miles. The upper drainage contains a large marsh and small lake named Ramsey Lake. Bed material in this marsh consists of pebbles, sands, and clays, and a large quantity of decaying organic matter is present. Water in the marsh flows as a series of pools, meandering through grassy, wet meadows. A short distance downstream, the stream becomes similar to Libby Creek, flowing through a series of narrow bedrock canyons and moraine material with heavily forested banks. Older clear-cuts are present along the north side of the drainage basin. A recent clear-cut completed during the fall of 1988, is present downstream from monitoring site of RA-200 (Exhibit 1-A).

Poorman Creek is a perennial stream located to the north of Ramsey Creek (Exhibit 1-A). Its headwaters also originate in a steep, glacial basin at an elevation of approximately 5400 feet. Poorman Creek converges with Libby Creek 5.3 miles downstream at an elevation of 3315 feet; the drainage area is approximately 6.1 square miles. Poorman Creek flows in a narrow, relatively straight channel with heavily forested banks. Streambed material consists of boulders, cobbles, pebbles, and sand. Poorman Creek maintains a constant flow, neither gaining nor losing appreciable flow during base flow conditions.

Little Cherry Creek flows through rolling, timbered hills on the lower slopes of the Cabinet range (Exhibit 1-A). Originating at an elevation near 4000 feet, the stream maintains perennial flow until its convergence

2.8 miles downstream with Libby Creek at 3100 feet elevation. The drainage size is approximately 1.9 square miles. Bed material ranges from boulders to sand and silt. Banks on the upper reach are forested; little underbrush exists due to the heavy forest canopy. Downstream, banks are collapsed, and small shrubs and forbs have reclaimed previously logged areas.

Bear Creek is the northern-most tributary to Libby Creek in the study area and lies to the north of Little Cherry Creek (Figure 1-2). Bear Creek originates at an elevation of 4600 feet and flows for 8.5 miles before converging with Libby Creek at an elevation of 3050 feet. Drainage size is about 15.0 square miles. Upper Bear Creek contains a large marsh consisting largely of tall grasses. Flowing springs were observed in the area during the spring inventory conducted in June, 1988. Most of these springs had dried up by July, 1988. The main stem of the stream is fed by runoff and several small drainages. Narrowing toward the mouth, the stream incises into lake bed silts with small exposed bedrock outcrops. Streambed material is composed primarily of boulders and cobbles which have formed a large channel bar at the mouth. The banks are vegetated by large conifers, shrubs, and grasses.

3.1.2 Rock Creek Drainage

Rock Creek is formed by the convergence of the East and West Forks of Rock Creek (Exhibit 1-B). The two forks drain an area of approximately 33 square miles.

The headwaters of the East Fork of Rock Creek are formed by Rock Lake at an elevation of 4958 feet. Enclosed within a very steep basin, the lake is fed by snowmelt during the spring and summer. Avalanches descend onto the lake in the winter, and several slide paths are visible along bare, high rock walls surrounding the lake. The East Fork of Rock Creek receives flow from the lake and from nearby springs. In the upper reaches, the stream is quite steep, flowing over one waterfall approximately 60 feet high. Incised into a bedrock canyon, large boulders and cobbles comprise the majority of the bed material.

The Heidelberg Mine (Exhibit 1-B) is located in this steep portion of the basin. The main adit lies adjacent to the highest waterfall where hydropower was generated for use during past mining operations. The midsection of the upper East Fork drainage then meanders across a bench through a series of marshes and small ponds filled with fallen trees and grasses. This area is known as Rock Creek Meadows.

At the confluence of East Fork Rock Creek with the West Fork of Rock Creek, the main stem of Rock Creek is formed (Exhibit 1-B). Immediately downstream of this convergence, water is lost to the alluvial groundwater system. The lowest reaches of Rock Creek are typically dry during summer and fall months. Streambed materials consists of large boulders and cobbles. Forest understory is very thick in the Rock Creek drainage with large trees lining the banks.

Flow in the West Fork of Rock Creek (Exhibit 1-B) is intermittent with numerous small springs providing flow above its confluence with East Fork. In the upper reaches, the stream is incised into a bedrock canyon; at one point the stream flows over a waterfall approximately 30 feet high. Boulders and cobbles comprise the majority of the bed material.

3.1.3 Wilderness Area Conditions

The portion of the main Cabinet Mountains between major east- and west-side drainages consist of rugged topography and bare bedrock exposures that lie within the Cabinet Mountains Wilderness. The ore body to be mined is present at depth beneath the Wilderness, and access to it is planned via drifts whose portals lie outside the wilderness boundary.

High mountain glaciation has created cirques within the Cabinet Mountains that act as collection basins for runoff and snowmelt. Rock Lake and Saint Paul Lake (Exhibit 1-B) are the primary lakes overlying the proposed mining activity. They are located at the 4700-4950 ft. levels, and serve as headwater collection points for Rock Creek and the East Fork Bull River, respectively. Other lakes, such as Libby Lakes and Isabella Lake (Exhibit

1-B), are more intermittent and lie within closed depressions along the crest of the Cabinet Mountains. These lesser lakes are without association with any well-defined surface drainage system.

Snowmelt is the main source of recharge for major streams of the area. The high, steep, and barren terrain of the wilderness area serves as headwater areas for the Rock Creek and Libby Creek drainages being studied. The wilderness can therefore be characterized as a recharge area, with precipitation contributing to both surface and groundwater systems. Some interchange between surface water and groundwater can be expected within the wilderness, for in the absence of distinct surface channels both snowmelt and direct precipitation must either infiltrate or run off by overland flow.

Surface flows and water quality data of the Cabinet Wilderness are characterized as part of the two watersheds that drain the flanks of the Cabinet Mountains. Thus, they are not discussed as separate entities.

3.2 STREAMFLOW

Streamflow monitoring was initiated by U.S. Borax during June, 1986 on Rock Creek, and in September, 1987 on Libby Creek. Locations of streamflow gaging sites in the present investigation are shown on Exhibit I and are the same locations selected by U.S. Borax. Streamflow measurements conducted by Chen-Northern occurred twice-monthly during the rising limb of the hydrograph (April-June) and monthly for the period July, 1988-April, 1989. Staff and crest stage gages were installed at all sites proposed in the original Plan of Study (Appendix A). Surface water sampling sites, monitoring frequency, and stream gage type and locations are shown in Table 3-1. Stream discharge measurements collected from April, 1988 through April, 1989 are presented in Table 3-2.

TABLE 3-1

SURFACE WATER GAGING SCHEDULE[a]

LOCATIONS		STREAMFLOW MONITORING FREQUENCY			
DRAINAGE	SITE NO.	APRIL-JUNE	JULY-NOVEMBER	DECEMBER-APRIL	GAGE TYPE[b]
Upper Rock Creek	EF 200	5	5	*	N/I
	EF 300	5	5	*	staff/crest
	EF 400	5	5	*	staff/crest
	EF 800	5	5	*	staff/crest
West Fork Rock Creek	WF 20	5	5	*	staff/crest
Rock Creek (mainstream)	RC 850	5	5	*	staff/crest
	RC 2000	5	5	*	staff/crest
Libby Creek	LB 100	5	5	*	N/I
	LB 200	5	5	*	staff/crest
	LB 500	5	5	5	staff/crest
	LB 800	5	5	5	staff/crest
	LB 2000	5	5	*	staff/crest
	LB 3000	5	5	5	staff/crest/ISCO
Ramsey Creek	RA 100	5	5	*	N/I
	RA 200	5	5	*	staff/crest
	RA 600	5	5	5	staff/crest
Poorman Creek	PM 500	5	5	5	N/I
	PM 1000	5	5	5	staff/crest
Little Cherry Creek	LC 100	5	5	5	N/I
	LC 600	5	5	5	staff/crest
Bear Creek	BC 100	5	5	*	staff/crest

(a) Gaging station locations shown on Exhibit I.

(b) N/I indicates no stream gages installed.

* Site excluded from winter sampling program.

REVISED -- JUNE 23, 1989

TABLE 3-2

STREAM DISCHARGE MEASUREMENTS (CFS)
APRIL, 1988 THROUGH APRIL, 1989
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

LOCATION[a]	04/27-29	05/09-13	05/23-27	06/06-10	06/20-24	07/18-22	08/15-19	09/12-16	10/17-21	11/29-12/02[b]	12/14-16	01/24-27	02/22-23	03/28-31	04/11-14
EF-200	27.3	37.8	35.6	29.9	23.0	4.4	0.3	0	6.1						
EF-300	38.0	47.8	39.5	12.4[c]	22.0	5.6	0.5	0.4	6.5						
EF-400	#128	149.0	96.1	--	44.4	13.6	3.2	1.9	21.3						
EF-800	--	--	--	--	105.3	16.1	1.6	0.3	26.4						
WF-20	17.4	21.7	14.0	13.0	6.2	2.0	0.2	0	0						
RC-850	--	125	299.6	153.3	83.4	14.3	128.0	0	24.2						
RC-2000	--	--	--	--	69.2	7.6	0	0	0						
LB-100	15.4	48.9	40.6	50.7	41.1	13.5	5.3	1.1	32.9						
LB-200	19.9	73.6	53.6	48.7	44.3	10.3	3.3	2.1	55.5						
LB-500	42.4	84.4	65.6	57.8	39.2	12.5	2.7	1.0	59.9	16.0	17.4	5.9	3.8	16.2	42.0
LB-800	75.9	173.8	157.8	91.7	39.5	24.4	7.2	2.9	84.5	35.7	31.1	15.1	12.9	33.5	108.4
LB-2000	95.3	204.0	190.6	128.5	113.7	25.7	9.8	5.8	110.0						
LB-3000	155.0	--	319.2	154.2	139.4	43.9	16.4	10.6	160.1	69.2	93.2	68.5	--[d]	155.2	270.1
RA-100	5.4	51.5	60.9	19.3	33.5	10.2	3.2	0.9	13.2						
RA-200	9.0	62.8	44.0	29.1	43.1	8.2	3.2	1.1	13.9						
RA-600	22.3	66.0	46.7	33.3	26.9	8.6	4.5	1.4	22.0	15.6	14.4	6.0	--[d]	13.3	37.2
PM-500	19.6	53.0	37.1	22.3	14.1	6.1	1.4	0.5	11.0	5.8	7.2	5.3	1.6	4.5	20.5
PM-1000	20.4	54.8	40.1	26.7	16.7	3.9	1.2	0.7	12.3	8.0	7.3	5.8	--[d]	8.0	31.8
LC-100	2.8	2.4	1.6	1.8	0.5	0.2 B	0.8 B	0.1	1.2	0.6	0.9	0.5	--[d]	1.3	6.7
LC-600	2.6	1.8	2.1	1.0	0.4	0.4	0.3	0.2	1.8	1.1	0.9	2.9	--[d]	9.0	13.2
BC-100	55.6	98.1	78.4	56.7	36.0	9.9	4.4	1.8	52.9						

(a) Station locations are shown on Exhibit I.
(b) Initiation of Winter Sampling Program.
(c) Probable equipment malfunction
(d) Thick ice accumulation over stream. No discharge measurement taken.
* All flows measured with pygmy or AA flow meters unless otherwise indicated.
* All values presented are in cubic feet per second.
B Bucket and stop watch
\# Estimated due to equipment malfunction during discharge measurement.
-- Flow could not be gaged due to high water conditions.

3.2.1 Measured Streamflows

Streamflow monitoring was initiated on Rock Creek by U.S. Borax during July, 1986. In 1987, the monitoring program was expanded to include sites on Libby, Ramsey, Little Cherry, Poorman Creek, and Bear Creek. Streamflow on Rock Creek has also been monitored by the U.S. Forest Service and ASARCO since November, 1984. Historic flow data are presented in Appendix D1.

A permanent stage recorder station was installed in a stilling well on the lower reach of Libby Creek at site LB-3000 (Exhibit I-A). Measurements by a continuous recorder were made using a float, pulley, and potentiometer system which records water level changes in the stilling well on an OMNIDATA data storage module (dsm). Continuous measurements of stream level were collected in the stilling well from May, 1988, through April, 1989. No measurements were collected in September, 1988 when the stilling well and Libby Creek lost communication because of the configuration of the channel and low stream-flows. Stream levels dropped below the level of intake pipes, and stream stage could not be recorded at flows less than about 10 cfs (Figure 2-1).

In October, 1988, streams rose in response to significant precipitation in the region. Changes in Libby Creek were recorded on the dsm and are presented in Appendix E. Also, when the stilling well site was visited for sample collection on October 17, 1988, the staff gage was found knocked over. Intense rains in the preceding 48 hour period probably sent debris downstream which dislodged the staff gage. A second gage was installed in the same location during the November sampling episode. The gage was washed out, again, in January, 1989. The DSM continued to operate during winter months; through January, February and early March when Libby Creek and the stilling well intake pipes were frozen.

From spring runoff and early summer flows in 1988, a stage-discharge relationship for site LB-3000 (Exhibit 1-A) was produced from staff gage readings and instantaneous discharge measurements taken during sampling episodes. This relationship and others are presented as rating curves in Appendix F.

Static water levels[1] measured by the continuous recording device in the stilling well were used in conjunction with stage-discharge relationships to calculate continuous discharge and stage measurements. Equations were developed to relate measured discharge with stream stage and stream stage with static water level. A best-fit line for the stilling well water level-stage relationship was constructed using instantaneous stream discharge measurements. The best-fit quadratic equation for the stilling well water level-stage relation is:

$$STAGE = -38.50 - 10.21\ (STATIC) - 0.6500\ (STATIC)^2.$$

A static water level-discharge relation was also developed using instantaneous flow measurements. The best fit exponential function for this relation, using data collected through mid-October, 1988 is:

$$Q = e^{[3.427\ (STATIC) + 34.72]}.$$

Further development of the equation has been precluded by staff gage wash outs. Appendix E contains actual static water levels measured by the continuous recorder, calculated discharge values, and calculated stage readings for the staff gage at site LB-3000 (Exhibit 1-A).

High flows on Libby Creek and Rock Creek precluded safe flow measurement at some stations during spring runoff in 1988 because of excessive water depth and high velocities. Actual measurements were made using a bridge board where applicable, but some stations could not be measured until water levels dropped. The 1988 summer was one of the driest on record. By late

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[1] Static water levels refer to measurements made in the stilling well by two methods: the continuous float recorder, and by steel tape during on-site sampling visits. Stream stage measurements are read directly from the staff gage located in the stream adjacent to the intake pipes of the stilling well (See Figure 2-1).

July, flow at many stream gaging locations was so low as to be difficult to measure. Site RC-2000, Rock Creek at Highway 200 (Exhibit 1-B), was dry in August, although this reach of the stream historically has intermittent flow.

Staff gages and crest stage gages were read during routine flow measurement episodes. Crest stage gages were not wetted during the spring and summer of 1988, however, because of low flows. In October, a significant precipitation event occurring over an approximate 48 hour a period, resulting levels to where several crest-stage gages were wetted and water levels in the stilling well at site LB-3000 rose higher than those recorded during spring runoff. The mathematical relationship formulated using instantaneous discharge measurements collected during previous monthly sampling episodes was applied to static water levels recorded by the data storage module (dsm) in October. Calculated discharges were extremely large for lower Libby Creek, and the data are suspect.

3.2.2 Streamflow and Flood Characterization

Flood peaks for 100, 50, and 25 year recurrence intervals were calculated for several sites on streams within the study area using methods developed by Omang and others (1986) and a Log-Pearson Type III analysis. Table 3-3 presents flood peaks calculated using the Omang method and Log-Pearson analyses.

Equations used in the Omang method are specifically developed for Montana. The predictive equations calculate selected floods peaks based on the following basin characteristics: drainage basin area, mean annual precipitation, and a geographic factor developed for northwest Montana.

TABLE 3-3

FLOOD PEAK ESTIMATES FOR SITES WITHIN THE STUDY AREA
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

NAME[a]	LOCATION	BASIN AREA MILE^2	DISCHARGE (cfs) CALCULATED USING OMANG AND OTHERS (1986)			DISCHARGE (cfs) CALCULATED USING LOG-PEARSON TYPE III ANALYSIS		
			100 YEAR	50 YEAR	25 YEAR	100 YEAR	50 YEAR	25 YEAR
BC-100	Bear Creek	15.0	622	538	476	1918	1319	859
EF-400	East Fork Rock Creek	6.3	599	472	457	1371	822	482
LB-200	Libby Creek	5.5	416	355	312	1325	772	439
LB-800	Libby Creek	20.8	947	827	740	2517	1653	1060
LB-3000	Libby Creek at Gage	63.4	1840	1637	1487	5692	3571	2167
LC-600	Little Cherry	2.2	78	64	53	1049	502	234
PM-1000	Poorman Creek	5.6	431	368	324	1331	778	444
RA-200	Ramsey Creek	3.3	325	275	240	1163	607	309

Based on methods described in Omang and others (1986)

(a) Station locations are shown on Exhibit I.

Drainage areas were measured using a compensating polar planimeter. Mean annual precipitation was mapped by scale from a map of the Average Annual Precipitation for Montana, prepared by the USDA - Soil Conservation Service and was calculated for use in the equation using the weighted average of measured values from each drainage basin at each site. A geographic factor for western Montana was calculated by Omang and others for use in the equation and was constant for all sites.

To provide a second estimate of flood peaks, a Log-Pearson Type III analysis was used to quantify flood estimates using yearly peak flow data and four nearby USGS gaging stations. Gaging stations on Granite Creek, Flower Creek, and Shaughnessey Creek are within 12 miles of the study area. These streams exhibit similar flow conditions and have comparable drainage areas as streams within the study area. Prospect Creek, near Thompson Falls, Montana, drains an area of 182 square miles and is included because of its larger drainage size and longer period of record. An identical period of record was used to calculate Log-Pearson values as was used in Omang method predictions.

Table 3-4 summarizes flood probability calculations completed by Omang and others (1986) and Chen-Northern's Log Pearson Type III analysis. Chen-Northern's Log-Pearson analyses are similar to the Omang calculations. ASARCO also completed a Log-Pearson Type III analysis for Prospect Creek near Thompson Falls, Montana, and these data are also presented in Table 3-4. It should be noted that ASARCO did not include data from the Prospect Creek gaging station from 1957-1960, but did include data from 1984. This period of record varies from that used in Omang and Chen-Northern's calculations.

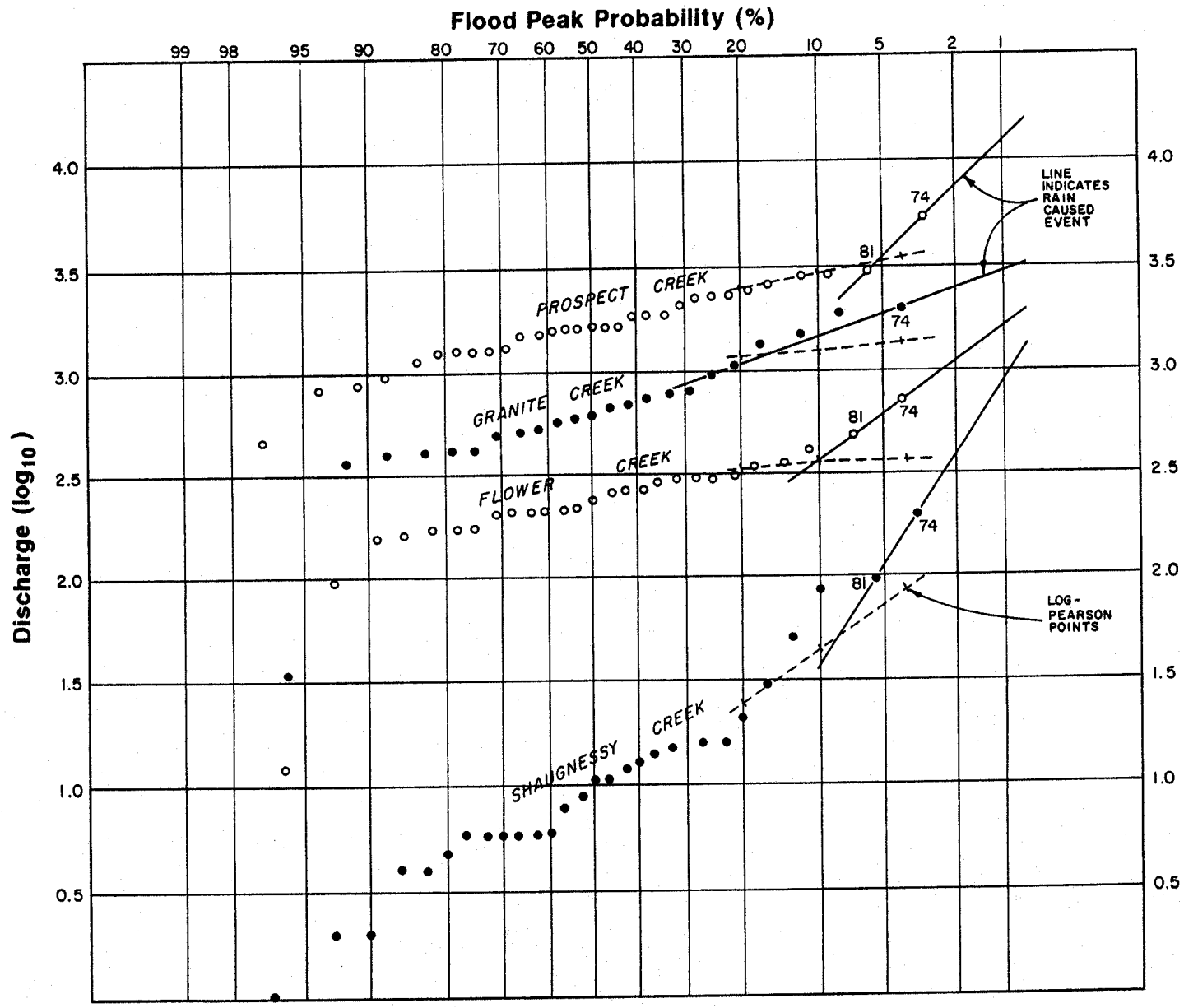
Yearly peak flow data from the four USGS gaging stations were plotted on probability paper for the period of record through 1986. Log-Pearson points, as calculated by Chen-Northern for 100, 50, and 25 year recurrence intervals, were plotted on the same graph. Figure 3-1 graphically presents the Log-Pearson predictive flood peaks and the USGS peak flow data.

TABLE 3-4

FLOOD PEAK ESTIMATES AT FOUR USGS GAGING STATIONS
USING THE OMANG AND LOG-PEARSON METHODS
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

USGS GAGING STATION	PERIOD OF RECORD	DRAINAGE BASIN AREA (mi^2)	OMANG et al. (1986) DISCHARGE (cfs)			CHEN-NORTHERN LOG-PEARSON TYPE III ANALYSIS DISCHARGE (cfs)			MAXIMUM OF RECORD
			100 YR	50 YR	25 YR	100 YR	50 YR	25 YR	
Prospect Creek	1956-1983	182	4460	4000	3550	4484*	4096*	3682*	5490
	27 years								
Granite Creek	1933, 1937-1944 1948, 1954 1959-1969, 1974	23.6	1870	1610	1370	1416	1402	1377	2000
	23 years								
Flower Creek	1960-1983	11.1	592	528	465	361	361	360	709
	24 years								
Shaughnessey Creek	1959-1983	1.16	171	124	87	231	154	99	200
	25 years								

* ASARCO Log-Pearson Type III predicted flows are 5159, 4313, and 3835 cfs for the 100, 50, and 25 yr. recurrence intervals, respectively for the same gaging station, but a different period of record.



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MONTANA PROJECT
Lincoln and Sanders Counties, Montana

Yearly Peak Flow for Four USGS Gaging Stations
FIGURE 3-1

In January, 1974, and again in January, 1981, two significant rain-caused precipitation events occurred. As depicted on Figure 3-1, the Log-Pearson analysis fails to recognize these atypical freak, rain-on-snow storms and inadequately predicts less frequent flood peaks. Omang and others (1986) recognizes this phenomenon for northwest Montana but not the western region where Libby is located. Curve determination is complicated by the few extreme floods caused by winter rain within a population of smaller floods caused by snowmelt or snowmelt mixed with rain.

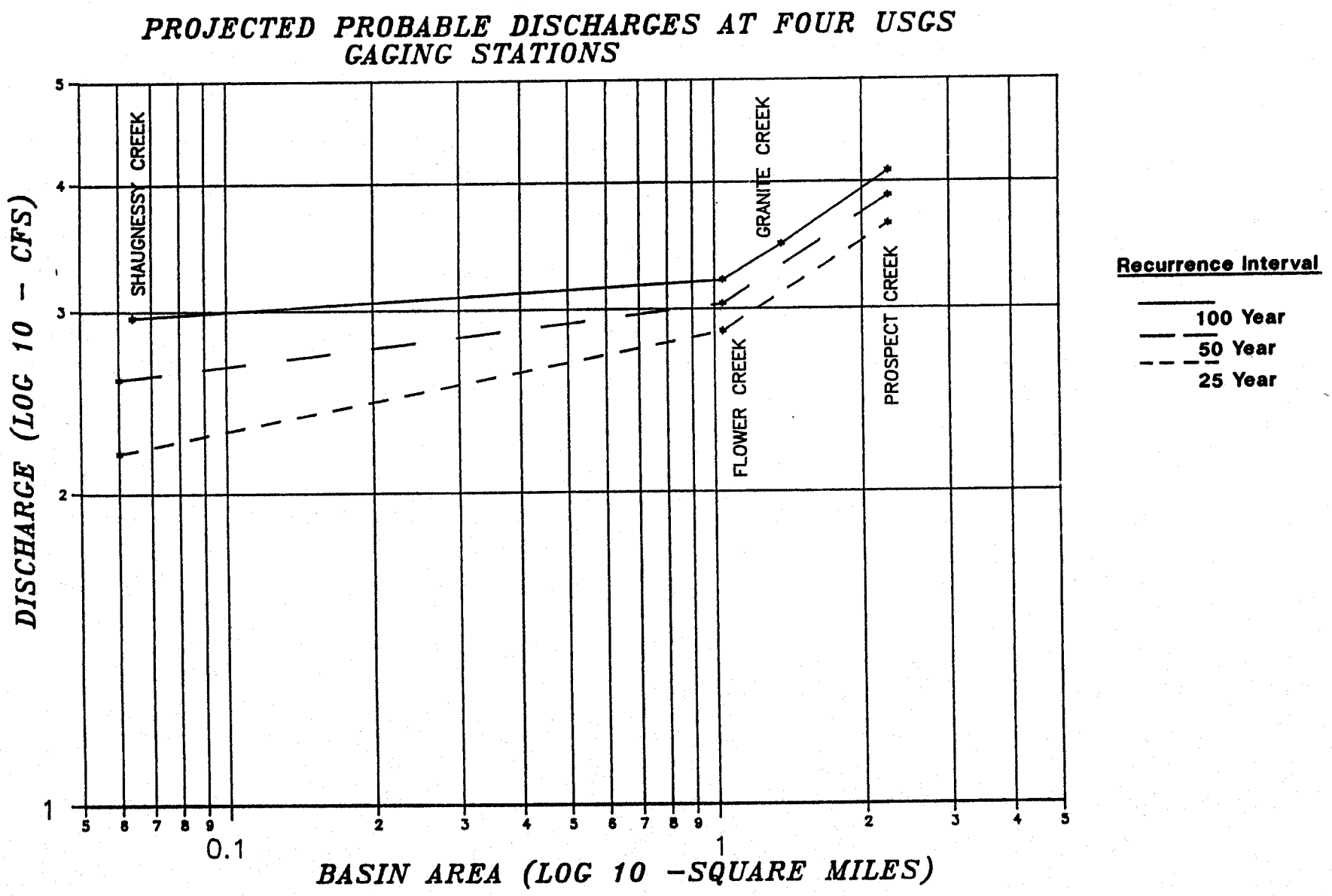
To account for the rare, winter flood peaks, an alternative predictive method was used. As suggested above, the mid-winter rain on snow peaks, if considered independently of the more typical floods, can be used to predict the 100, 50, and 25 year recurrence. A more accurate curve can be drawn by dividing the curve into two components: a steep line determined by rain-on-snow floods, and a less steep curve determined by snowmelt floods.

As presented in Figure 3-1, the line connecting the floods of 1974 and 1981 is extrapolated for each of the four USGS gaging sites to intercept the 1%, 2% and 4% probability of recurrence. From these intercepts, the log of the discharge is read from Figure 3-1 and then plotted against the log of the basin area in Figure 3-2. Flood peaks were obtained from Figure 3-2 by calculating the slope for the two sets of lines for the 100, 50, and 25 year peaks and then calculating discharge by

$$\text{Log } Q = \text{slope (log basin area)} + \text{(y-intercept)}$$

From this equation, the discharge for a particular basin area can be calculated based on mixed-population analysis. Discharge values for selected sites within the study area are presented in Table 3-3.

Predicted discharges using the mixed population analysis are similar to 25-year values predicted by the Omang method (Table 3-4). This is expected because the period of record for the four USGS gaging stations is approximately 24 years. The 50-year mixed population values are also larger than Omang calculations by approximately 100% (Table 3-4). 100-year



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MONTANA PROJECT
Lincoln and Sanders Counties, Montana

Projected Probable Discharges at Four USGS Gaging Stations
FIGURE 3-2

mixed population values are generally much larger than Omang values, but may represent an upper boundary for flood discharges while the Omang values may represent lower boundary estimates.

3.3 CHANNEL STABILITY CHARACTERIZATION

Table 3-5 presents information on each surface water monitoring site, including: bankfull width, mean channel-bed cobble size, percent vegetative cover on the banks, and other general comments. Mean cobble size data were collected using methods described by Dunne and Leopold (1978).

To give an indication of the expected channel stability under various flows, two methods of estimating material transport in the channel were applied to the data. The methods are: (1) an American Society of Civil Engineerings (ASCE) cobble entrainment formula and (2) permissible velocity data for design of channels. The results of these approaches are given below.

The ASCE formula (ASCE, 1977, p. 534) is intended to estimate the flow velocity that will lift and move rock in a channel. It is intended as a design tool to size revetment protection for dams and relates the size of revetment material to the flow velocity needed to entrain the material in the flow. The relationship is:

$$W = \frac{(4.1 \times 10^{-5} \quad G_s \; V^6)}{((G_s - 1)^3 \quad \cos^3 \; S)}$$

where: G_s = specific gravity of the stone

W = the weight of the stone in pounds

S = the angle of bed surface from horizontal

V = the velocity in feet per second

TABLE 3-5
STREAM DESCRIPTION
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

Station No.	Bankfull Width (ft.)	Bed Material Distribution (ft)	Bank Vegetation Percent Coverage		Comments
EF-200	20	0.10 - 1.30 mean = 0.35	90%	Shrubs, forbs, alder	Lake outlet smooth flow
EF-300	22	0.08 - 0.63 mean = 0.46	95%	Alder, ferns, grass, spruce and fir	Pool-drop with small water stalls. Several very large boulders on banks.
EF-400	31	0.7- 1.42 mean = 0.43	95%	Moss and lichen, larch, spruce, devils club	Pool-drop at sample site, continuous riffle below. Several large boulders on banks.
EF-800	54	0.07 - 0.44 mean = 0.23	95%	Moss and lichen on very large boulders, ferns,very large cedar, spruce	Gravel bar adjacent to stream extends 20' X 100' on left bank large in stream bar upstream bar upstream of site.
WF-20	19	0.11 - 0.51 mean = 0.22	100%	Alder, grass, fern, spruce, cedar	Continuous riffle
RC-850	52	0.85 - 0.07 mean = 0.32	90%	Ferns, shrubs, cedars, shrubs	Continuous riffle
RC-2000	33	0.10 - 0.73 mean = 0.32	95%	Grasses and shrubs, cedars	Continuous riffle
LB-100	~21 (variable)	0.09 - 0.64 mean = 0.25	100%	Grasses, shrubs, forbs, spruce	Pool-drop ratio 3:1. Several large slabs in stream channel.
LB-200	25	0.10 - 0.80 mean = 0.32	100%	Shrubs, forbs, alder, willow	Continuous riffle
LB-500	37	0.10 - 1.23 mean = 0.54	100%	Spruce, alders, grasses	Continuous riffle, numerous scattered rocks.
LB-800	36	0.05 - 2.35 mean = 0.49	100%	Spruce, cedar with medium understory, alder and grasses	80% continuous riffle, with some drops and pools.
LB-2000	58	0.05 - 1.10 mean = 0.35	100%	Spruce, cedar, alder, medium understory	Continuous riffle (one pool @ gage 120' long).
RA-100	27	sand, silt, clay and organic fines	100%	Tall grasses, alders	Slow, smooth, meandering, log jams causing pools.
RA-200	45	0.06 - 0.73 mean = 0.22	80%	Large cedar, hemlock and spruce, minor alder and berry ferns, minor grasses	Continuous riffle, below bridge, pool drop above bridge.
RA-600	27	0.06 - 3.81 mean = 0.67	95%	Predominantly alder with some spruce, low brush and grasses	Small drops and pools with riffles.
PM-500	29	0.06 - 3.00 mean = 0.61	100%	Spruce, alder, cedar, low bushes, thins with distance from bank	Very small drop and pool with continuous riffle.

TABLE 3-5
STREAM DESCRIPTION
(continued)

Station No.	Bankfull Width (ft.)	Bed Material Distribution (ft)	Bank Vegetation Percent Coverage		Comments
PM-1000	28	0.04 - 1.20 mean = 0.34	80%	Spruce, cedar, alder, low underbrush	Continuous riffle with 40% small drops and pools.
LC-100	8	0.04 - 0.85 mean = 0.25	60%	Cedar, hemlock, ferns, thimble berry	
LC-600	14	0.02 - 0.34 mean = 0.13	85%	Pine, spruce, alder, small underbrush, grasses	Small pools, riffles.
BC-100	38	0.15 - 1.70 mean - 0.55	90%	Alder, grasses	Continuous riffle.

Note: Station prefixes refer to station location as follows:

EF - East Fork of Rock Creek
WF - West Fork of Rock Creek
RC - Rock Creek
LB - Libby Creek
RA - Ramsey Creek
PM - Poorman Creek
LC - Little Cherry Creek
BC - Bear Creek

Rearranged, the equation is:

$$V^6 = \frac{(W (G_s - 1)^3 \cos^3 S)}{(4.1 \times 10^{-5} \quad G_s)}$$

Calculations were made to estimate the velocities required to move the mean-size cobbles for two stream reaches in the study area.

1) On upper Libby Creek, between sites LB-100 and LB-200 (Exhibit I), where W = 4.02 pounds (assuming rock diameter equals 0.29 feet); G_s = 165 pounds per cubic foot (assuming rock density approximating quartz and feldspar); and S = 3° (assuming a slope of .06 ft/ft), then:

   V = 37.3 ft/sec

2) On Poorman Creek, between sites PM-500 and PM-1000 (Exhibit I), where W = 19.41 pounds (assuming a rock diameter of 0.49 feet), then:

   V = 48.2 ft/sec

Obviously, these velocities are much greater than may be reasonably expected in the stream channels on the project site. However, it should be remembered that the ASCE formula estimates the flow velocity

to "entrain" a rock in the flow; not just cause impending motion. Therefore, channel scour would begin before reaching these flow velocities.

The permissible velocity approach is used in the design of channels with potentially erodible bottoms. It is intended to give designers "the greatest mean velocity that will not cause erosion of the channel body" (Chow, 1959,. p. 165). Based on data compiled by Fortier and Scoby (Chow, 1959, p. 165) the "Maximum Permissible Velocity" for a "coarse gravel" bottom is 4.00 fps and that for "cobbles" is 5.00 fps.

Applying the above information to a natural channel leads to the conclusion that flow velocities of 4-5 fps are likely to initiate movement in the coarse fraction of the bedload; however channel scour should require higher flow velocities.

3.4 FLOODPLAIN MAPPING

Both floodplains and low-lying areas such as low terraces and footslopes having high potential for flooding were delineated on aerial photography provided by U.S. Borax. Flat-floored, marshy meadows (lake remnants).

created by glacial morainal damming in upper reaches of major drainages were also outlined. These areas are shown on Exhibit II.

Floodplain development in area drainages has been limited by the degradational character of area streams. Only Libby Creek has developed a floodplain of any significance. Between Bear Creek and the mountain front above Howard Creek there is a section of Libby Creek which flows through a relatively low-lying, trough-like area. This segment is characterized as aggradational with lateral erosion and accretion occurring periodically in association with overall regional downcutting. The low-lying area is interpreted to have been the site of a glaciofluvial lake that provided the temporary base level necessary for local departure from overall regional degradation. To a lesser extent, lower portions of Bear Creek also show evidence of similar aggredational behavior, but post-glacial downcutting has resulted in almost complete removal of both floodplain deposits and earlier lakebed sediments.

Areas mapped as floodplain are gravel and cobble-choked streambed segments devoid of significant vegetation. These areas are readily visible on air photos due to extensive reworking of streambed materials during local 1980-1981 flooding. Other low-lying areas mapped as low terraces and footslopes tend to support short-term vegetation and have high potential for future overbank flooding.

3.5 SURFACE WATER QUALITY

Water quality samples were collected in accordance with procedures identified in the Plan of Study (Fletcher Associates and U.S. Borax, 1988). A total of 15 surface water sampling episodes were completed through April, 1989. In conjunction with prior sampling in the study area, surface water sampling has been taking place for over two years. The sampling locations are identical to streamflow monitoring sites as shown on Exhibit I.

Tabulated water quality data collected during spring, summer, and fall months for 1988 appear in Appendix G1. Water quality samples have been collected and analyzed for the complete list of parameters shown on Table 2-3. Detection limits utilized for the first sampling episode were subsequently changed for three parameters: ammonia, total suspended solids, and nitrate+nitrite as N, because negotiations concerning target detection limits were ongoing when the first sampling episode took place. The current detection limits presented in the QA/QC program, Appendix C, are those agreed upon by Noranda, Montana Department of State Lands, and the U.S. Forest Service.

Surface water quality samples from all sites were analyzed for oil and grease during the first two sampling episodes in April and May, 1988. Oil and grease was detected in an initial bottle blank, which led to questions concerning the presence of oil and grease in natural waters. A third confirmation sample was collected in September at those sites which contained oil and grease in either of the first two sample runs (Table 3-6). Oil and grease samples from the third sampling episode were initially analyzed using standard procedures. Those samples showing detectable amounts of oil and grease underwent additional analyses. This process splits the total oil and grease into two fractions: mineral oils consisting of petroleum hydrocarbons; and vegetable oils containing natural vegetable oils and animals greases.

TABLE 3-6

OIL AND GREASE VALUES FOR SEPTEMBER SAMPLING

MONTANA PROJECT

LINCOLN AND SANDERS COUNTIES, MONTANA

STATION NO.[a]	AMOUNT OF OIL AND GREASE[b] DETECTED USING STANDARD ANALYTICAL METHODS (mg/L)	AMOUNT OF OIL AND GREASE[c] REMAINING AFTER EXTRACTION WITH SILICA GEL (mg/L)
LB-200	<1.0	NA
LB-500	<1.0	NA
LB-800	1.0	<1.0
LB-2000	<1.0	NA
LB-3000	2.2	<1.0
RA-100	<1.0	NA
RA-200	1.6	1.3
PM-1000	1.4	<1.0
BC-100	<1.0	NA

NA - Not analyzed because initial analysis reported less than 1.0 mg/L.
(a) Stations are shown on Exhibit I. (b) Mineral oil including petroleum.
(c) Vegetable oil.

The analysis involves passing the sample over a silica gel filter. Vegetable oils pass through the gel, whereas mineral oils are trapped. A sample collected at site RA-200 on upper Ramsey Creek (Exhibit 1-A) was the only sample with a detectable amount of vegetable oil. LB-3000 and LB-800 on Libby Creek, and PM-1000 on Poorman Creek (Exhibit 1-A) contained detectable amounts of mineral oil, indicating petroleum hydrocarbons were present at these sites. These results may be explained by the proximity of these sites to frequently traveled roads, although a more precise explanation is lacking.

Nitrate + nitrite as N concentrations ranged from <0.01 mg/L to 2.0 mg/L. Problems occurred on some sampling runs when QC blanks were reported above method detection limits. Nitrate contamination of these blanks is possible from one or both of two sources: deionized water used during sampling, or poor decontamination procedures. In the first case, deionized water begins to deteriorate immediately after processing. Nitrogen-fixing bacteria or algae can increase nitrogen concentrations in deionized water used to prepare the QC sample blanks. In the second case, a 10% nitric acid solution is used to decontaminate all field equipment used for sample collection. A small amount of residual acid remaining on equipment surfaces can contaminate QC samples and contaminate natural samples with measurable nitrate. This is believed to have occurred during the first sample episode in April, 1988. As discussed in Section 2.0, the nitric acid rinse procedure was changed to eliminate sample contamination potentially caused by nitric acid.

The contrast in values of nitrate + nitrite as N is the most significant difference between Noranda and ASARCO water quality data. ASARCO values ranged from <0.02 to 12.0 mg/L during spring sampling in 1985 and 1986. It is difficult to compare these values because sample contamination is possible or suspected in both investigations.

Cadmium occurred in both natural samples and QC blanks from the onset of the Montana Project study. Concentrations in natural samples have consistently been less than 0.005 mg/L; however, blanks have shown values in the range of 0.0001 to 0.005 mg/L. Numerous experiments were conducted to determine the source of such low-level cadmium contamination in QC blanks. An initial experiment suggested that cadmium is leached from 5-gallon carboys used to ship deionized water from the laboratory. To minimize or correct this source of cadmium contamination, sample bottles used for total recoverable metals were rinsed once with nitric acid solution by the Chen-Northern laboratory, and carboys were rinsed with two acid solutions before filling with deionized water. This procedure began in October, 1988.

ASARCO also detected trace amounts of cadmium in quality control blanks at approximately the same levels which the Montana Project has experienced, 0.0003 to 0.0006 mg/L. In general, however, reported metals values are very low, with detectable amounts at or near the respective method detection limits for both ASARCO and the Montana Project.

The USFS and ASARCO have also collected water quality data from several locations within the Montana Project area. Data collected by these organizations are presented in Appendix D2. A comparative analysis of ASARCO and Montana Project surface water data indicates that four sites (Table 3-7) in common between the ASARCO and Montana Project investigations are located on the East Fork, West Fork, and main stem of Rock Creek (Exhibit 1-B). ASARCO data collected during snowmelt and spring runoff in 1985 and 1986 were compared with Montana Project data at the same sites for 1988.

Common ion values are plotted for the four common sites on a trilinear diagram (Figure 3-3). Slight variations in water quality occur between Montana Project and ASARCO sample data from year to year. ASARCO data indicate predominantly calcium-magnesium bicarbonate waters, whereas Montana Project data indicate mixed-cation bicarbonate waters. In general, common ion values are very low at all sites, regardless of which

TABLE 3-7

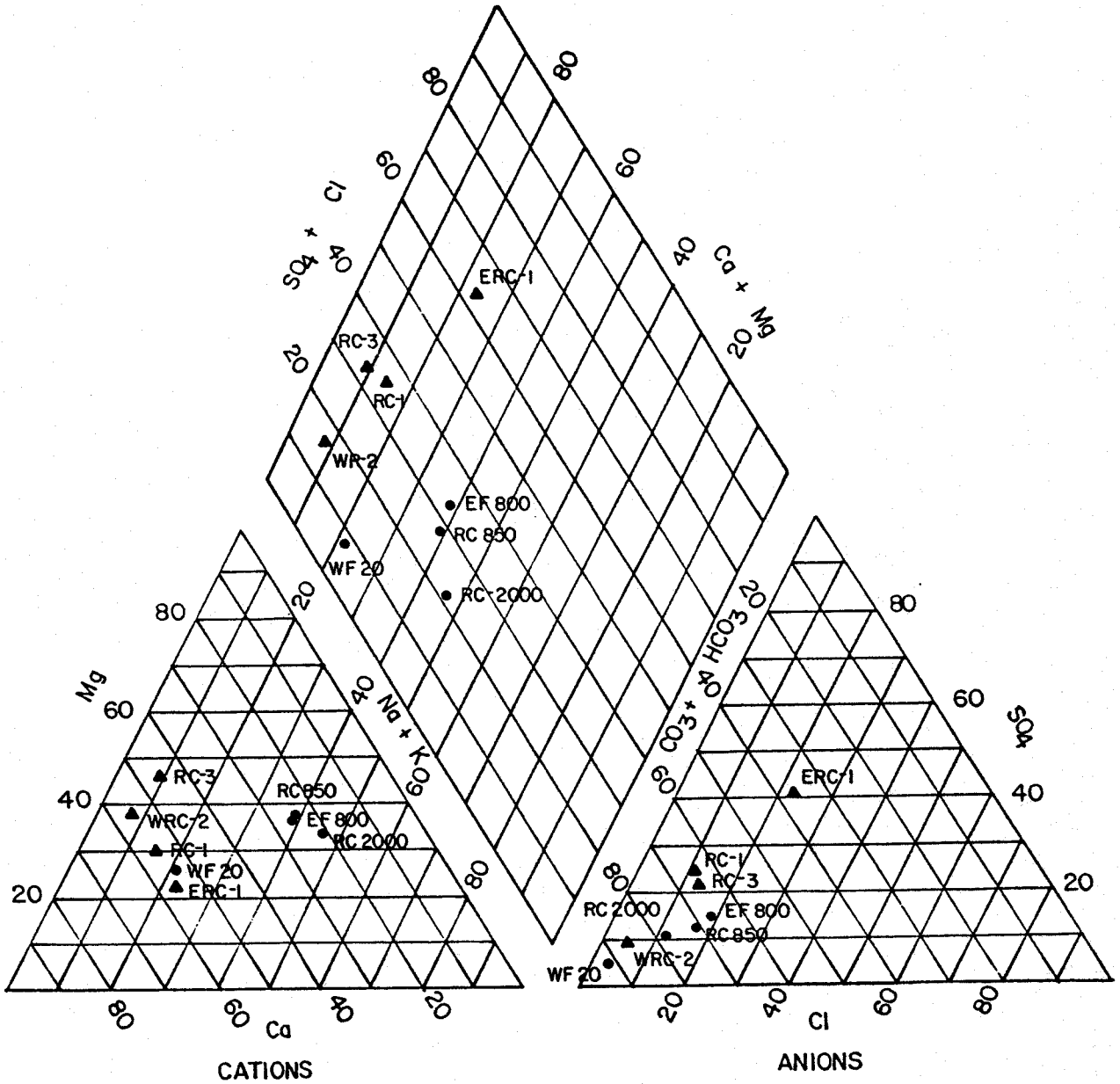
MONTANA PROJECT AND ASARCO SITES IN COMMON IN THE ROCK CREEK DRAINAGE MONTANA PROJECT LINCOLN AND SANDERS, COUNTIES, MONTANA

Chen-Northern	Flow (cfs) Spring 1988	ASARCO	Range of Flow (cfs) 1985 1986
RC-2000	69.2[a]	RC-1	41.6-194
RC-850	125-299	RC-3	57-217
EF-800	--[b]	ERC-1	42-174[c]
WF-20	13-21.7	WRC-2	17.6-44

a Gaged one time only

b Could not wade during the period of comparison

c Calculated by indirect methods



▲ ASARCO Data (1985-86)
● NORANDA Data (1988)

Trilinear Plot of MONTANA PROJECT and ASARCO Data for Sites in Common on Rock Creek

FIGURE 3-3

organization, ASARCO or Montana Project, sponsored the data collection. It is notable that slight variations in reported concentrations can be observed graphically, as shown on Figure 3-3, but because the absolute values of these concentrations are so low, the actual significance of these differences is believed to be negligible.

Hardness for ASARCO samples range from a high of 37 mg/L on the West Fork to 1.0 mg/L on the East Fork of Rock Creek. Montana Project reported hardness values ranging from 26 mg/L on the West Fork to <6 mg/L on the East Fork of Rock Creek. ASARCO's alkalinity values are also slightly higher, ranging from <1.0 mg/L to 36 mg/L, and 4 mg/L to 36 mg/L for Montana Project samples.

In summary, much of the data collected by ASARCO are comparable to those collected for the Montana Project, with two significant caveats: first, ASARCO's method detection limit, especially for metals, are typically much higher than those used for the Montana Project; and second, the time periods of the field investigations are obviously dissimilar.

U.S. Borax began collection of water quality data at six sites on Rock Creek in June, 1986. Surface water samples were analyzed for common ions, nutrients, and total recoverable metals. The comparability of US Borax and Montana Project data is discussed in Appendix G4. Surface water quality sampling continued on Rock Creek in June, 1987, and expanded to included sites on Libby, Little Cherry, Ramsey, and Poorman Creeks in September, 1987 and February, 1988. Actual data are contained in Appendix D2, Historic Water Quality Data.

In general, water quality analyses indicate water of good quality. Common ions were measured at concentrations at or near their respective detection limits. Total recoverable metals were analyzed below U.S. Borax detection limits. Total hardness ranged from 3.0 to 37.8 mg/L; total alkalinity as $CaCo_3$ was measured from 4 to 39 mg/L. Field and laboratory measurements of specific conductance and pH were also consistent with the Montana Project data.

Nutrient values were consistently below U.S. Borax detection limits, with measurable concentrations of Kjeldahl nitrogen at its detection limit of 0.1 mg/L.

In summary, U.S. Borax surface water quality data are comparable and similar to Montana Project results. Although, U.S. Borax detection limits were higher for virtually all parameters, the results indicate the same good quality water with very low concentrations of total recoverable metals, nutrients, and common ions. However, quality control samples were not a part of the U.S. Borax sampling program, and the data are impossible to verify or validate.

A statistical summary of water quality data collected during the present Montana Project study appears in Appendix G3. Criteria used to determine which samples are used in the statistical calculations are presented in Section 2.2.1.7.

3.5.1 QA/QC Program Results

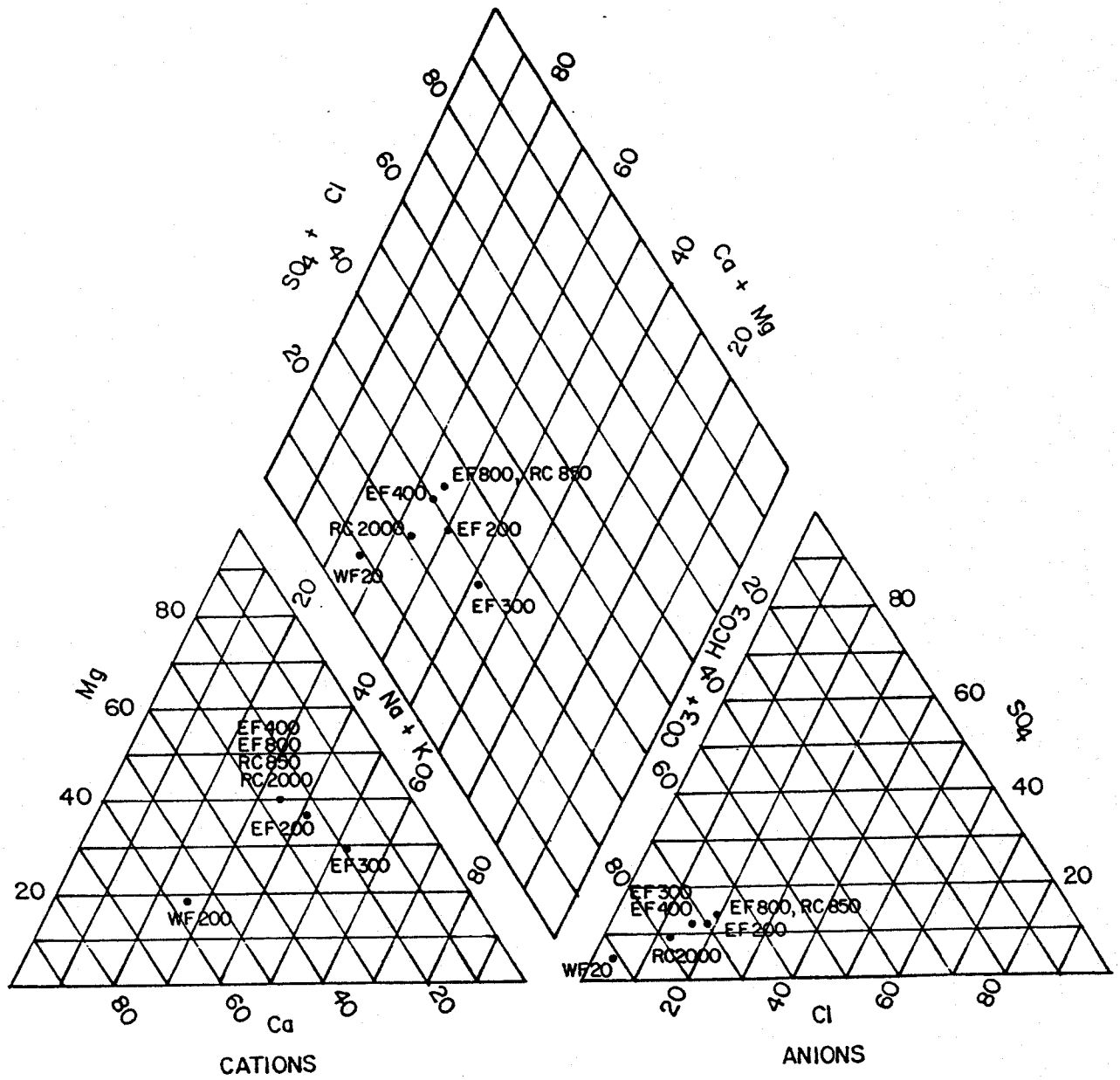
The collected surface water quality data are reported in Appendix G1 and the results of the QA/QC program are given in Appendix G2. The QA/QC results are in the form of QC codes generated by the computerized QA/QC program to flag data that does not meet the acceptance criteria given in Appendix C. A statistical summary of the accepted data is given in Appendix G3 and data validation statements are provided in Appendix G4.

3.5.2 General Observations and Characterizations

Surface water data collected in the study area are found in Appendix G1. Water in the Rock Creek and Libby Creek drainages is of good quality. Measured total dissolved solids (TDS) concentrations throughout the study area are less than 70 mg/L. Hardness values are low, with approximately one-half of the sampling locations reporting 6 mg/L. No hardness values over 50 mg/L are reported for remaining locations. Specific conductance

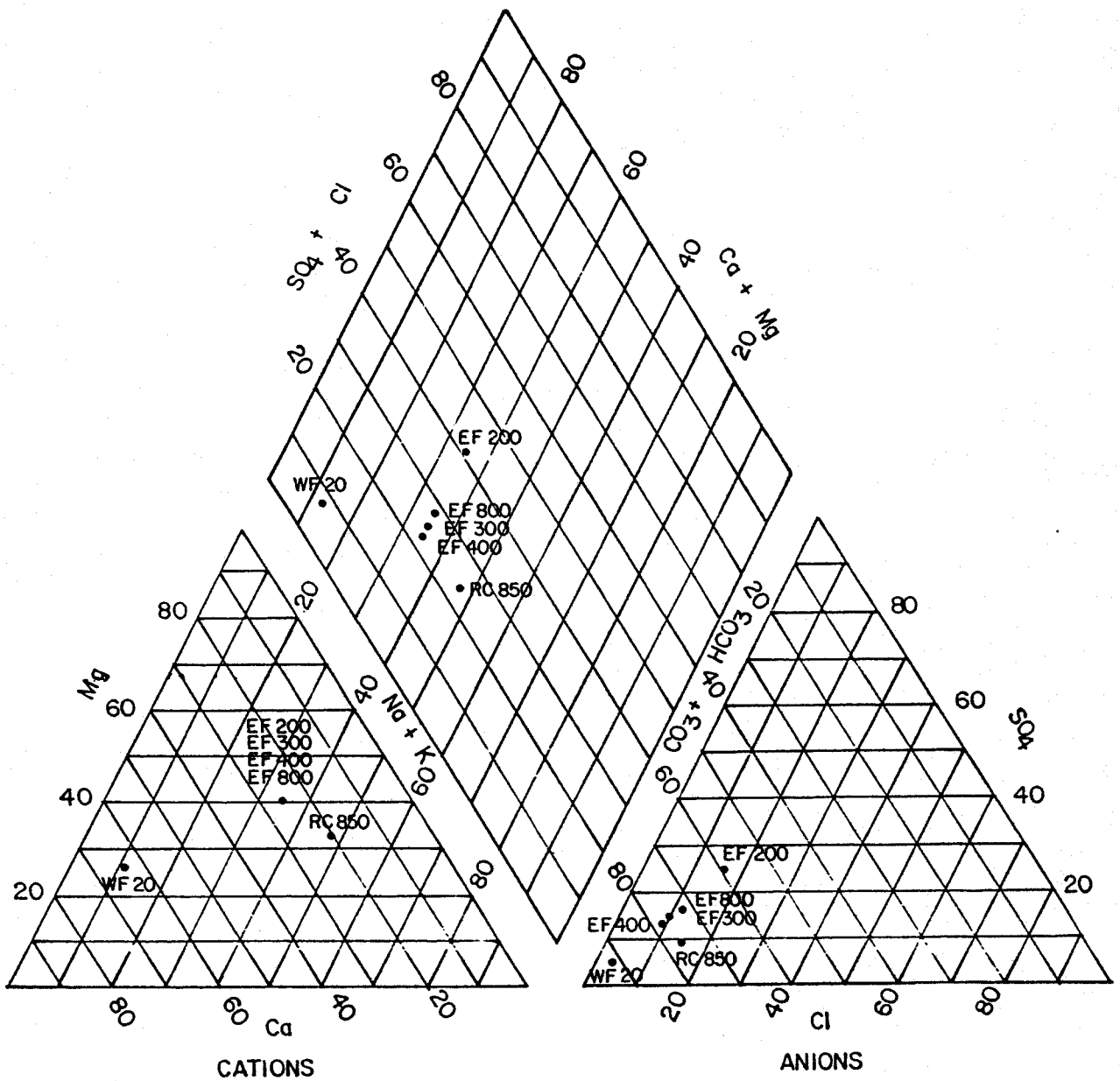
values measured throughout the study area range from 5 to 156 umhos/cm; pH ranges from 5.7-8.7 S.U. Bicarbonate is the predominant anion. Trilinear diagrams are plotted for Spring and Summer 1988 water quality data for Rock Creek and for Spring, Summer, Fall and Winter quarters for selected sites in the Libby Creek drainage (Figures 3-4 through 3-8A).

At all sampling locations, fluoride, total phosphorus, and orthophosphate were present at measurable concentrations collected during spring runoff, but declined to near or below detection limits by late summer. Total phosphate concentrations increased in February, March, and April, 1989 to above those measured during Summer, 1988.

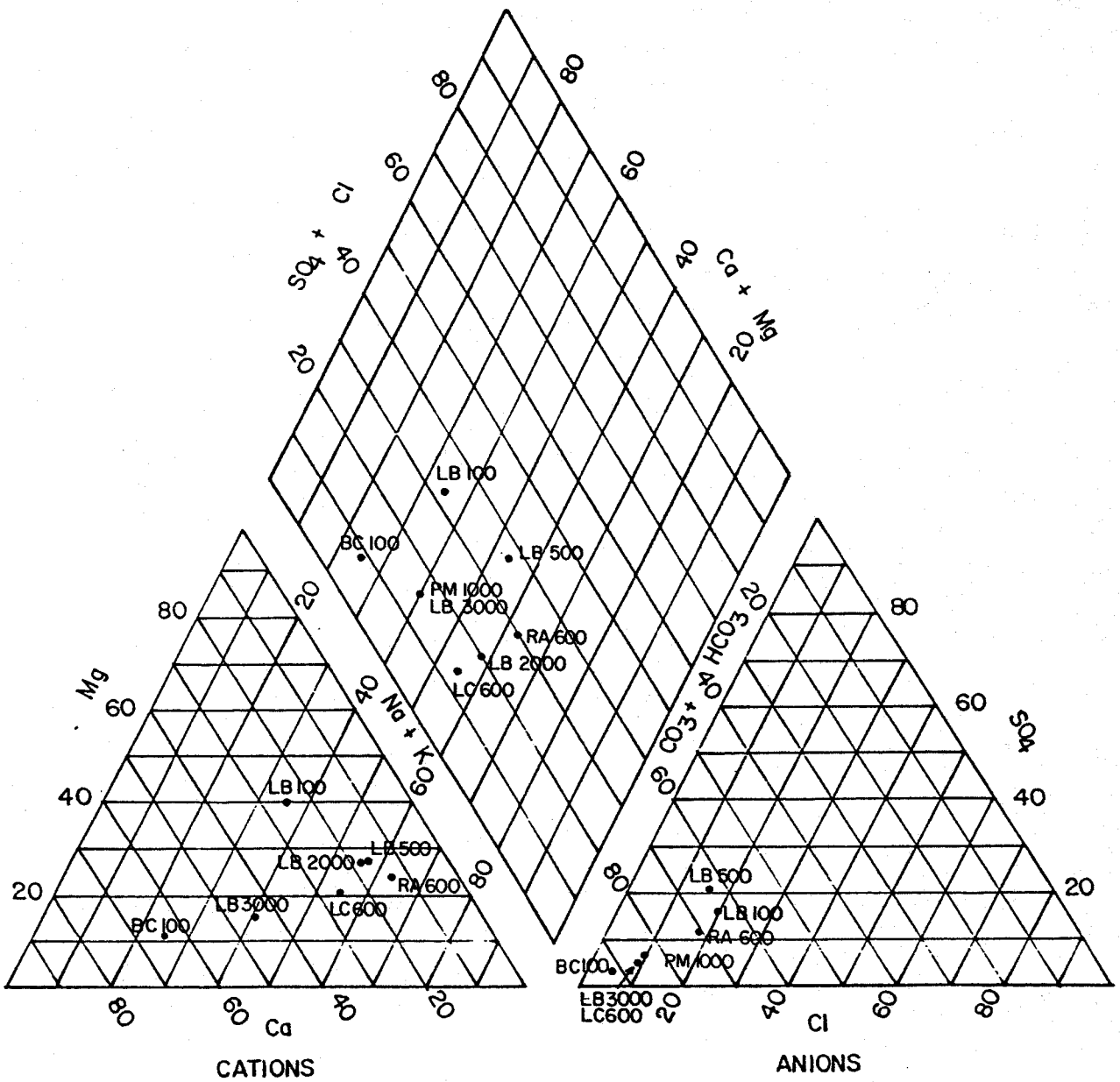


Trilinear Plot of Spring Surface Water 1988 Data - Rock Creek

FIGURE 3-4

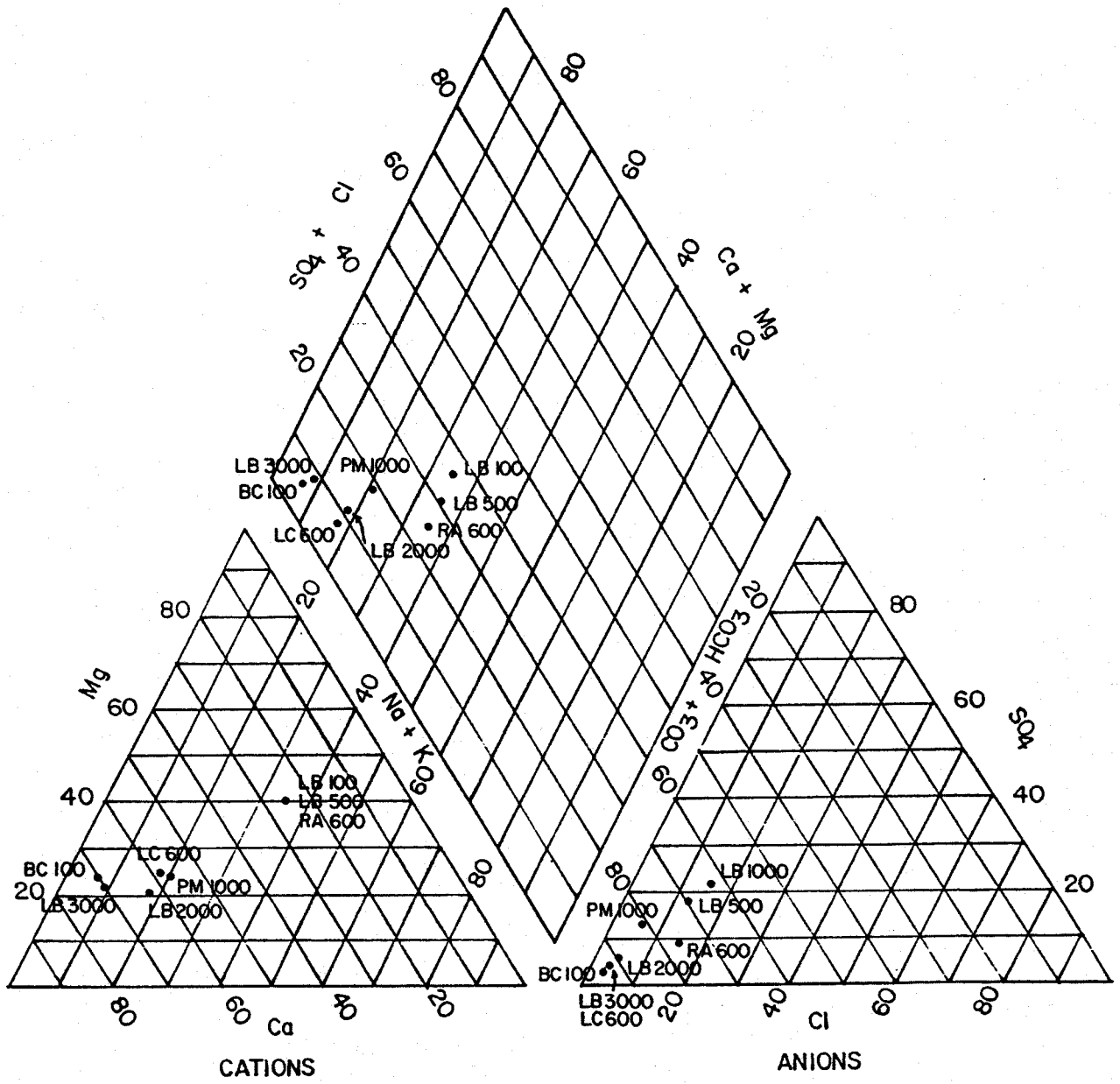


Trilinear Plot of Summer Surface Water Data - Rock Creek



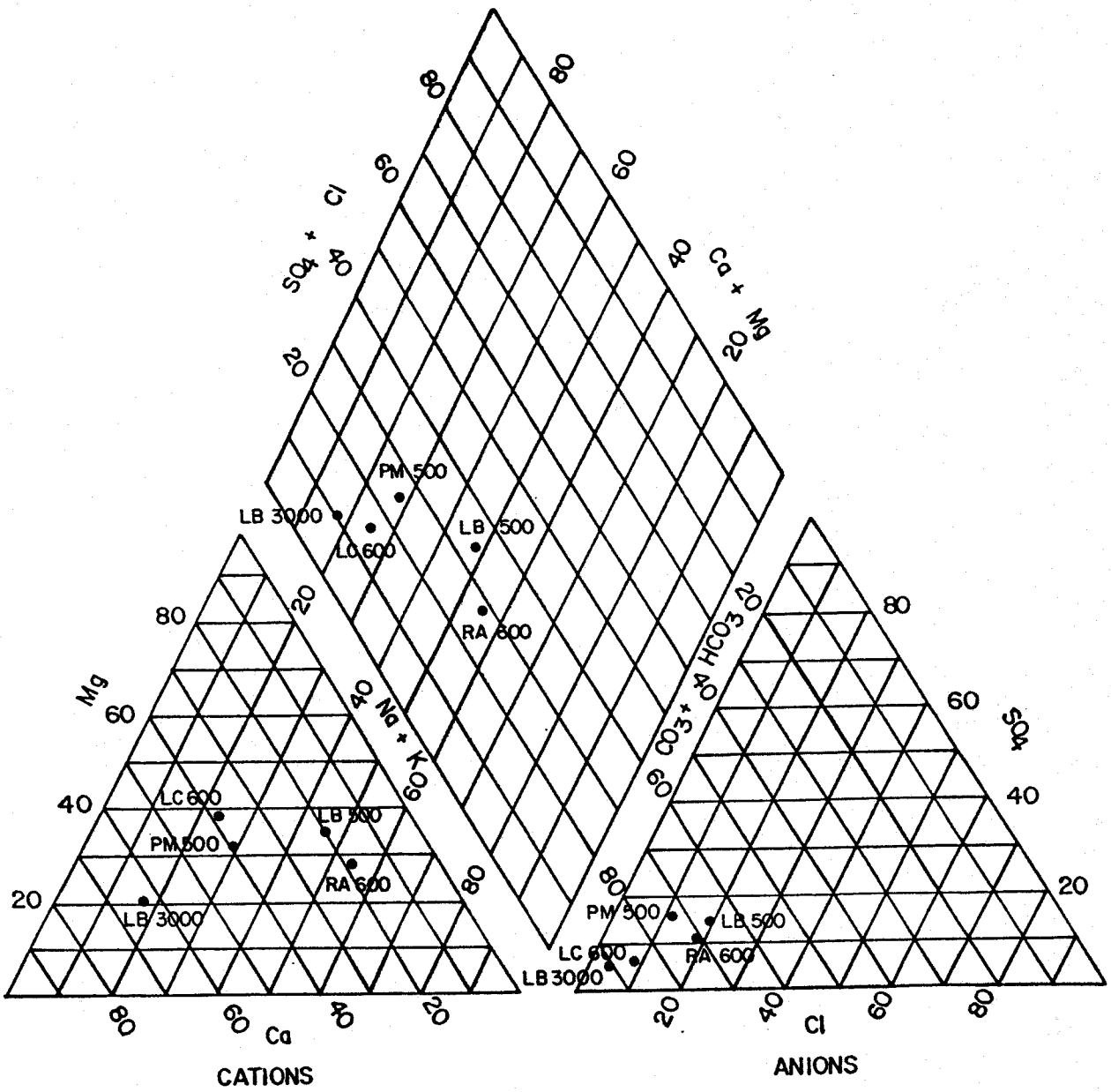
Trilinear Plot of Spring Surface Water 1988 Data -
Selected Sites on Libby, Ramsey, Little Cherry, Poorman and Bear Creeks

FIGURE 3-6

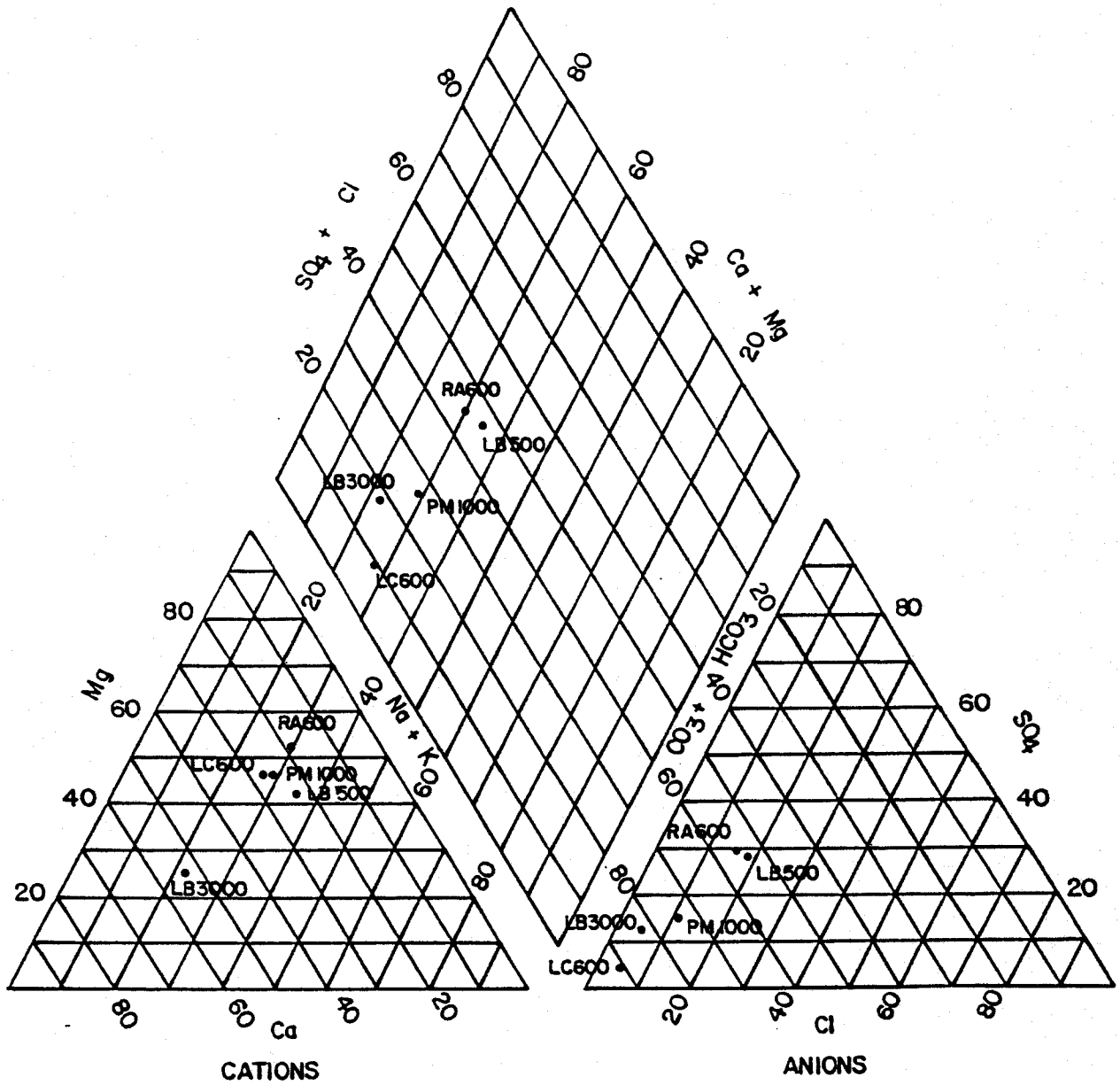


Trilinear Plot of Summer Surface Water Data -
Selected Sites on Libby, Ramsey, Little Cherry, Poorman and Bear Creeks

FIGURE 3-7



Trilinear Plot of Fall Surface Water Data -
Selected Sites on Libby, Ramsey, Little Cherry and Poorman Creeks



Trilinear Plot of Winter Quarter Surface Water Data
Selected Sites on Libby, Ramsey, Little Cherry and Poorman Creeks

Aluminum, arsenic, chromium, manganese, mercury, molybdenum, and zinc are consistently below their respective detection limits. Silver and iron occurred in low concentrations during runoff sampling. Measurable cadmium was detected during the study, but problems with QA/QC samples make precise quantification of its presence impossible.

3.5.2.1 Spatial Water Quality Analysis

Evaluations of spatial trends in surface water quality data were completed using water quality data from sites within the same drainage. Analyses of spatial variations are presented below by drainage.

3.5.2.1.1 Libby Creek

Libby Creek receives flow from four tributaries in the study area (Exhibit 1). These tributaries increase hardness and alkalinity over four times through the length of Libby Creek in the study area. The greatest increase appears to occur below Ramsey Creek. Hardness at LB-3000 averages 17 mg/L, with a maximum of 49 mg/L reported in September. Alkalinity averages 24 mg/L at LB-3000, with a maximum of 57 mg/L reported in September.

Average nitrate + nitrite as N concentrations in Libby Creek decreased (from an average of 0.14 to 0.08 mg/L) in a downstream direction until the Bear Creek confluence. Bear Creek has the highest hardness (50 mg/L in September, 1988), and alkalinity values (60 mg/L) in the study area and causes increases in these constituents in Libby Creek.

Ramsey Creek (Exhibit 1-A) has a higher average TSS value (2.2 mg/L at RA-100) due to organic debris contributed by the marsh during spring runoff. A decrease in nitrate occurs downstream from RA-100 to RA-200, similar to the decrease on upper Libby Creek. TDS concentrations ranged from 2 mg/L to 17 mg/L at RA-100 to 1 mg/L to 7 mg/L at RA-200. Maximum total phosphorus and orthophosphate concentrations were analyzed at .006 mg/L and .005 mg/L respectively at RA-100 and increased slightly downstream to .0150 mg/L and .010 mg/L respectively at RA-200. There is an increase

in organic nitrogen as indicated by Total Kjeldahl Nitrogen minus ammonia from RA-100 to RA-600. Common ion concentrations do not increase measurably in this stream and are not an important source of dissolved solids in Libby Creek.

Poorman Creek (Exhibit 1-A) contributes hardness and alkalinity to Libby Creek, because the average concentrations of hardness (6 mg/L) and alkalinity (14 mg/L) at PM-1000 are higher than those in Libby Creek. Nitrate decreases slightly downstream from an average of 0.08 to 0.04 mg/L. No other significant changes occur in this short reach.

Little Cherry Creek has high alkalinity and hardness values compared to all other creeks in the Libby drainage except Bear Creek. Total hardness as $CaCo_3$ increases in a downstream direction from <3 mg/L to 10 mg/L at LC-100 and from 3 to 35 mg/L at LC-600. Correspondingly, calcium increased from a maximum upstream of 3 mg/L to 9 mg/L at the downstream site. Magnesium increased from <1 mg/L at LC-100 to 3 mg/L at LC-600. No significant changes were observed in sodium and potassium.

3.5.2.1.2 Rock Creek

East Fork of Rock Creek contains slightly elevated copper values at Rock Lake (.001 mg/L to .008 mg/L), but these concentrations appear to decrease in a downstream direction. Station EF-400 contained copper at detectable levels of <.001 mg/L to .003 mg/L. The presence of these measurable copper levels are believed to be due to the lake's proximity to the ore body. Lead was measured above the detection limit during two sampling episodes; first at EF-800, and second at RC-2000 (Exhibit 1), however, no significant trend exists. Total dissolved solids (TDS) gradually increase downstream.

West Fork of Rock Creek contributes hardness in the form of calcium and alkalinity as bicarbonate, which raised the specific conductance at RC-850, below the confluence with the West Fork, above that at EF-800, located above the confluence with the West Fork (Exhibit I).

Nitrate + Nitrite as N values on the East Fork of Rock Creek range from 0.01 to 0.11 mg/L during spring runoff. Values for April and May were higher than those reported during subsequent summer and fall sampling episodes. No significant trends occur in downstream directions, and values from Station EF-400, below Rock Creek Meadows, show no significant increase in nutrients concentrations.

Rock Creek downstream from the confluence of the two forks shows continued increases in hardness and alkalinity.

3.5.2.2 Seasonal Variations

Particular constituents in surface waters are affected by seasonal flow variations. To date, results from ten sampling episodes have been analyzed.

High spring flows are characterized by increased nitrate + nitrite as N. Concentrations increase during runoff apparently from leaching of weathered soils. Summer flows exhibited the lowest values for the baseline period. Values for nitrate + nitrite as N increased slightly in early winter months, especially during February. Total phosphorous and orthophosphate are measurable during spring runoff and may be attributable to phosphates derived from surface runoff. Total phosphorous and orthophosphate concentrations subsequently decrease to near or below detection limits following spring runoff conditions with only slight fluctuations throughout the baseline period.

Values for hardness and total dissolved solids increased with a decrease in discharge, concentrating common ions and dissolved solids in the water. Total suspended solids have fluctuated during the study period: increasing slightly during runoff, then decreasing during the steady flow of early and mid-summer. Slight increases in TSS concentrations were measured during extremely low flows. This latter increase is probably due to a combination of sampling difficulties associated with extremely low flows and an

increase in algal growth with the warmer temperatures associated with late summer, low-flow conditions. Winter sampling values were slightly lower or the same as concentrations reported during summer low flows. Values for daily TSS samples collected by the ISCO sampler at LB-3000 are presented in Appendix G2. Measured values at this site range from <1 to 30 mg/L with the majority of daily samples containing less than 10 mg/L total suspended solids.

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Certain metals, such as silver and copper, were detected at higher levels during the spring runoff sampling events, but declined to near or below detection limits during summer and early fall flow conditions. Only very slight fluctuations above detection limits occurred during fall and winter months.

Data validation statements were generated for surface and groundwater quality samples. Comparability, completeness, representativeness, accuracy and precision of surface water data for the Montana Project were analyzed and are presented in Appendix G4. Comparability, completeness, and representativeness were analyzed for groundwater data (Appendix J2); however, due to the limited size of the data set as discussed in Section 2.2.2.10, qualitative analysis of accuracy and precision are provided.

3.6 ALTERNATIVE FACILITIES SITES

Two alternative plant and mine portal sites and two alternative tailing disposal sites received consideration during the development of surface water baseline data for the Montana Project. Surface water monitoring station locations were selected such that alternative facility sites would be bracketed by baseline monitoring stations.

3.6.1 Plant and Mine Portal Sites

Alternative plant and mine portal sites for the Montana Project are identified as the Libby Creek site and the Ramsey Creek site (Figure 3-9). These two sites represent alternative locations for the mine production portals and associated ore processing plants.

Libby Creek Site: The Libby Creek site is located at an elevation of approximately 4300 feet in the Libby Creek drainage. Mine portals would be located on the north side of the creek with the associated ore processing plant on the south side.

The site is dominated by steep rock slopes to within approximately 200 feet of the valley bottom Geotechnical Report (Morrison-Knudsen 1989). Libby Creek throughout this reach is a high energy stream with glaciofluvial gravels and colluvium as the dominant bed load.

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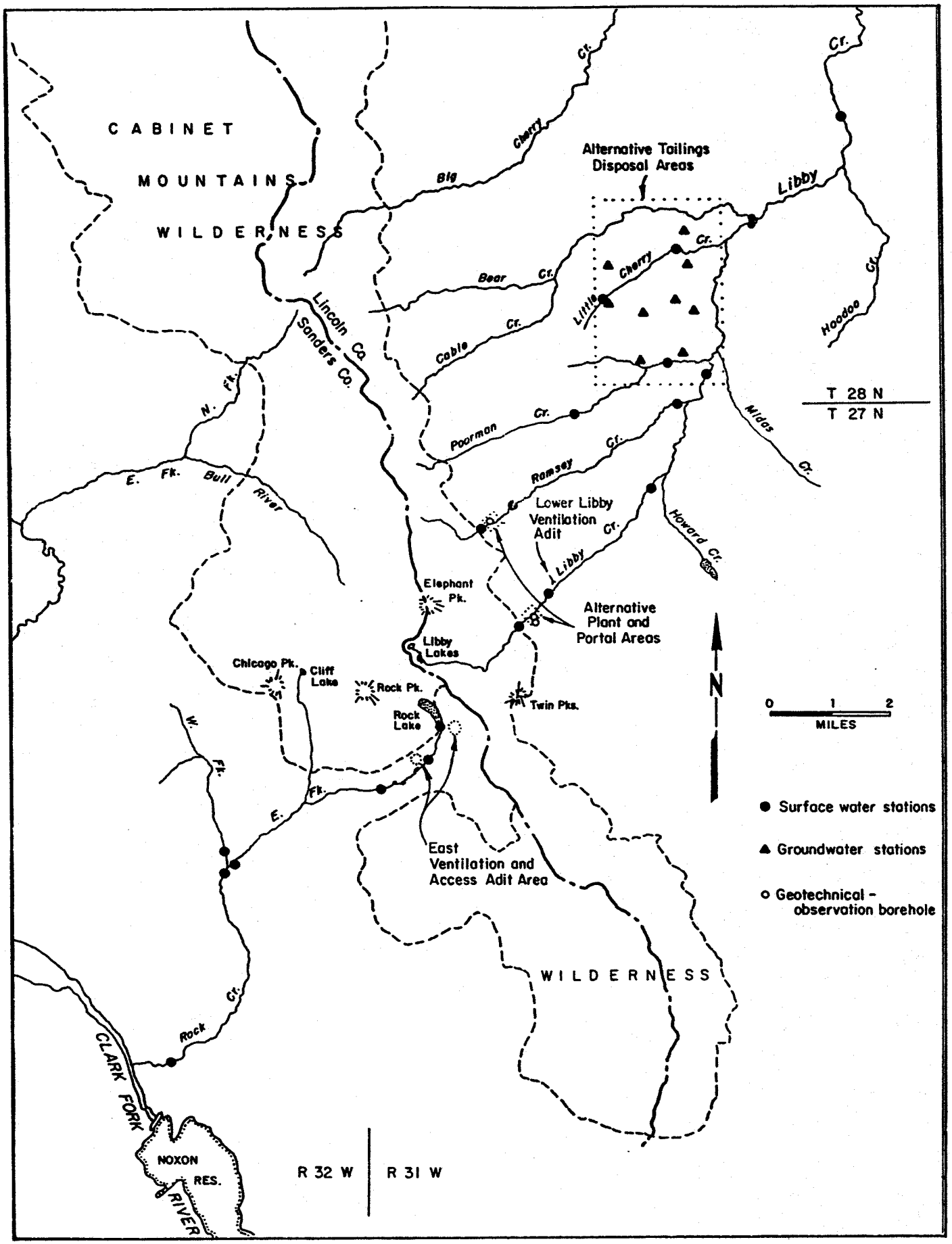

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Alternative Mine Facility Sites
FIGURE 3-9

The Libby Creek site is situated between surface water monitoring stations LB-100 and LB-200 (Exhibit 1). Water quality and flow does not differ measurably between these two stations. Detailed surface water baseline information is contained in Sections 3.2 and 3.5 of this baseline report and in Appendix G.

Ramsey Creek Site: The Ramsey Creek site is located at an approximate elevation of 4450 feet in the upper reaches of the drainage. Mine portals would be located on the south side of Ramsey Creek with the associated ore processing plant located on the north side of the creek.

The Ramsey Creek site is similar to the Libby Creek site in that it is characterized by steep rock slopes with valley fill dominated by glaciofulvial gravels and colluvium. The valley bottom in the vicinity of the portal and plant site is a small, marshy area. Detailed descriptions of the Ramsey Creek alternative site are provided in the Geotechnical Report (Morrison-Knudsen, 1989).

The Ramsey Creek site is bracketed by surface water monitoring stations RA-100 and RA-200 (Exhibit 1). Water quality and flow data collected at these two stations do not differ measurably between the two monitoring stations. Detailed surface water information is contained in Sections 3.2 and 3.5 of this report and in Appendix G.

3.6.2 Alternative Tailing Disposal Sites

The alternative tailing disposal sites are identified as the Little Cherry Creek site and the Poorman Creek site. The two alternative sites are located adjacent to each other on the west side of Libby Creek at an approximate elevation of 3400 to 3700 feet respectively. Detailed descriptions of the alternative tailing disposal site are contained in the Geotechnical Report (Morrison-Knudsen, 1989).

Little Cherry Creek Site: Surface water monitoring stations for the Little Cherry Creek site include LC-100, LC-600, and LB-2000 (Exhibit 1). Station LC-100 is upstream of the tailing disposal area, while station LC-600 is near the downstream end of the disposal site. Station LB-2000 is below the confluence of Little Cherry Creek and Libby Creek (Figure 3-8).

The Little Cherry Creek site is dominated by glaciofluvial gravels which cap and interfinger with glacial lake silts associated with Libby Creek. Little Cherry Creek remains a high energy stream throughout this reach; bedload is dominated by large cobbles and boulders. The stream has eroded portions of the drainage to bedrock leaving extensive exposures of the glacial lake sediments and slopewash gravels.

Stream flow data and water quality information collected for LC-100 and LC-600 are contained in Appendix G. No significant differences exist between data collected at the two stations. Flow in Little Cherry Creek decreased to less than 0.5 cfs by late summer.

Poorman Creek Site: The Poor Creek alternative tailing disposal site is located immediately south of the Little Cherry Creek site. Surface water monitoring stations for the Poorman site include PM-500 (upstream) and PM-1000 (downstream) (Exhibit 1).

The Poorman Creek site is similar to the Little Cherry Creek site in terms of surface and subsurface materials. Water quality and flow data for both stations are similar. Poorman Creek stream flow decreased through the season to less than 1.0 cfs.

3.7 SUMMARY

The surface water baseline investigation was designed to determine streamflow and water quality conditions of the natural, pre-mine environment in the project study area. To accomplish this objective, 21

surface water sites were selected at which discharge and water quality samples would be collected for a period of one year. This sampling program supplements previously collected data for the same study area.

Semimonthly discharge measurements were completed from April through June; monthly measurements were made thereafter. In addition to instantaneous flow measurements, a continuous gaging station was installed at the lowest reach of Libby Creek in the study area. Measurements from the stilling well and the staff gage were correlated with instantaneous discharge measurements, and a relationship was established. Staff and crest gages were installed at 16 sites and stage-discharge relationships were developed.

Calculations of flood peaks were completed using methods described by Omang and others (1986). Flood peaks for recurrence intervals of 100, 50 and 25 years were calculated using an equation based on basin characteristics. A Log-Pearson Type III analysis also calculated flood peaks for sites within the study area. Estimates for the 25 year recurrence intervals are most similar between the two methods.

Water quality sampling was completed simultaneously with stream discharge measurements. Samples were collected from each location and analyzed by Chen-Northern's laboratory in Billings, Montana. Target detection limits were approved by Montana Department of State Lands and the U.S. Forest Service. Sampling results show that area surface water is of good quality, calcium bicarbonate type with very low concentrations of TSS and selected metals.

Very few sites in the study area have metals detectable in the surface water. Hardness and alkalinity, although low throughout the study area, show downstream increases. The highest hardness and alkalinity concentrations were measured at Bear Creek, West Fork Rock Creek, and Little Cherry Creek (Exhibit 1). Nutrients were at concentrations near these detection limits throughout the site, with slightly higher nitrate levels occurring in the upper Libby and Ramsey Creek drainages. Total suspended sediment concentrations were quite low at all sites.

An integral part of water quality sampling program is the quality assurance/quality control (QA/QC) program, designed to produce data of known accuracy and reliability. Customized computer software facilitates data entry of water quality results. After data validation, a QA/QC check is performed using blind field standards, bottle and cross-contamination blanks, and field duplicates to identify data of questionable validity. Statistical calculations have been performed on samples of known accuracy and reliability (Appendix G).

Chen-Northern, Inc.

SECTION 4.0

4.0 GROUNDWATER

Investigations concerning groundwater resources for the Montana Project focused primarily on characterization of groundwater in vicinity of the alternative Poorman and Little Cherry tailing impoundment sites. In accordance with the Plan of Study for groundwater hydrology, the following work tasks were completed: an aerial photogeologic study of the region covering both mine production facilities and tailing impoundments; a geophysical reconnaissance investigation of the alternative tailing disposal sites; installation of observation wells in the Poorman and Little Cherry areas for sampling and monitoring of groundwater; and aquifer testing to characterize aquifer hydraulics. In addition, a well, spring and adit inventory was undertaken throughout the project area. Results of these tasks are summarized in this section.

4.1 LOCAL HYDROGEOLOGIC SETTING

The occurrence, distribution, and flow of groundwater in the project area are controlled by both local and regional geology. Groundwater is transmitted in Recent alluvium and colluvium, Pleistocene lacustrine and glaciofluvial deposits, and in Precambrian metasediments. Recent deposits are confined to existing surface channels, including terrace deposits. Lacustrine silts and clays are present in the alternative tailing impoundment areas and represent glacial lakebed deposits associated with regional ice damming. Glaciofluvial deposits are primarily associated with an alluvial apron along the eastern mountain front of the Cabinet Range. Bedrock of the project area consists of a thick sequence of metamorphosed siltstones and sandstones (argillite and quartzite) of the Precambrian Belt Supergroup. Heterogeneous mixtures of gravel, sand, silt and clay, comprise the valley fill of mountain valleys; colluvium blankets other portions of the area.

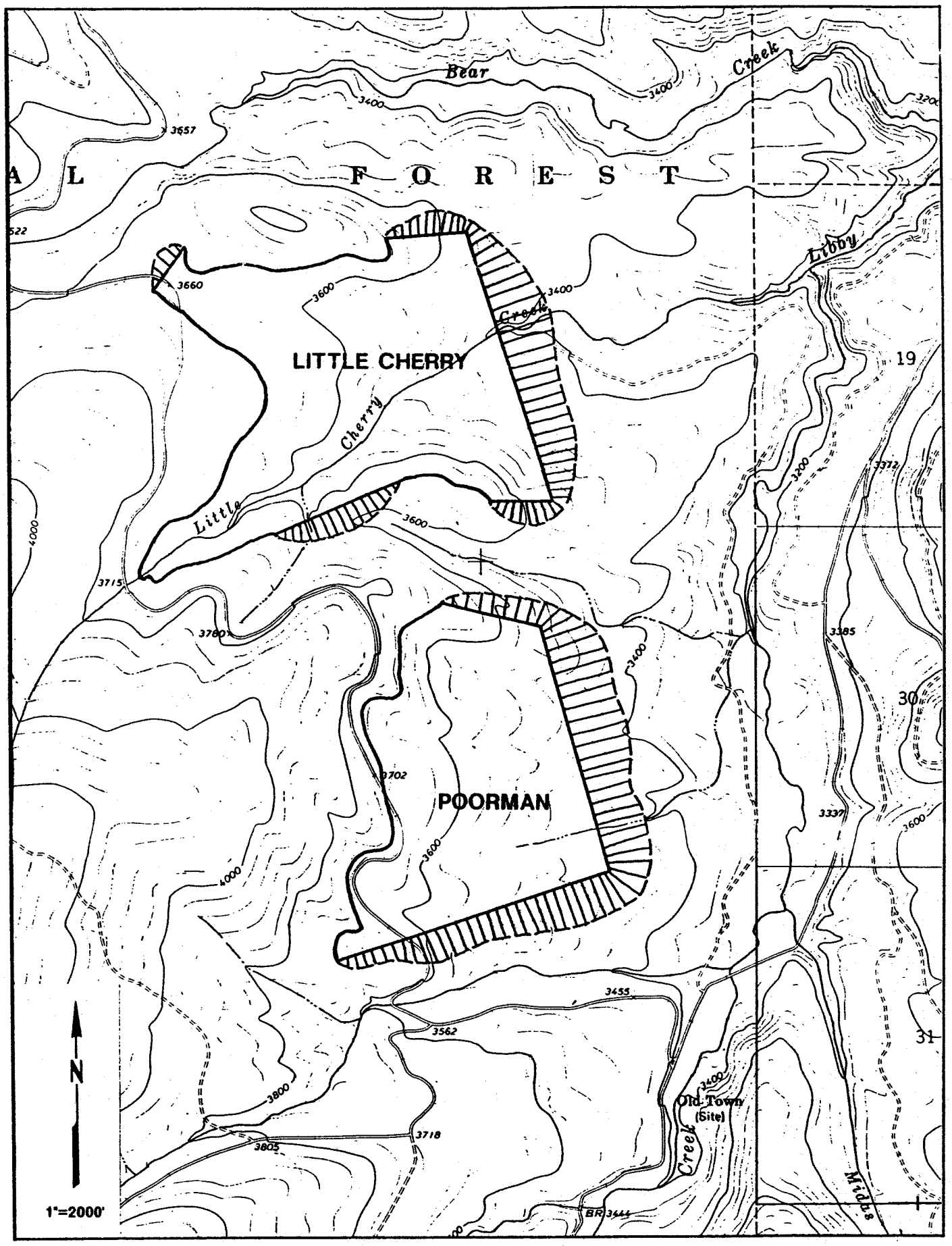
Groundwater flow is generally from topographically high areas in the Cabinet Mountains to lower valleys. Lack of numerous high-flow springs and the relatively low base flow of major streams of the area indicate that groundwater flow systems in the project area are either deep or limited by low permeabilities. Coarse materials tend to yield larger quantities of water whereas fine grained lacustrine silts and colluvium with high silt matrix yield lesser water quantities. Fractured bedrock permits some groundwater movement, but generally the primary porosity and permeability of Belt metasediments limits groundwater transmittal.

Regional groundwater recharge occurs from infiltration of precipitation, snowmelt and streamflow. Significant recharge potential in the project area is provided by annual precipitation that ranges from 30-60 inches. Streamflow recharge of groundwater is confined primarily to mountain front areas of abrupt gradient change, whereas groundwater discharge occurs locally from minor springs and seeps, and as flow into upper reaches of streams. Groundwater discharge to Libby and Bear Creeks may occur both above and below mountain front segments. Both recharge and discharge conditions appear to fluctuate seasonally.

4.2 HYDROSTRATIGRAPHY

4.2.1 Aerial Photogeology

Previous reports indicate that glacial till is widely distributed throughout the project area, especially in low areas such as the alternative tailing disposal sites (Figure 4-1). Regional reports cite the presence of terminal moraine remnants in lower portions of the Libby Creek Valley and locally in Lake Creek, Yaak, and Fisher River drainages (Alden, 1948; Johns, 1970). These reports also refer to the obvious glaciated character of the Cabinet Mountains. The inference is that continental or alpine glaciation, with associated ice erosion and morainal deposition, is the rule rather than the exception for much of northwest Montana.



Index Map of Alternative Tailings Disposal Sites

FIGURE 4-1

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A geomorphic landform analysis was conducted as part of the aerial photogeologic mapping task. Except for glaciofluvial and glaciolacustrine deposition, local ice sculpturing of high mountain peaks with local cirque development, and remnants of small terminal moraines in headwater areas of major drainages, no evidence was found for regional glaciation and direct ice activity. Features such as U-shaped valleys, over-steepened valley sides, evidence of ice scour and bedrock abrasion, and hanging valleys are absent throughout lower elevations of all major stream valleys, especially on the east side of the project area. Major topographic features in the form of lateral-terminal moraine configurations, or typical pot and kettle topography associated with ground moraines, are also noticeably absent.

Based on photogeologic observations supported by field checks, it appears that Recent direct ice action was limited to elevations of the project area above 5000 feet elevation. The main exception were those ice lobes necessary for the formation of moraines in headwater areas. Glaciofluvial and glaciolacustrine activity, on the other hand, were more widespread and probably are of greater local hydrogeologic significance.

Bedrock consists of Belt units of Precambrian age. Included are units of the Ravalli Group, its overlying Wallace Formation, and the underlying Pritchard Formation. The general distribution of these Belt metasediments is shown on Exhibit II, although actual contacts are undefined. Representative bedrock attitudes are also mapped, as are major structures readily interpreted from photos. Where expressed on drainage divide ridges, bedding and joint traces are also shown. These provide some evidence of the preferred structural grain governing groundwater movement within the bedrock units.

Joint patterns include those systems related to regional folding plus a superposed regional system. Both ac and ab joint orientations (a=vertical axial plane trace, b=fold axis, and c is perpendicular to the ab plane and essentially parallel to bedding) are present; these are especially well developed throughout the large anticlinal fold mapped along the east flank of the Cabinet Range. The east-northeast trending ac set appears to be

particularly pervasive and is well developed with close spacing. The north-northwest trending ab set are equally pervasive and well developed, but more widely spaced. Both sets are strongly vertical, thus potentially enhance groundwater movement in preferred directions. The superposed regional joint system trends north-northeast, also appears to be essentially vertical, and although not pervasive, is well developed locally with wide spacing. The trend of this latter set appears to be unmodified by major fault or fold structures.

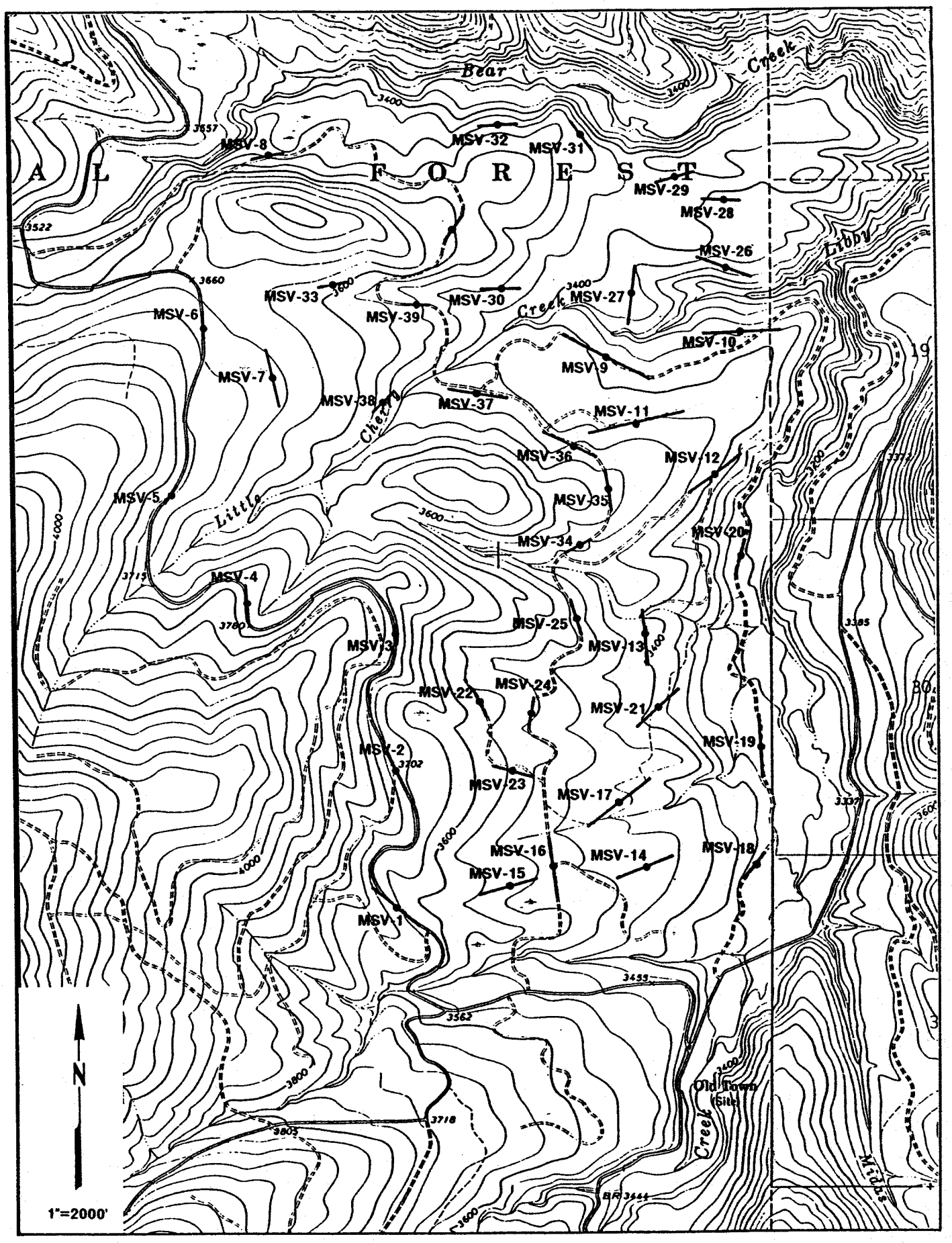
4.2.2 Geophysical Reconnaissance

A near-surface geophysical reconnaissance of the Poorman and Little Cherry sites was conducted using the direct resistivity method. Electrical soundings were made at forty locations where straight, flat field arrays with random orientations could be established (Figure 4-2). Monitor well locations were selected partly on the basis of resistivity interpretations that indicated thick lacustrine silts and variable bedrock depths up to 300 feet along eastern portions of the proposed tailings impoundment sites (Figures 4-3 and 4-4). A zone of overlap and interfingering of these silts with coarser glaciofluvial gravels is also inferred.

Comparisons of resistivity data with seismic refraction results provided by another Noranda consultant, Morrison-Knudsen, and to logs of monitor wells and boreholes, appear to support interpretations of resistivity data.

4.2.3 Hydrostratigraphic Units

Precambrian bedrock of the project area consists of fine-grained interbedded argillites, siltites and quartzites with lesser carbonate beds. In spite of their metamorphic character, primary sedimentary features are well preserved. Except for open joints and fractures, consolidated bedrock units have limited groundwater potential. Their overall fine-grained composition, compounded by low-grade metamorphism, tends to limit their water transmission potential.



Field Locations for Resistivity Sounding Stations

FIGURE 4-2

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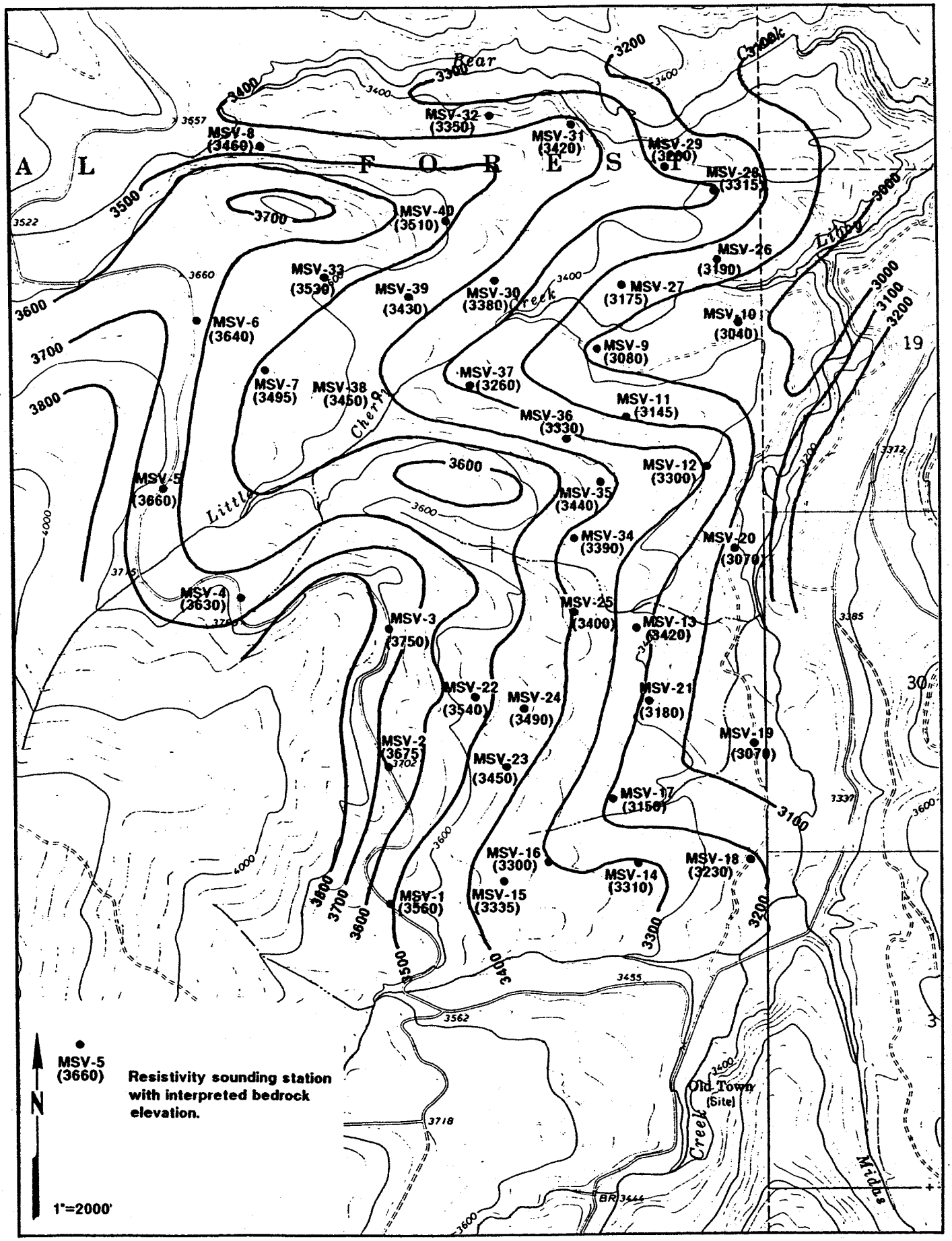
MONTANA PROJECT



Approximate Bedrock Configuration
Interpretated From Apparent Resistivity Soundings

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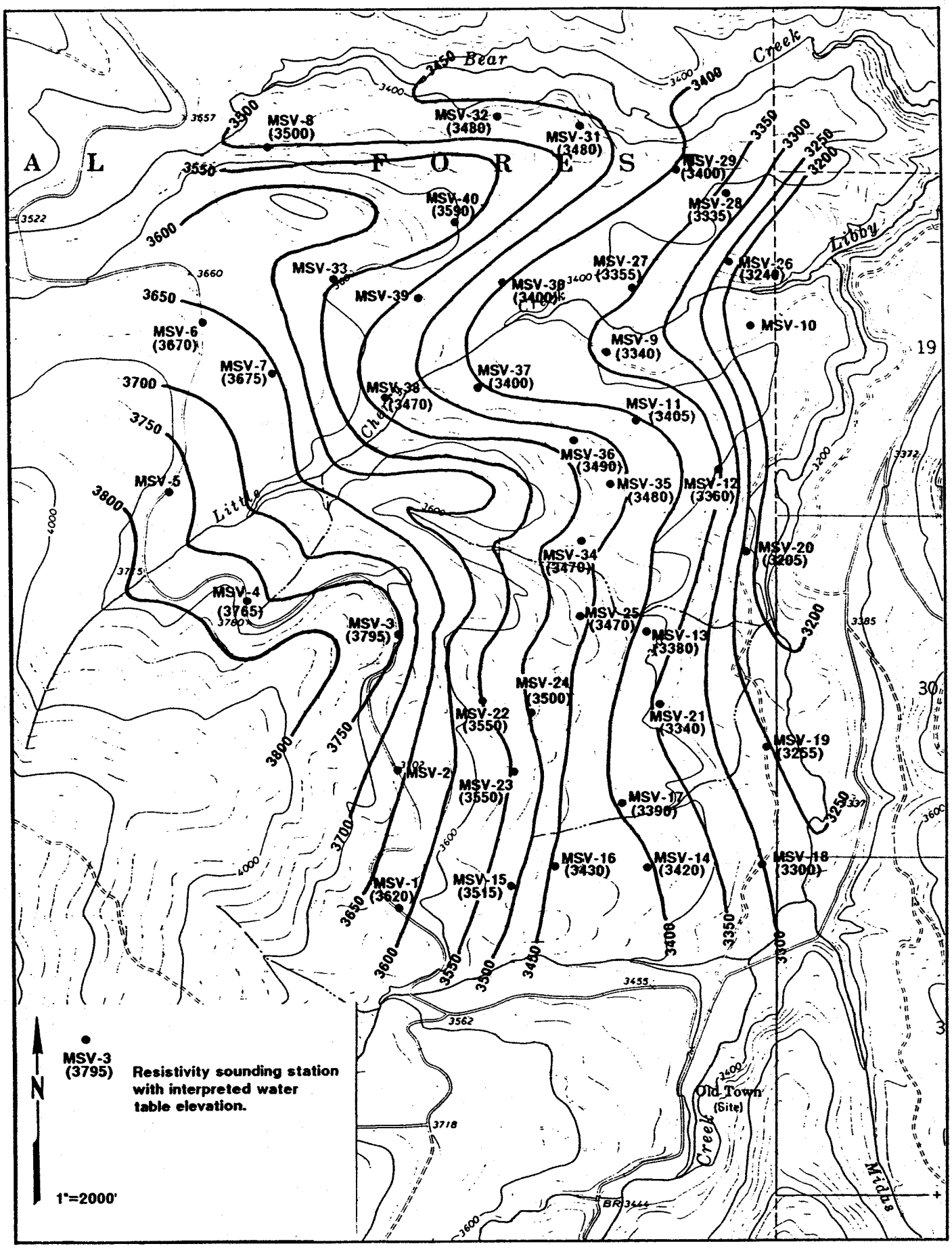
Lincoln and Sanders Counties, Montana

FIGURE 4-3



Approximate Water Table Configuration
Interpreted Form Apparent Resistivity Soundings

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Lincoln and Sanders Counties, Montana

FIGURE 4-4

Unconsolidated deposits of the project area have been subdivided into four hydrogeologic categories: active and inactive alluvial floodplain deposits and mountain meadow flats; transient valley deposits of mountain streams; colluvium covered bedrock; and glaciofluvial and glaciolacustrine deposits of the alternative tailing disposal sites.

Floodplain deposits (Qal) consist of a relatively thin gravel and cobble veneer deposited along aggradational sections of Libby and Bear Creeks (Exhibit II). These materials are constantly reworked by limited lateral stream movement with net downstream transport over time. Depth to bedrock varies but tends to be shallow enough to permit moderate bedrock control over stream channel development. Lateral shifting of both material and active channels appears to be associated with the magnitude of sediment supply and related depositional choking during periods of high flow. Periodic degradation and aggradation of these sections of stream result in local but temporary braiding, meander development, and in point-bar and overbank deposition.

Mountain meadow areas are essentially sites of temporary lakes created by local morainal damming of streams flowing out of the Cabinet Mountains. Local silt and/clay lakebed deposits may be present, although recent breaching of moraines may have resulted in the erosion and removal of some of the original lakebed material. These are flat, low-lying areas, thus subject to periodic inundation. Being primarily depositional areas with near-surface water tables, they are included with floodplains.

Segments of eastside drainages, upstream of the main mountain front, are characterized as being primarily degradational. In these downcut valleys, materials of differing type and genesis are mapped together as valley deposits (Qv). These materials are essentially transient and are comprised of slope wash, landslide debris, alluvial fan materials, and talus accumulations of variable texture, composition, thickness, and degree of sorting that have accumulated in valley bottoms and at the base of steep side slopes (Exhibit II). These deposits act as conduits for surface water and groundwater as they flow from the mountains. At points of issuance

from the mountain front, combined streamflow and interflow may be a major source of groundwater recharge for unconsolidated deposits underlying areas being considered for tailing disposal.

Portions of the alternative tailings disposal sites are comprised of heavily forested ridges and slopes of intermediate elevation. These areas are underlain by bedrock at relatively shallow depths (<50 ft. on average) with colluvial mantles of slope wash and weathered debris of variable thickness (Qc). These covered areas (Exhibits II and III) have hydrogeologic significance because the presence of a thin unconsolidated veneer enhances soil development and retards runoff through infiltration of moderate to heavy precipitation and snowmelt. These areas occupy spur ridge extensions that serve as drainage divides. Their colluvial cover tends to interface gradationally with exposed bedrock and deposits of adjacent low lying terrain. For this reason, mapped contacts are dashed to indicate their poorly defined, interpretive nature.

The principal hydrostratigraphic unit underlying the alternative tailing disposal areas is of dual composition. This unit, mapped as Qg (Exhibit II), is composed of very fine-grained, well-sorted and stratified lakebed silts and sands both overlain and underlain in part by coarse, poorly-sorted and roughly stratified, fluvial apron deposits of till-like character. Both are indirectly associated with glacial activity in the region and are considered to be genetically related as glaciofluvial and glaciolacustrine deposits. They overlap and interfinger, and thus are not readily separated by a single line of contact.

Glacial damming by regional ice sheets has been well documented in northwest Montana. In the project area, specifically the alternative tailing disposal sites, a small glaciolacustrine lake formed independent of, but simultaneous with, glacial damming of the upper Fisher River with shoreline at an approximate elevation of 3550 feet (Exhibit II). Lakebed silts and fine sands cover the eastern parts of the tailings disposal areas in bench-like or terrace fashion in spite of partial removal by post-depositional erosion. According to field observations, these silts

directly overlie bedrock units. In hand sample they are finely-laminated (varved) and; in spite of their fine-grained texture; cross-bedding, and scour and fill structures consistent with the effects of wave action are visible. At the mouth of Midas Creek these lakebed sediments may represent more marginal portions of the lake for this material is much more sandy textured than normally encountered as though deposited in a deltaic environment.

Downstream of the eastside mountain front, all streams of the project area have deposited extensive fluvial aprons that coalesce and intertongue with colluvial debris shed directly from drainage divides and the lakebed sediments of the alternative tailing sites. These streams are incised several feet into these unconsolidated deposits, which appears to be a more recent change from earlier aggradational behavior. Alluvial fan deposition was apparently in response to high flow and high load conditions created by glacial ablation. Coupled with an abrupt decrease in gradient as these streams discharged from mountain canyons onto a lakebed surface, meltwaters of alpine glaciers appear to have rapidly deposited considerable amounts of mixed, poorly-sorted and roughly-stratified material whose heterogeneity results in an overall till-like character.

The existence of a zone of interfingering of glaciofluvial and glaciolacustrine deposits was confirmed during the drilling of monitor wells in the Little Cherry and Poorman impoundment sites area. This zone roughly parallels the 3550 feet contour within central portions of the alternative tailing disposal sites and corresponds to the contact zone separating these deposits (Exhibit III). The overlapping nature of these deposits is related to fluctuations in Pleistocene lake levels and to variations in fluvial sediment supply. Actual shoreline position undoubtedly shifted through time as these deposits were being laid down. It is, therefore, possible to encounter lakebed silts in the subsurface beneath deposits mapped as glaciofluvial gravels, and to encounter gravels in the subsurface beneath deposits mapped as glaciolacustrine silts within central portions of the tailings disposal sites.

A filled channel is mapped within the Little Cherry tailing impoundment area (Exhibit III). Its presence was initially revealed by the drilling of monitor well LCTM 8 which encountered 120 feet of interbedded, poor to moderately-sorted, variably-textured, fluvial deposits before entering lacustrine silts. Morrison-Knudsen's borehole USB-2, approximately 2100 feet to the west, also appears to have drilled into similar materials. In spite of its limited depth, USB-4 also appears to penetrate interbedded fluvial materials. The extent of this buried channel can only be inferred, however. Borehole USB-1 encountered the same wedge-like zone of interfingered glaciofluvial and glaciolacustrine deposits common to both impoundments, not channel fill material, as did USB-5 approximately 3700 feet west-northwest of well LCTM-8.

Although surface evidence for a filled channel is lacking, there are field conditions that help define its extent. Along the north bank of Little Cherry Creek, 2000 feet to the northeast of well LCTM-8, and along the west bank of Libby Creek, 3500 feet to the east, there are 140 foot exposures of lacustrine silts that extend from the surface downward to exposed bedrock (Exhibit III). Any eastward extension of a filled channel in the subsurface would have to pass between these two outcrops. Surface evidence for such an extension consists only of the lack of ponding characteristic of near-surface lakebed exposures. According to geophysical data, the location of the inferred channel is consistent with a zone where depth to bedrock approaches 300 feet. Thus, as much as 180 feet of silt may locally underlie the filled channel.

Little Cherry Creek is presently cutting downward along the contact between channel-fill deposits and lacustrine silts. It is doubtful that Little Cherry Creek is responsible for the development of an ancestral channel of the dimensions inferred. Numerous quartzite boulders up to 1-2 feet in diameter were encountered in well LCTM-8 throughout the 120 feet of channel depth. Both size and composition of these boulders suggest that a stream of moderate size flowed through the Little Cherry area at some time in the past with a provenance outside the immediate area. Geomorphic

relationships tend to suggest that the filled channel may be an abandoned segment of Cable Creek prior to its diversion or capture by Bear Creek. It is conceivable that post-glacial deposition by a high-load stream resulted in channel filling along a low gradient section, thus diverting its flow northward into Bear Creek. Such an explanation is consistent with the regionally abnormal and abrupt change in Cable Creek's direction of flow at its point of issuance from the mountain front.

4.3 WELL, SPRING, AND ADIT INVENTORY

Based on the literature review and field reconnaissance, no existing wells were identified within close proximity to the project area. The nearest well serves the Howard Lake Campground: its distance from both mine and tailing disposal site, in the Little Cherry Creek drainage eliminated it from consideration. The old Heidelberg adit at the head of Rock Creek was observed to flow in the spring, but by summer, only standing water was noted. Several minor springs and seeps were observed throughout the Poorman and Little Cherry tailing impoundment areas in association with surface exposures of lacustrine silts early in the season, but their ephemeral nature precluded their being inventoried. Spring and adit locations are shown on Exhibit I, and pertinent data are provided in Table 4-1.

TABLE 4-1

WELL, SPRING, AND ADIT INVENTORY
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

Number	Location	Elevation	Discharge	Geologic Source	Remarks
SP-01	Below saddle between Bear Creek and Big Cherry Creek	3500 ft.	est. 2-3 gpm June	Lacustrine silts	Ceased flowing
SP-02	Little Cherry Creek	3320 ft.	est. 1-2 gpm June	Lacustrine silts	Ceased flowing
SP-03	Lower East slope of Cable Mountain	4320 ft.	est. 4-5 gpm June	Colluvium	Ceased flowing
SP-04	Upper Libby Creek	4200 ft.	8.9 gpm August	Colluvium	Measured by timed bucket
SP-05	Upper Rock Creek	4300 ft.	4.5 gpm August	Colluvium	Measured by timed bucket
SP-06	Upper Rock Creek Heidelberg adit	4100 ft.	-------	Bedrock	Standing water

* Locations are shown on Exhibit I.

Only those few springs actually flowing or with high potential for perennial flow have been included in the inventory. Only two of these had flow that could be measured and sampled during the first quarterly sampling period in August, 1988. Spring SP-01 represents flow from a large seepage area on the north side of Bear Creek just below the saddle between it and Big Cherry Creek to the north (Exhibit I). SP-02 is a similar type of feature on the north side of Little Cherry Creek. Both are characteristic of the seepage zones associated with lacustrine silt deposits. It is possible that in normal years these seeps are perennial, but in 1988 they became dry before August. Springs SP-03, SP-04, and SP-05 (Exhibit I) are typical of those present throughout the region where streamcut valleys intersect bedrock fractures, or where flow is channelized within colluvium or valley fill deposits. Most of these owe their existence to snowmelt, especially where underlying bedrock of low permeability is involved.

Springs flowing at the time of first groundwater sampling in August, 1988, include SP-04 and SP-05. Their waters are of good quality, low in temperature, and of near-neutral pH. Field parameters and water quality analyses are reported in Appendix J1.

4.4 WILDERNESS AREA GROUNDWATER CONDITIONS

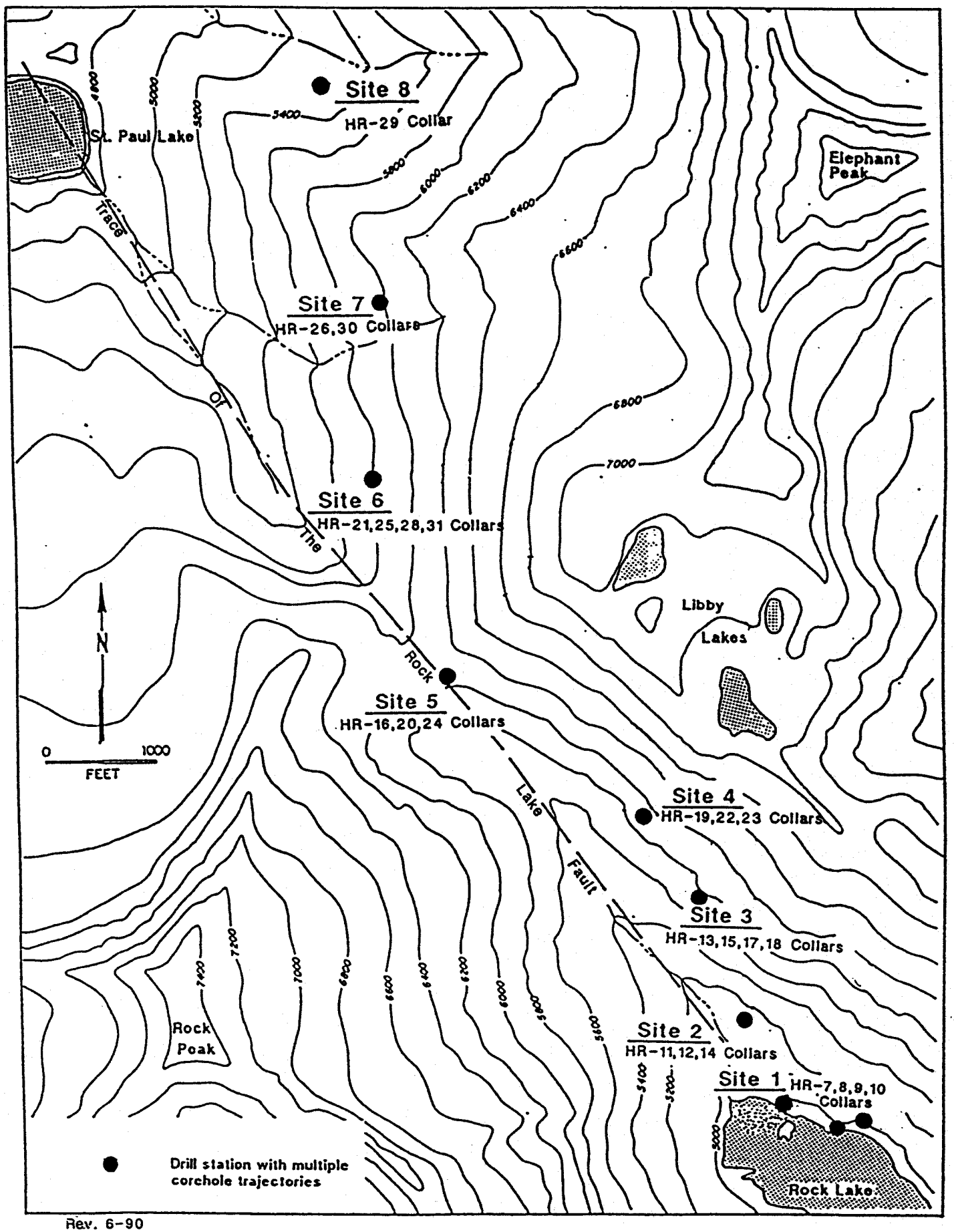
Bedrock within the Cabinet Mountains and the area to be mined consists of argillites and quartzites that act as aquicludes, i.e. as materials generally incapable of transmitting significant quantities of water. Their hydraulic conductivities normally range from 10^{-7} to 10^{-11} cm/s under ordinary hydraulic gradients. However, due to loss of original ductility through metamorphism and subjection to periods of tectonic stress, these materials have become heavily jointed and fractured. Thus, their groundwater transmissivity has been enhanced by development of fracture porosity and permeability. These fractured rocks presently have conductivities in the 10^{-4} to 10^{-6} cm/s range, according to slug/bailer tests in shallow bedrock at the confluence of Rock Creek and the Clark Fork.

The only aquifer potential that can be defined for the Wilderness Area is that created by fracturing. Because fracture porosity and permeability normally decrease with depth, groundwater flow in a fractured rock system tends to be unconfined and limited to a near-surface regime. Thus, any impact of mining is somewhat conditional on depth of mining, extent of fracture density and aperture size, and the degree to which mining intersects such a fractured media. With exponential decrease in hydraulic conductivity with depth within fractured rocks, vertical groundwater flow appears to be limited relative to horizontal flow. At mining depths of 200 ft. or more, such flow would be minimal. Infiltrated waters therefore tend to be directed through an integrated fracture system to topographically low areas, with ultimate discharge into lakes and surface streams.

As an unconfined system, static groundwater levels within fractured bedrock may define a water table. The only evidence for static water levels are lake surfaces and stationary water levels reported by drillers in exploration boreholes (Figure 4-5). A detailed examination of the depths of lost returns, lost circulation, and rod greasing in these boreholes was conducted in an attempt to determine whether a regional groundwater table exists.

At Site 1, adjacent to Rock Lake, no mention of lost return or circulation conditions were reported in boreholes HR 7-10; apparently, these encountered groundwater from the near-surface to their total drilled depths up to 800 ft. below the surface of Rock Lake. Sites 2 and 3 reported lost returns, lost circulation, and instances of rod greasing throughout their respective drilled depths of 900 and 1200 feet below lake level.

Except for stationary water levels in HR 19 and HR 26 at 5400-5500 elevations (500 ft. depths), all boreholes at sites 4-7 also lost water at various depths without defining a static water table. Site 8, however, HR 27 and HR 29 reported making water at the 4400-4500 level. This site is 2100 ft, east of Saint Paul Lake whose surface is at 4715 ft. elevation. Because lost circulation was also reported in HR 29 at a level of 5040 ft., it appears that a water table near lake level can be inferred at Site 8 between 4400 and 5040 elevation.



Rev. 6-90

U.S. Borax Drill Summary

FIGURE 4-5

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The high degree of variability exhibited by borehole records can be interpreted two ways; either such information is highly suspect and not suited for water table definition; or it simply reflects the high degree of complexity and lack of fracture and flow continuity in fractured rocks.

Accepting the existing information, it may be concluded that lake surfaces are reflections of a groundwater table associated with fractured bedrock. Such a water table may not be either horizontally or vertically continuous.

Downstream of Rock Lake, at an elevation of about 4100 ft., discharges of 50-60 gpm have been estimated in the Heidelberg adit. Based on 5 ft. radius, a 900 ft. depth, and a K value of 10^{-5} (average of four well tests in lower Rock Creek), an inflow of 50 gpm can be calculated. The Ho value used is approximately the elevation difference between the adit and the surface of Rock Lake. This is further evidence for the existence of a local system reflected by lake level.

4.5 MONITORING WELLS

Groundwater monitoring wells were completed in the Poorman and Little Cherry alternative tailing impoundment areas. These wells serve a number of purposes. First, they provide subsurface information on lithologies present at the impoundment sites that, in conjunction with geophysical data, assist in the evaluation of hydrogeologic conditions. Second, they provide the means for baseline water quality determinations and permit future sampling and monitoring of water quality. And third, these wells were used for aquifer testing and characterization of aquifer hydraulics related to site suitability. Table 4-2 summarizes monitor well completion data.

TABLE 4-2
MONITORING WELL COMPLETION SUMMARY
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

Well No.	Location	Lithology Perforated	Drilled Depth	Cased Depth	Type/Size Casing	Perforated Interval
PM-1	Upgradient (Poorman)	not drilled, bedrock at surface	-------	-----	--------	---------
PM-2	Upgradient (Poorman) and Pump test	Glaciofluvial gravels	39.5 ft.	39 ft.	4" PVC	24-39 ft.
PM-2OB		(Observation well for testing of PM-2, distance from PM-2: 40 ft.	39 ft.	39 ft.	6" Steel	24-39 ft.
PM-3	Downgradient (Poorman)	Glaciofluvial gravels	48 ft.	45 ft.	2" PVC	35-45 ft.
PM-4	Downgradient (Poorman)	not drilled (PM-5 duplicate)	-------	--------	---------	---------
PM-5	Downgradient (Poorman)	Glaciofluvial gravels	43 ft.	41.5 ft.	2" PVC	31.5-41.5 ft.
PLCM-6	Downgradient (Poorman and Little Cherry)					
	Shallow completion	Fluvial gravels	56 ft.	18 ft.	2" PVC	8-18-Ft.
	Deep completion	Glaciofluvial gravels	56 ft.	55.5 ft.	2" PVC	45.5-55.5 ft.
LCM-7	Downgradient (Little Cherry)	not drilled	--------	--------	--------	--------
LCTM-8	Downgradient (Little Cherry) and Pump Test	Fluvial channel (inside 6" fill steel) interval	140 ft.	93 ft.	4" PVC	45 ft. over 33-93 ft.
LCM-9	Downgradient (Little Cherry)	Glaciofluvial gravels	75.5 ft.	72 ft.	2" PVC	57-67 ft.
LCM-10	Upgradient (Little Cherry)	Glaciofluvial gravels	40 ft.	40 ft.	2" PVC	25-40 ft.
LCM-11	Upgradient	Fluvial gravels (?)	62.5 ft.	62 ft.	2" PVC	57-62 ft.
LCM-12	Downgradient (Little Cherry)	not drilled	-------	--------	--------	---------

* Locations are shown on Exhibits I and III.

Monitor well locations (Exhibits I and III) were selected so that groundwater baseline data could be obtained both upgradient and downgradient from the alternative tailing disposal sites, and to test as many different groundwater zones as possible. Wells PM-1, PM-2, LCM-10, and LCM-11 were designed as upgradient wells, two each per site. PM-2 was to test gravels of the fluvial apron considered to be the primary source for groundwater recharge of the Poorman site. Other upgradient wells were to define colluvium and slope-wash contributions to the impoundment areas.

All other wells were constructed at downgradient sites. PM-3 was planned as a test of post-glacial deposits associated with Poorman Creek. Wells PM-4, PM-5, LCM-7, LCTM-8, and LCM-9 were planned to test lacustrine silts and interbedded fluvial gravels present within the alternative impoundment areas. PLCM-6 was dual completed to test shallow and deep horizons and specifically located to serve as one of the downgradient monitor wells for both alternative impoundment sites. Well LCM-12 was chosen as a monitor of potential bedrock flow. Well LCTM-8 was also planned as the primary pump test well; its location was interpreted as providing the thickest section of unconsolidated materials present within the tailings disposal area.

As monitor wells were constructed, it became evident that hydrogeologic conditions in some locations differed from those initially thought to exist. The drilling program was therefore altered while underway to benefit from new data as they were obtained. Some wells were not drilled, whereas some changes were made in completion design and in planned aquifer testing. Well PM-1 was not drilled because bedrock was encountered near-surface at the planned location. Well PM-2 was completed as a pump test well, with subsequent installation of PM-2 OB to serve as an observation well. Wells PM-4 and LCM-7 were considered to duplicate others, lacking the potential to contribute additional data of any significance. Well LCM-12 was deleted due to the absence of groundwater at the bedrock contact in other wells drilled. Although not drilled to the depth originally planned, well LCTM-8 provided significant hydrogeologic data; the filled channel deposits encountered necessitated a change from its original conception.

The wells that were ultimately completed adequately characterize the groundwater conditions of the proposed tailings impoundment sites and provide sufficient data for determining aquifer hydraulics. In addition, they permit reasonable monitoring of groundwater levels during the baseline study period.

4.6 WATER LEVEL MONITORING

Based on mid-August, 1988 static water levels (Table 4-3) a potentiometric map was prepared for the alternative tailing impoundment sites (Exhibit III). The contoured data indicate that groundwater flow corresponds roughly to topography with flow being from west to east across both sites. In the case of the Little Cherry site, groundwater flow appears to be somewhat channelized. This condition is interpreted as being in response not only to topography, but in part to the apparent filled channel encountered in well LCTM-8. The apparent buried channel at the Little Cherry site is excavated within lacustrine silts and filled with coarse fluvial gravel which, except for its silty matrix, would normally conduct groundwater across the north-south zone of glaciofluvial/glaciolacustrine deposits. Exhibit IV contains a cross-section showing the sub-surface configuration of this channel based on the combined interpretation of well and field data.

Throughout most of the area static water levels measured in August, 1988 were found to be higher than the level at which water was encountered during actual drilling. Comparisons between static water levels, drilling levels and "water table" levels interpreted from resistivity soundings, show that groundwater underlying much of the area is slightly confined. This is especially true in the case of the Poorman site where wells PM-5 and PLCM-6 flow at the surface in response to artesian conditions. This zone of artesian flow corresponds closely to the zone of interfingering of coarse gravels with lacustrine silts. The area considered most susceptible to surface artesian flow is shown on Exhibit III.

TABLE 4-3

GROUNDWATER LEVELS

ll(a) o.	Ground Elev. (ft)	Casing Top Elev. (ft)	Stick-up Height	Static Water Depths from Ground Surface (ft) 7/88	8/88	10/88	01/89	3/89	4/89(e)
-2	3683.7	3686.0	2.3	-15.1	-15.2	-15.4	-13.6	-12.4	--
-3	3439.8	3442.8	2.95	-13.1	-13.4	-13.6	-13.8	-13.4	--
-5(b)	3379.8	3383.9	4.2	+15.3	+16.9	+16.9	--(c)	--(d)	+15.7
CM-6 allow	3445.2	3447.7	2.45	-7.2	-7.4	-7.6	-5.8	-4.0	--
CM-6(b) eep	3445.2	3447.7	2.45	+ 8.6	+8.3	+8.2	--(c)	8.2	+9.4
[illegible]	3380.4	3382.9	2.5	not stable	-12.4	-13.6	-10.4	-9.9	--
M-[illegible]	3416.6	3419.7	3.12	-9.2	-9.8	-10.9	-8.5	-7.8	--
M-10	3739.0	3742.0	3.1	-12.9	-12.9	-13.2	-5.5	-5.2	--
M-11	3754.9	3757.6	2.73	-11.3	-13.8	-12.8	-4.7	-4.5	--

(a) Locations are shown on Exhibits I and III.

(b) Artesian wells have a psi measurement converted to static water level from ground surface.

(c) Artesian well plugs frozen. No psi measurement taken.

(d) Well seal failure. No psi measurement taken.

(e) Only artesian readings taken.

Inferred groundwater surfaces across the impoundment sites differ depending on whether they are determined from static water levels or from levels interpreted from resistivity and drilling. The latter surface results in gradients of 0.1 ft/ft along the western side of the two sites, changing to a flatter gradient of .05 ft/ft through middle portions, and then reverting back to 0.1 ft/ft along the eastern Libby Creek side. The potentiometric surface, on the other hand, suggests a more uniform .075-.08 ft/ft gradient across the Poorman site and a .05 ft/ft gradient across the Little Cherry site. Differences in the surfaces defined by these gradients correspond to the areas of confined conditions, especially in the case of the Poorman site (Exhibit IV).

4.7 AQUIFER CHARACTERIZATION AND HYDRAULICS

Hydraulic conductivities and transmissivities throughout both alternative tailing impoundment areas are low to very low, indicating that the materials present are not good aquifers (Table 4-4). Coarse materials present contain a silty matrix that decreases their capacity for transmitting groundwater. Finer-grained lacustrine silts are characterized as aquicludes; other heterogeneous mixtures tend to act as aquitards. Only moderately-sorted, glaciofluvial gravel layers in the subsurface and thin deposits of ephemeral surface channels appear to permit flow of any magnitude.

Interfingering of glaciolacustrine and glaciofluvial deposits of differing transmissivities is responsible for non-uniform hydraulic conditions within the alternative tailing disposal areas. The downgradient confinement of an aquifer (fluvial gravels) by an aquiclude (lacustrine silts) permits hydraulic pressures to build so that surface artesian conditions are created. In the Little Cherry area, such aquifer confinement is apparently mitigated by a filled channel consisting of deposits whose transmissivities preclude severe restriction of groundwater flow.

TABLE 4-4
AQUIFER TEST DATA
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

Well No.	Aquifer	Hydrogeologic Conditions	Type Test	Method	K (gpd/ft^2)	T (gpd/ft)
PM-2	Glacio-fluvial	Partially confined apron	Pump test (constant flow)	Cooper-Jacob	45-86	448-860
PM-20B	"	"	"	Theis	46	463
"	"	"	"	Cooper-Jacob	87	874
PM-3	Sub-lacus-trine glacio-fluvial	"	Slug test	Bouwer-Rice	10	275
PM-5	"	Confined	Flow test (constant drawdown)	Jacob-Lohman	2.8	28
"	"	"	Shut-in test	"	2.1	21
PLCM-6 (Deep)	"	"	Flow test (constant drawdown)	"	94-145	940
"	"	"	Shut-in test	"	95-145	945
PLCM-6 (shallow)	Ephemeral stream channel	Unconfined	Slug test	Bouwer-Rice	40	500
LCTM-8	Buried fluvial	Partially confined channel	Pump test	Cooper-Jacob	2.7	120
LCM-9	Sub-Lacus-trine glacio-fluvial	Confined	Slug test	Bouwer-Rice	2	100
LCM-10	Glacio-fluvial apron	Partially confined	"	"	.05	1.3
LCM-11	Filled fluvial channel (?)	" "	"	"	0.5	25

* For slug tests, parentheses indicate calculations based on drill log thicknesses. Locations are shown in Exhibits I and III.

As monitoring wells were constructed, it was evident that materials encountered in PM-2 (Exhibits I and III) had higher potential for groundwater transmittal than those of most other wells. This well was therefore completed as a pump test well with an observation well installed 40 feet to the north.

Well PM-2 was pump tested for four hours. Aquifer test data are contained in Appendix I. Steady state conditions appeared to be reached after 20-25 minutes of pumping. Because of the presence of nearby Poorman Creek, these plots were initially thought to represent a recharge boundary. A distance-drawdown plot made from time-drawdown data suggests that the effective zero-drawdown distance for the test conducted extends about 250 feet from the pumped well, thus falling short of potential influence from Poorman Creek. Therefore, it is unlikely recharge from Poorman Creek was recognized.

Hydraulic parameters calculated from data for PM-2 and PM-2 OB are included in Table 4-4. All remaining test data and calculated hydraulic conductivities and transmissitivies are consistent with the hydrogeologic conditions and aquifer materials present. Transmissivities for aquifers in the impoundment areas range from 1 to 945 gpd/ft, with conductivities in the 0.05 to 145 gpd/ft^2 range. Overall, groundwater flow is minimal within all hydrogeologic units of the area.

An estimate of groundwater flow through the filled channel present within the Little Cherry tailing disposal site was also determined. According to the mapped subsurface channel configuration (Exhibits III and IV), a cross-sectional area of 96 sq. ft. is considered available to conduct groundwater across the site. Using the hydraulic conductivity of 2.7 gpd/ft^2 determined from an aquifer test of well LCTM-8, and a hydraulic gradient of 0.05, groundwater flow through the filled channel is calculated to be only 0.9 gpm (1,296 gpd). This is a very low magnitude of flow, and it would be considerably less through lakebed silts present elsewhere at the two sites.

4.8 GROUNDWATER QUALITY

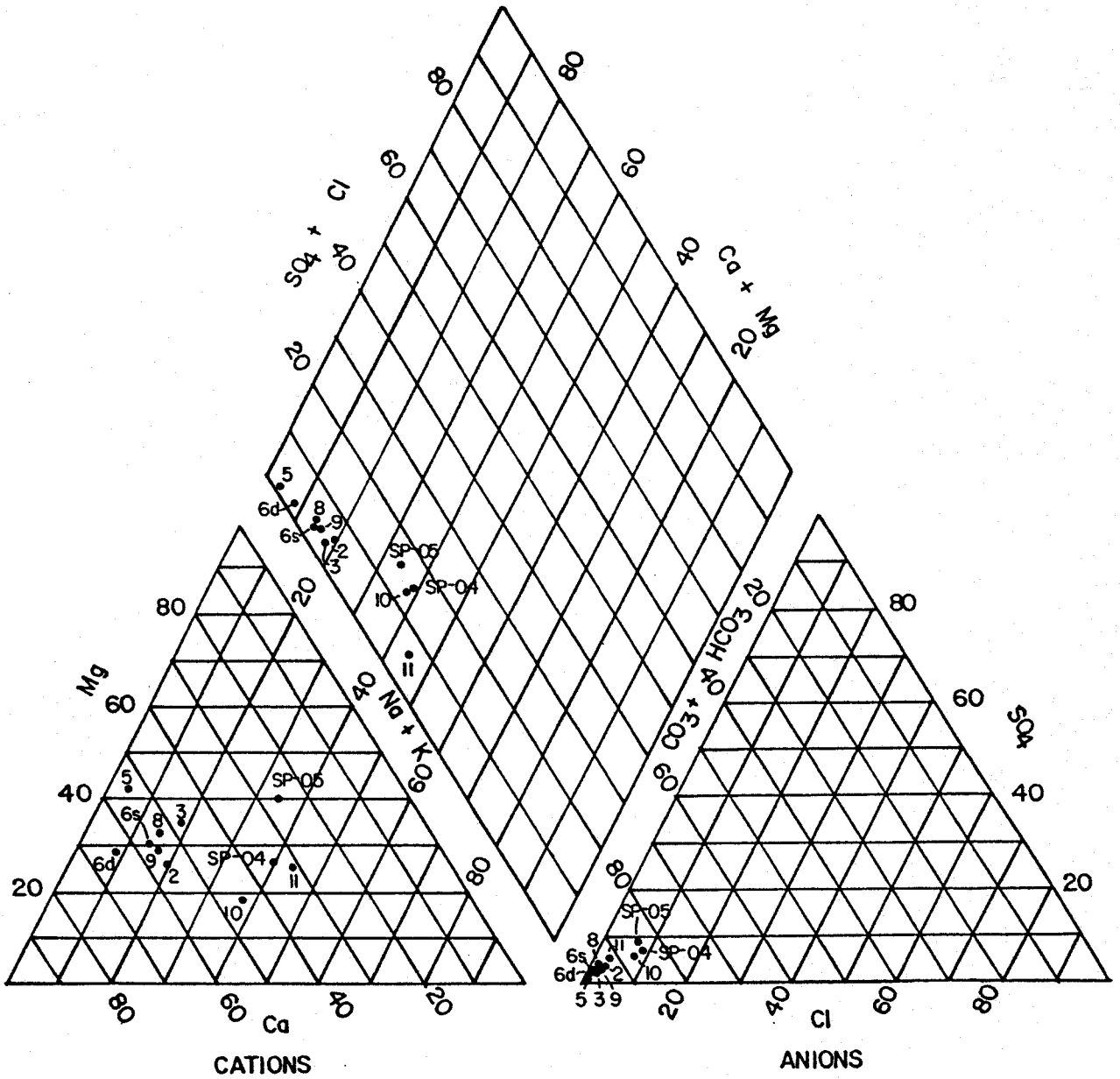
4.8.1 QA/QC Program Results

Groundwater quality data collected to date (Appendix J1) is comprised of two sampling events completed in August and October, 1988. The same QC computer codes that apply to the surface water quality database have been applied to the groundwater quality database to identify those natural or QC samples which fail to meet specific QA/QC criteria. However, because of the very limited number of samples, no detailed QA/QC analysis has been performed on these data, and no statistical summary of this database is deemed meaningful at this time. Groundwater quality data validation statements are presented in Appendix J2.

Groundwater quality characterization is based on both groundwater sampling of each well in the alternative tailing disposal areas, and on samples of springs located in upper Libby and Rock Creeks. Sampling is on a quarterly basis; the first collection was made in mid-August, 1988, and a second sample was collected in mid-October. Data from these two sampling runs are presented in Appendix J1.

4.8.2 General Observations and Characterizations

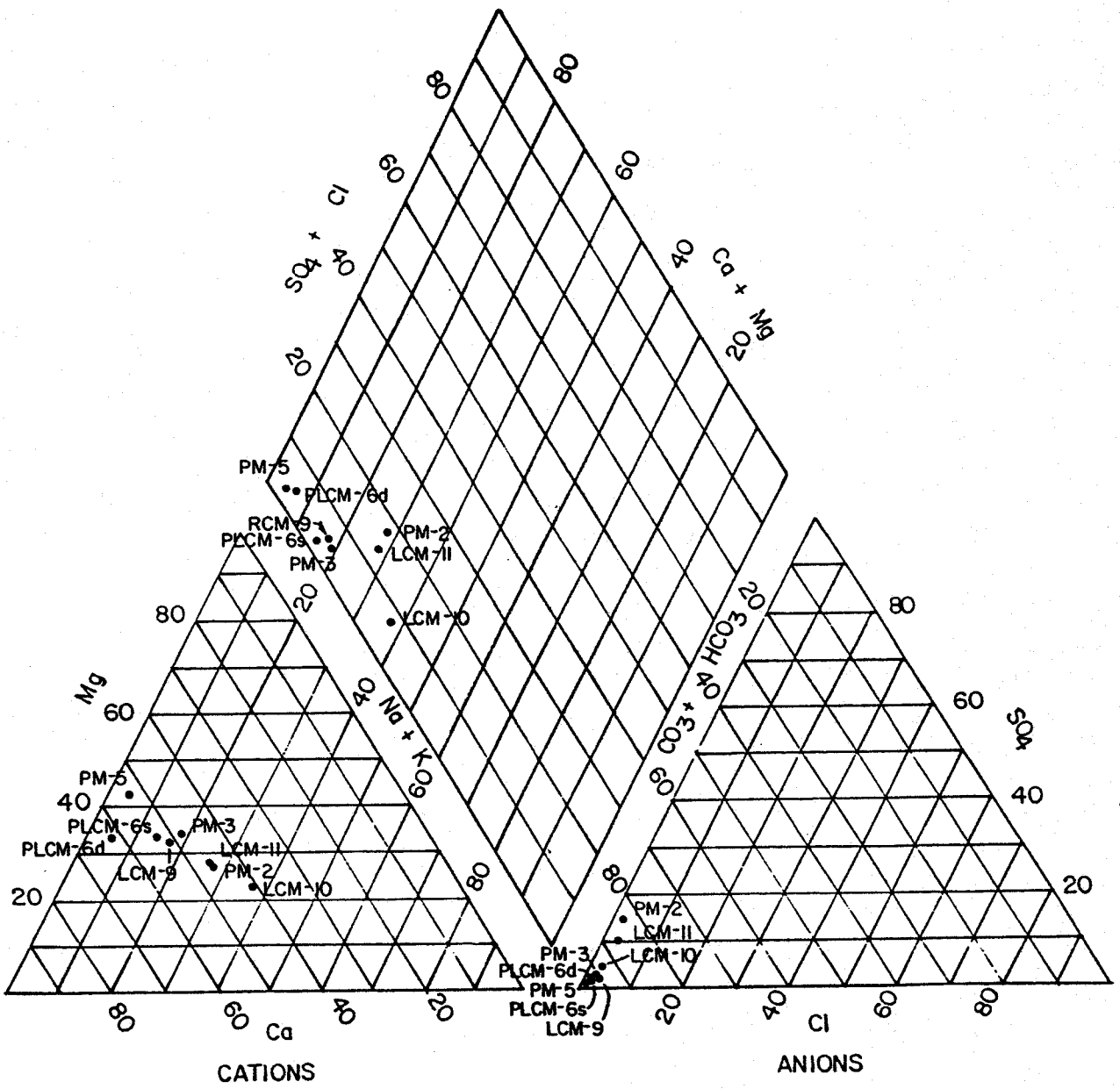
Analyses of groundwater samples collected in August, 1988, are plotted on Figure 4-6. A bimodal grouping results. The majority of groundwater samples analyzed are clearly a calcium bicarbonate type. Samples from wells LCM-10 and LCM-11 plot with spring samples SP-04 and SP-05 (Figure 4-6); however, this group does not appear to have a dominant cation. The spring samples of this separate group have significantly lower ion concentrations than samples from wells LCM-10 and LCM-11, and in terms of overall water quality character, appear to be more closely related to surface waters than to groundwaters (Appendices G and J).



Trilinear Plot of August, 1988, Groundwater Data

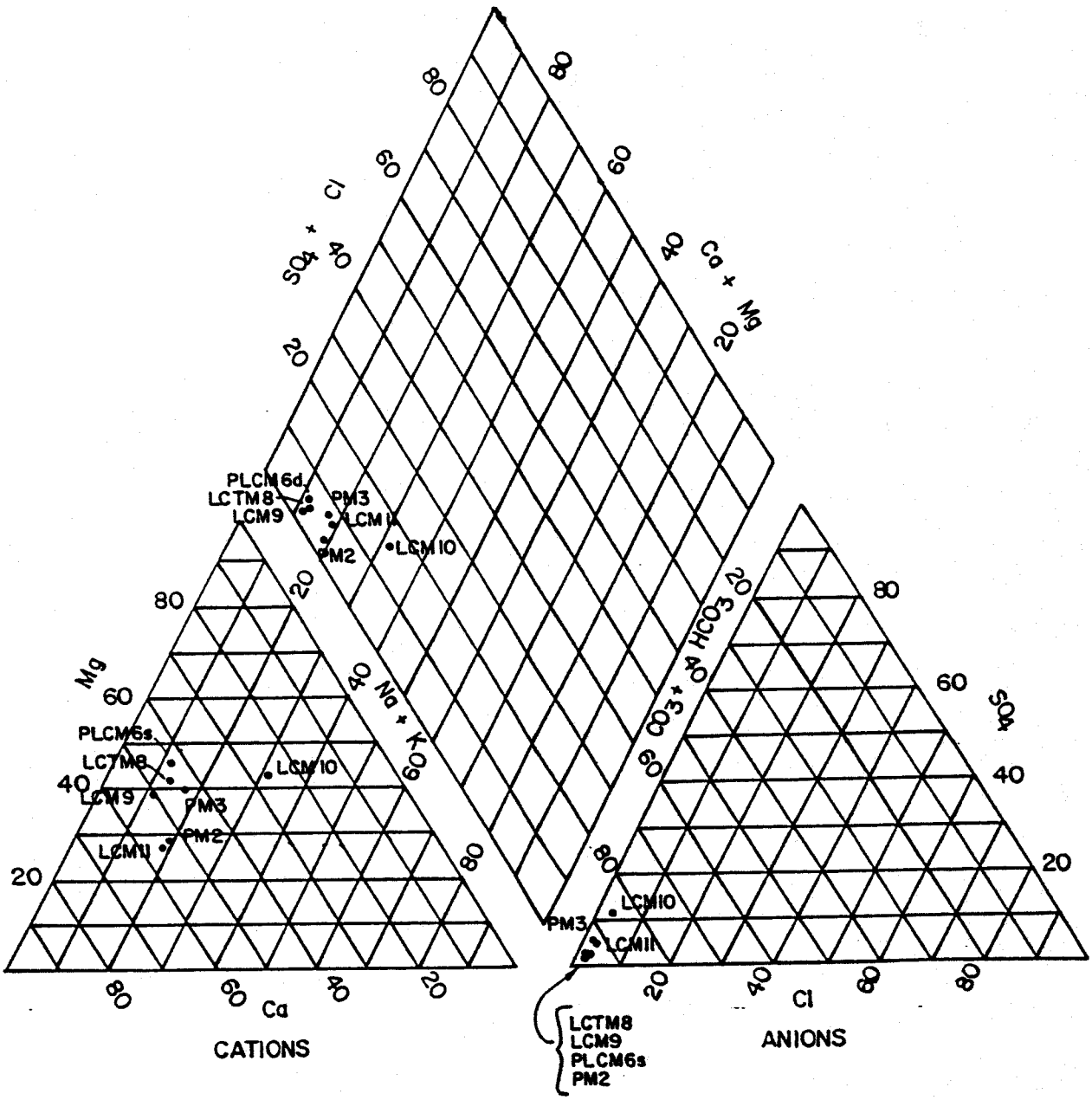
The slight chemical differences between groundwater of wells LCM-10 and LCM-11, as compared to others, suggest that groundwater upgradient from the Little Cherry tailing impoundment site may not have travelled as far. These two samples may be slightly more representative of groundwater recharge waters than do other wells analyzed.

Analyses of groundwater samples collected from monitoring wells during the second quarter sampling period (October, 1988) indicate very little change from August sampling. Most significant is the apparent stabilization of all wells and verification of the bimodal grouping of chemical data on trilinear plots. On the basis of second quarter data plots (Figure 4-7), it is apparent that waters of upgradient wells closely represent recharge waters that evolve to a characteristic Ca, Mg-bicarbonate type with downgradient migration.

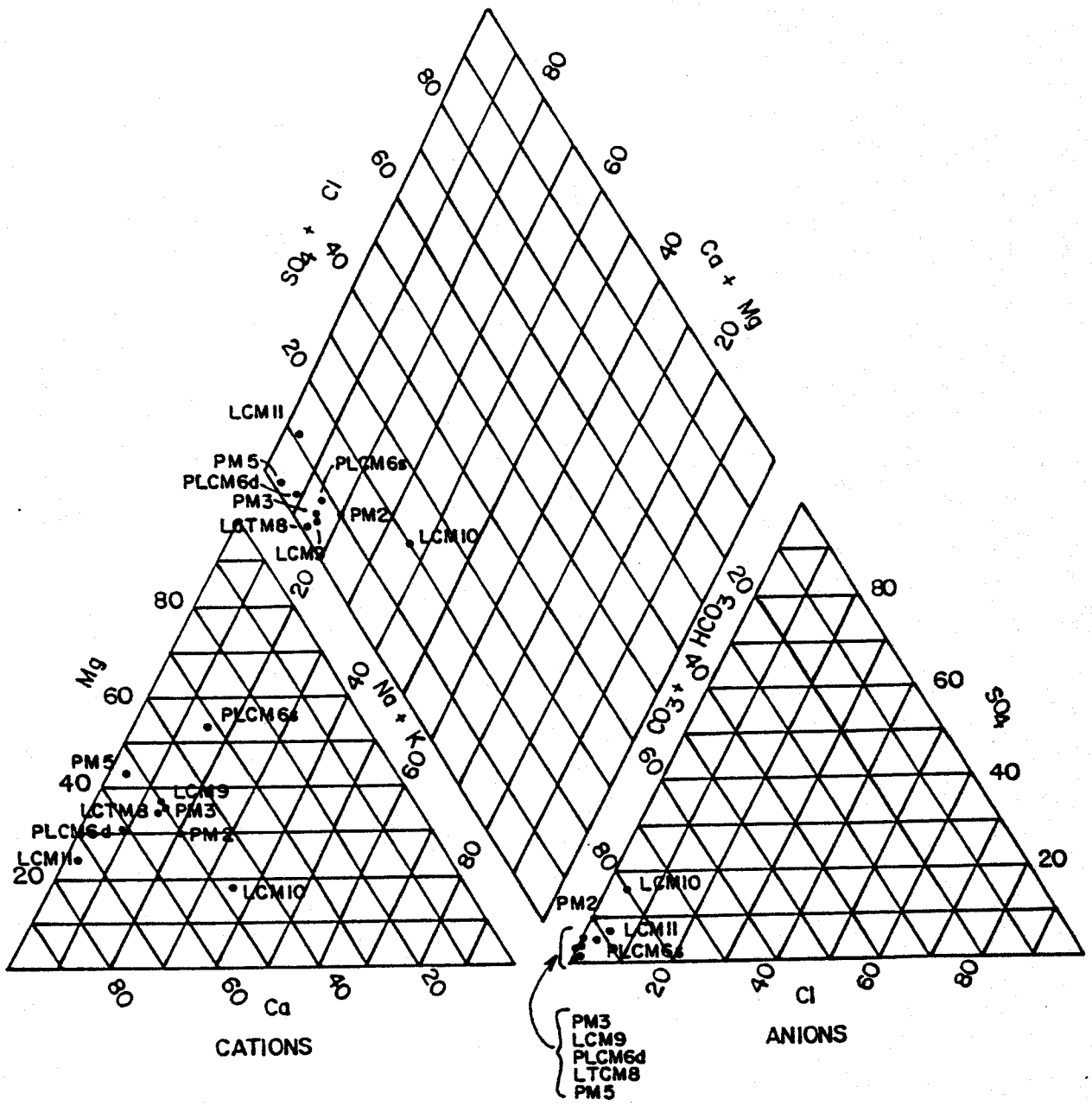


Trilinear Plot of October, 1988, Groundwater Data

FIGURE 4-7



Trilinear Plot of Third Quarter (January, 1989), Groundwater Data



Trilinear Plot of Fourth Quarter (March, 1989), Groundwater Data

NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana

FIGURE 4-7B

4.8.3 Significant Trends, Differences, and Similarities

No major trends were revealed by samples of the first collection period, nor did chemical differences or similarities seem to correlate hydrogeologically. All groundwater samples were generally found to be of good quality. Concentrations for most parameters remained consistantly near or below detection limits for the baseline period of study. Major cation and anion concentrations are low, as are total dissolved solids (TDS), sodium-adsorption ratio (SAR), and specific conductance (SC) values. Metals concentrations were slightly above method detection limits in most cases and showed no seasonal fluctuation during the four quarterly sampling periods.

Major differences include higher than normal pH for PLCM-6 (shallow) which decreased from 8.7 s.u. in August, 1988 to 7.7 s.u. in March, 1989. Concentrations greater than detection were also noted for nitrates (0.11-1.1 mg/L), manganese (0.02-1.09 mg/L), and for cadmium (0.001-0.006 mg/L) in several samples. However, these concentrations are well below any level of concern for public drinking water.

PM-2, an upgradient well, and LCM-11 were found to have the lowest SC value (98 umhos/cm), whereas PM-5, a downgradient well, had the highest measure of this parameter (335 umhos/cm). The latter well is also located farther downgradient than any other well. A trend toward increasing ion concentration with increased distance of flow is therefore suggested. This observation is consistent with established water quality theories.

Seasonal variation occurs in values for nitrate + nitrite as N for all wells with the exception of PLCM-6 (deep, flowing artesian). Generally, concentrations increased from August to October, and decreased significantly into January; March and January were only slightly above the detection limit. Sulfate values remained near detection limit during the

entire study period. Total dissolved solids and hardness varied seasonally. Increases in both parameters occurred in LCM-10, LCTM-8, and PM-5. The remaining wells showed no increase or a decrease in TDS and hardness concentrations from August, 1988 to March, 1989.

Metals values during the baseline study showed no seasonal fluctuation. Most values were below or near detection limits at all stations.

REVISED -- JUNE 23, 1989

4.9 RECHARGE AND DISCHARGE INTERPRETATIONS

All major streams of the project area originate in the Cabinet Mountains. This elevated topography also serves as a primary groundwater recharge area by means of infiltration of runoff, precipitation, and snowmelt. Subsequent groundwater flow is toward better defined groundwater systems established in unconsolidated, heterogeneous deposits of valley bottoms. These valley deposits subsequently direct both surface and groundwaters from the mountains to lower elevations.

Although no major regional discharge area can be defined within the project area, there are small, local areas where additions and subtractions to groundwater are occurring (Exhibit II). These local recharge and discharge relationships are strongly seasonal; thus, they may cause fluctuations in water table levels groundwater flow regimes.

Areas of potential groundwater recharge by local stream losses tend to occur where present streams flow over older glaciofluvial surfaces. At times of high surface flow (spring runoff), recharge of unconsolidated materials (mapped as Qg, Exhibit II) likely occurs. The alternative tailing disposal sites are located downgradient from such recharge areas.

Major eastside streams of the project area flow either to Libby or Bear Creek. Local groundwater discharge zones are mapped (Exhibit II) where channel incision by Libby and Bear Creek have created bank-like exposures of lacustrine sediments of up to 140 feet. Most downcutting has occurred along the contact between lakebed materials and bedrock; thus, the western and northern boundaries of the tailing disposal areas are possibly zones of localized groundwater discharge. Abrupt steepening of groundwater gradients and high hydraulic heads associated with these over-steepened valley walls are reflected by minor slumping, active seepage, and lack of surface ponding of the lakebed surface immediately adjacent to the valley sides.

4.10 Alternative Facilities Sites

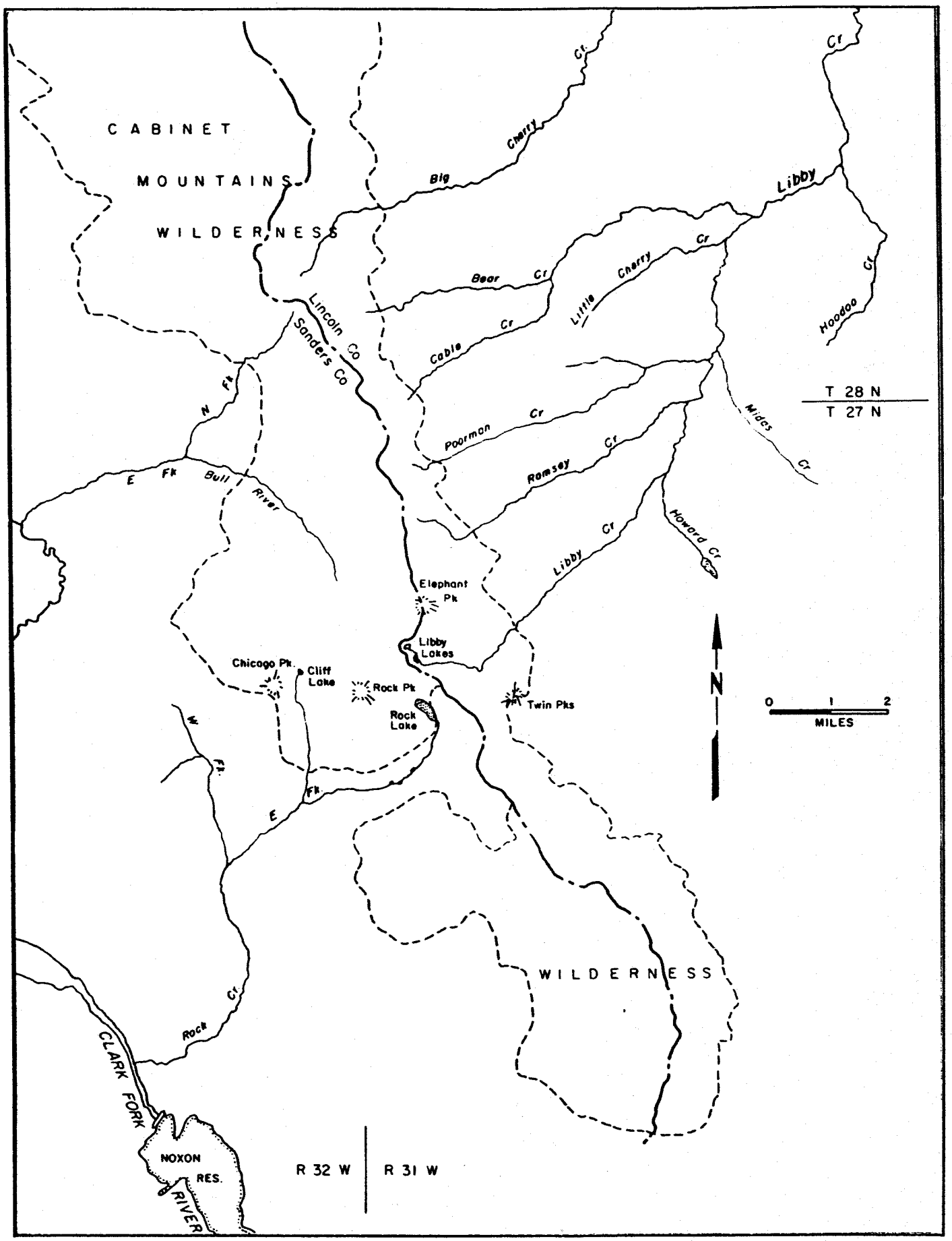
Groundwater investigations were conducted for alternative mine facility sites for the Montana Project. Morrison-Knudsen Engineers obtained groundwater information in the vicinity of the alternative plant and mine portal sites, including the Libby Creek and Ramsey Creek locations (Figure 4-8). Detailed groundwater information was also collected by Chen-Northern for the alternative tailing disposal sites, which included the Little Cherry Creek and Poorman Creek locations (Figure 4-8). Detailed site descriptions and baseline data are contained in the Geotechnical Report (Morrison-Knudsen, 1989) and groundwater data are presented in Appendix J of this document.

4.10.1. Alternative Plant and Mine Portal Sites

The alternative plant and mine portal sites include the Libby Creek site at an approximate elevation of 4300 feet, and the Ramsey Creek site at an elevation of 4450 feet.

Ore processing plant locations at both alternative sites are similar with respect to surface and subsurface materials. Materials include a combination of bedrock or glaciofluvial outwash and talus overlying bedrock (Morrison-Knudsen, 1989). Seismic refraction surveys conducted by Morrison-Knudsen at the Libby and Ramsey sites indicated that bedrock was probably encountered at depths ranging 30 to 70 feet at the Libby site and 24 to 70 feet at the Ramsey site. Mine portals at both the Libby site and the Ramsey site would be constructed in bedrock. Both sites are characterized by shallow talus cover at the selected portal locations.

Static groundwater level measurements were recorded from geotechnical boreholes completed during the site investigations. Depths to groundwater at the Libby Creek plant site were measured at 12 to 16 feet, and at a measured depth of 22 feet at the Ramsey Creek site (Morrison-Knudsen, 1989). None of the test pits which were excavated at either site encountered groundwater.



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Lincoln and Sanders Counties, Montana

Project Area
FIGURE 4-8

4.10.2. Alternative Tailing Disposal Sites

Baseline investigations for groundwater in the Little Cherry Creek and Poorman Creek alternative tailing disposal sites included the completion of nine monitoring wells; one well was a dual completion.

Both tailing disposal sites are dominated by poorly-sorted glaciofluvial outwash and glacial lakebed sediments. The outwash material is deposited directly on ice-scoured bedrock and interfingers with the overlying glacial lakebed sediments that were deposited as the paleo-lakeshore advanced up the mountain front. Resistivity surveys, refraction surveys, and drilling conducted in the study area indicate that the thickness of this valley fill package ranges from 0 feet at a few exposures of bedrock to over 200 feet at the Poorman site.

A total of thirteen aquifer tests were performed within the poorly-sorted glaciofluvial materials. The range of permeabilities recorded was 0.05 to 145 gpd/ft^2, with an average value of 50 gpd/ft^2.

Groundwater is recharged locally by infiltration of precipitation, snowmelt, and streamflow, primarily at the uppermost contact with bedrock. Groundwater flow is generally along the bedrock contact to where it discharges to springs, directly to local streams, or other locations beyond the study area.

An artesian condition was identified in the lower portion of the Poorman Creek site. Lakebed silts in this part of this site form a cap on the underlying glaciofluvial outwash. Farther to the north, near the Little Cherry Creek site, this artesian condition does not exist, presumably due in part to the breach in the silt cap by an infilled paleochannel.

Groundwater at both alternative tailing sites is of good quality. Groundwater quality data are presented in Section 4.8 of this baseline report and in Appendix J.

4.11 SUMMARY

The primary objectives of the groundwater resources investigation for the Montana Project are to provide baseline information on existing groundwater conditions, characterize water quality, and provide a means for future groundwater monitoring. Major emphasis was placed on investigating the alternative tailing impoundment sites, because they are considered to be the areas where greatest impacts from mining activities may occur. These areas also have the highest potential for the presence of aquifers.

The occurrence and distribution of groundwater throughout the project area are controlled by both local and regional geologic conditions. In headwater areas of major drainages, where mine production facilities may be located, groundwater recharge conditions dominate. Groundwater flow is confined primarily to mixed valley deposits, including small terminal moraines, and Belt bedrock. Groundwater is then directed from the higher valleys outward to the eastern mountain front of the Cabinet Mountains where, along with streamflow, it locally recharges the glaciofluvial and glaciolacustrine deposits underlying areas being considered for tailing disposal. Except for fracture permeability, Belt bedrock is probably not a viable aquifer.

Aside from minor bedrock exposures and intermediate colluvium-covered slopes, the alternative tailing impoundment sites consist of both saturated and unsaturated lakebed silts that interfinger with coarse, moderately-sorted, heterogeneous materials deposited in an alluvial fan-like manner along the mountain front. In spite of the presence of fluvial gravel layers, these deposits have low to very low permeabilities and transmissivities, and thus are probably not significant water-bearing units (Table 4-4).

Within the alternative tailing disposal sites, groundwater flow is generally from west to east. The hydraulic gradient flattens across the zone of interfingering between glaciofluvial and glaciolacustrine deposits,

and confined aquifer conditions with sufficient hydraulic head to result in flowing wells occurs within the Poorman site. A filled channel penetrates this zone in the Little Cherry site, but aquifer test data indicate transmissivities are nearly as low as the lakebed silts.

Analyses to date show all groundwater to be soft to moderately hard calcium bicarbonate type with low concentrations of total dissolved solids and metals. Spring water samples are found to be very similar to surface waters, and probably represent local reemergence of infiltrated runoff.

No major groundwater discharge areas were identified within the project area, although local areas of groundwater discharge were identified on the basis of seepage from saturated lakebed silt deposits. Where stream incision has taken place along the eastern and northern margins of the glaciofluvial sediments within the alternative tailing impoundment areas, the groundwater gradient is locally steepened. Although hydraulic parameters of existing materials preclude significant groundwater flow, some minor seasonal discharge to Bear and Libby Creeks probably occurs.

Chen-Northern, Inc.

SECTION 5.0

5.0 REFERENCES

Alden, W.C., 1953. Physiography and Glacial Geology of Western Montana and Adjacent Areas. U.S. Geological Survey. Professional Paper 231, 200 pp.

American Public Health Association, 1985. Standard Methods for the Examination of Water and Wastes.

ASARCO, 1987. Volume 1, Environmental Baseline Reports, Rock Creek Project, Sanders County, Montana.

ASCE, 1977. Manuals and Reports on Engineering Practice No. 54, Sedimentation Engineering. p. 534 edited by V.A. Vanoni.

Chow, Open-Channel Hydraulics, McGraw-Hill, Inc., p. 165, 1959

Chow, Handbook of Hydrology, McGraw-Hill, Inc., pp 8-15, 16, 1964.

Dunne T. and Leopold, L.P., 1978. Water in Environmental Planning. W.H. Freeman and Company. pp. 665-668

EPA, 1983. Methods for Chemical Analysis of Water Wastes (EPA-600/4-79-200), Revised March, 1983

EPA, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029).

Fletcher Associates and United States Borax and Chemical Corporation, 1988. Plan of Study, Collection of Environmental Baseline Data, Montana Silver Venture Project, Lincoln and Sanders Counties, Montana.

Gibson, Russell, 1948. Geology and Ore Deposits of the Libby Quadrangle, Montana: with Section on Glaciation by W.C. Alden; U.S. Geological Survey. Bulletin 956, 131 pp.

Gregory, K.J. and Walling, D.E., 1973. Drainage Basin Form and Processes. John Wiley and Sons. pp. 161-163.

Johns, W.M., 1970. Geology and Minerals Deposits of Lincoln and Flathead Counties, Montana; Montana Bureau of Mines and Geology. Bulletin 79, 182 pp.

Omang, R.J., C. Parrett and J.A. Hull, 1986. Methods for Estimating Magnitude and Frequency of Floods in Montana, Based on Data Through 1983. U.S. Geological Survey, Water-Resources Investigative Report 86- 4027, Helena, Montana.

Northern Engineering and Testing, 1988. Quality Assurance/Quality Control Program.

Richards, Keith, 1982. Rivers - Form and Process in Alluvial Channels. Methuen and Co., p 110.

Strahler, A.N., 1957. Qualitative Analysis of Watershed Geomorphology. Trans. Am. Geophysical Union, Vol. 38, pp. 913-920.

Thornbury, W.D., 1965. Regional Geomorphology of the United States, John Wiley & Sons, Inc.

U.S. Department of Agriculture Soil Conservation Service, 1980. Average Annual Precipitation - Montana (based on 1941-1970 base period), Bozeman, Montana.

U.S. Geological Survey, 1982. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. Geological Survey Water- Supply Paper 2175, pp. 79-183.

APPENDIX A

Chen-Northern, Inc.

APPENDIX A

APPROVED PLAN OF STUDY

United States Department of Agriculture | Forest Service | Kootenai NF | 506 US Highway 2 West Libby, MT 59923

Reply to: 2810

Date: December 12, 1988

Joe Scheuering
Noranda Minerals Corp.
P.O. Box 7176
Reno, NV 89510

RE: Plan of Study (POS) - Water sampling program

Dear Joe,

Per letter of November 1 from Gary Fletcher, the agencies accept your revised (September 1988) QA/QC program for surface and ground water data collection.

Per letter of November 16 from Gary Fletcher regarding surface water sampling locations, the agencies accept the proposed modifications with the following clarification that the locations dropped in both the Libby Creek and Rock Creek project areas during the winter months will be added to the sampling program next spring. Also, a statement should be made that if Noranda plans something more than a ventilation adit on the Rock Creek side, the sampling program would be reviewed and possibly modified again.

The agencies request that the proposed modifications be reflected as an addendum to the POS. The addendum should be a revised Section 4, Hydrology with appropriate signature page and cover.

The agencies are reviewing the proposed revisions to the Wildlife and Vegetation sections, and will provide comments as soon as possible.

If you have any questions, please contact either Kit or me.

Sincerely,

Ron Erickson

Ron Erickson
ES Project Coordinator

cc: Gary Fletcher
Brent Bailey
Kit Walther, DSL

FLETCHER
ASSOCIATES

17740 East Hinsdale Avenue
Aurora, Colorado 80016
(303) 693-2516

November 16, 1988

Jim Rathbun
Forest Supervisor
Kootenai National Forest
506 U.S. Highway 2 West
Libby, MT 59923

Kit Walther, Chief
Hard Rock Bureau
Montana Dept. of State Lands
1625 Eleventh Avenue
Helena, MT 59620

Re: Montana Mining Venture
Water Quality Sampling Locations

Gentlemen:

Northern Engineering and Testing, Inc. (NET) has presented Noranda with a revised schedule for surface water quality sampling during the winter months. This request is based on access and safety.

In addition, NET has reviewed the existing data collected on Rock Creek by NET, ASARCO, and the U.S. Forest Service and believes that there is sufficient data available to preclude NET's collection of further data on the lower reaches of Rock Creek.

Following is the proposed modification to the surface water quality sampling program during the winter months, as well as those stations to be deleted permanently. This schedule was discussed with the U.S. Forest Service and Montana DSL during October and November.

Libby Creek Project Area

NET will continue to collect surface water samples from all locations on the Libby Creek side of the project area. However, during the winter months, snow accumulation and avalanche danger may result in the following sites not being sampled:

(Libby Creek) LB 100, 200, 2000
(Ramsey Creek) RA 100, 200
(Bear Creek) BC 100

The winter sampling program will include the following surface water stations.

	Station	Activity
Libby Creek	LB 500	Sampling & gaging
	LB 800	Sampling & gaging
	LB 3000	Sampling & gaging
Ramsey Creek	RA 600	Sampling & gaging
Poorman Creek	PM 500	Sampling & gaging
	PM 1000	Sampling & gaging
Little Cherry Creek	LC 100	Sampling & gaging
	LC 600	Sampling & gaging

Groundwater sampling will continue on the existing schedule on the Libby Creek side of the project area.

Rock Creek Project Area

NET will permanently drop the following surface water quality sampling locations.

East Fork Rock Creek	EF 800
West Fork Rock Creek	WF 20
Rock Creek	RC 850
Rock Creek	RC 2000

Data has been collected on all of these sites by the U.S. Forest Service and/or ASARCO. The U.S. Forest Service commenced sampling in 1974 and ASARCO in 1983.

During the winter months, the following stations may be deleted because of access and safety considerations due to snow accumulation.

East Fork Rock Creek EF 200, EF 300, EF 400

The NET field personnel will inspect the sites and determine if access is possible during the winter.

With the exception of the sites permanently deleted, NET will commence collection at all sites as access and safety permit in 1989. If you have any questions, please contact me.

Sincerely,

Gary J. Fletcher

Gary J. Fletcher
GJF:af
cc: Joe Scheuering
Brent Bailey

SIGNATURE PAGE

The U.S. Forest Service (USFS) and Montana Department of State Lands (MDSL) have reviewed the Draft Plan of Study (POS) issued January 20, 1988 and made comments to clarify and correct the Draft POS. U.S. Borax has incorporated the changes and submits this Final POS to the USFS and MDSL.

There are three plant site alternatives and two tailings disposal site alternatives to be studied in the collection of environmental baseline data. These alternatives appear to be practical, economic, and environmentally acceptable at this early phase of the evaluation. If, during the course of this study, it is determined that one or more of the alternatives have become unacceptable, they may be dropped and others added. The dropping and/or adding of alternatives would require review and modification where appropriate of this Plan of Study by the agencies and U.S. Borax to insure adequate collection of environmental baseline data. It is also understood that based on baseline data findings, the Plan of Study may be modified by the agencies and U.S. Borax.

The affixed signatures document acceptance of this Final POS. All substantial changes to the POS will require a new Signature Page.

Kenneth M. Reim Date: 6/16/88
Kenneth M. Reim
Manager, Mining Development
United States Borax & Chemical Corporation
3075 Wilshire Boulevard
Los Angeles, California 90010-1294

James F. Rathbun Date: 6/23/88
James F. Rathbun
Forest Supervisor
Kootenai National Forest
Forest Service
United States Department of Agriculture
506 U.S. Highway 2 West
Libby, Montana 59923

Kit Walther Date: 6-17-88
Kit Walther, Chief
Hard Rock Bureau
Montana Department of State Lands
Capitol Station
Helena, Montana 59620

Section 4

HYDROLOGY

To mine and process the silver-copper ore, permits must be obtained from both the U.S. Forest Service (USFS) and Montana Department of State Lands (MDSL). The mine permitting process for both the USFS and MDSL requires water resources environmental baseline data for the area to be mined, as well as for areas surrounding the mine's production facilities and tailing disposal area(s).

Outlined in the following is the Plan of Study for surface-water and groundwater hydrology. Included are the objectives, scope of work, reporting procedures and proposed quality assurance/ quality control plan.

4.1 OBJECTIVES

The proposed Plan of Study for the hydrological baseline investigation has specific objectives as follows:

- Provide the necessary information for mine planning, engineering, design and development of the reclamation plan.

- Be carried out under an appropriate quality control/ quality assurance program such that all data collected during the investigation are of known reliability, precision, and accuracy.

- Provide sufficient information concerning baseline conditions in the area to be affected so as to have a complete permit application for MDSL and USFS.

- Provide sufficient information for the agencies to prepare an environmental impact statement (EIS). An EIS will probably be required under both Federal and Montana environmental policy acts (NEPA and MEPA, respectively). There must be an adequate database to make reasonable predictions of the cumulative effects of mining in the region, as well as to allow an assessment of alternative sites for mine, process plant and ancillary facilities.

- To collect quality baseline data so that a water quality monitoring plan can be developed and implemented to adequately detect direct effects of the mine operations on water quality.

4.2 SCOPE OF WORK

The proposed scope of work discussed in this section is for surface-water and groundwater hydrology; project coordination, reporting and proposed schedule. The proposed schedule is based upon what is perceived to be the most advantageous timing for project implementation and completion, given northwestern Montana's climatic and hydrologic conditions and other project tasks and engineering evaluations that remain to be completed.

The general scope of work for this hydrologic baseline investigation is based upon professional judgement, knowledge of Montana and its environment, and MDSL's published guidelines for prospective mine permit applicants.

4.2.1 Surface-Water Hydrology

The surface water investigation is divided into seven tasks:

Task A.1	Literature Review and Data Retrieval
Task A.2	Data Base Construction
Task A.3	Streamflow and Flood Characteristic Calculations
Task A.4	Floodplain Mapping
Task A.5	Gaging Station Construction and Flow Measurement
Task A.6	Water Quality Sampling
Task A.7	Data Analysis

Task A.1 - Literature Review and Data Retrieval. Upon commencement of the investigation, the hydrologic specialist shall review all available files of U.S.Borax for pertinent baseline information. U.S.Borax has already initiated surface-water sampling episodes in the study area. These data shall be obtained and reviewed for accuracy and relevance, and be included in the database. Asarco's baseline data collected for Rock Creek will be reviewed, summarized and correlated with the information collected for Upper Rock Creek.

Additional information concerning surface water resources in the area shall be sought from appropriate state and federal agencies, such as: Montana Department of Natural Resources and Conservation (MDNRC), Montana Department of State Lands (MDSL), Montana Bureau of Mines and Geology (MBMG), Montana Department of Health and Environmental Sciences (MDHES), U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), U.S. Bureau of Mines (USBM), U.S. Bureau of Land Management (BLM),

U.S. Bureau of Reclamation (USBuRec), National Oceanic and Atmospheric Administration (NOAA) and U.S. Department of Commerce (USDCOM). This list is not to be considered exhaustive; other federal, state, and local agencies would be contacted for pertinent information if reason exists to do so. Further, private sources shall likewise be contacted for similar information, such as former and present mine property owners and utility companies. Private water information, including springs, wells and other surface water, will be evaluated within one mile of the proposed plant and tailings disposal sites.

In addition to surface-water resource data and information, the investigator shall attempt to identify and collect all available meteorological and climatic data for the study area, which shall also be available for the evaluation of air quality (Section 3). A continuous precipitation gauge will be installed at the meteorological station at the proposed tailings disposal site.

A project file shall be developed such that all information is readily identifiable and retrievable. Reports and pertinent text shall be compiled in a single area, and data shall be reviewed for subsequent entry into a computerized database.

Task A.2 - Database Construction. During and following execution of Task A.1, the investigator shall construct a computerized database for entry of all relevant historical and project data to be collected and analyzed during this investigation. Either custom or commercial software shall be appropriate, so long as data entry can be readily performed, corrected, evaluated, and printed.

The computer system and database to be employed shall be PC IBM-AT or compatible and such that U.S.Borax and its designated recipients may readily retrieve and utilize these project data.

Task A.3 - Streamflow and Flood Characteristic Calculation. The investigator shall estimate streamflow characteristics for drainages within the study area, to include peak flows (using methods developed by Parrett and Omang, 1981; SCS, rational or other appropriate methods), average annual runoff (using methods based upon runoff per unit area, channel geometry, or other method accepted within the profession). Base maps to be used for these calculations shall be of a scale of 1:24,000, or that equivalent to USGS 7.5 minute topographic maps. Larger scale maps may be used if available and would be of a scale of 1:4,800.

Streamflow characteristics to be calculated include statistical flood peak flows for recurrence intervals of 25, 50, and 100 years. The investigator shall also calculate representative storm runoff peak streamflows, based upon the SCS method. Probable Maximum Floods (PMF) shall also be calculated.

The investigator shall calculate the flood peaks and storm runoff peaks for several readily identified points within each drainage

basin under study. The following stream drainages shall be included in these efforts:

East Side	West Side
Bear Creek	
Little Cherry Creek	Rock Creek
Poorman Creek	
Ramsey Creek	
Libby Creek	

Tentative specific points within each drainage identified above for which the streamflow characteristics are to be calculated are identified on Figure 4-1 in the map pocket. The discipline coordinator will assist in the final site selection.

Task A.4 - Floodplain Mapping. The investigator shall delineate on maps of a scale of 1:24,000 the extent of the active floodplain for each of the streams identified in Task A.3 above. Mapping shall attempt to define the extent of modern floodplain, based upon aerial photo analyses, field mapping of observed geomorphic and other physical evidence, as well as upon calculations made as part of Task A.3. The investigator shall make reasonable efforts to reconcile any discrepancies noted from its assembled and completed efforts from execution of this task with any other floodplain mapping efforts known by the investigator to exist for the study area and drainages under investigation (e.g. USFS).

It is not the intent of this task to enter into detailed or sophisticated computer modeling exercises.

Task A.5 - Gaging Station Construction and Flow Measurement. Permanent recording stream gaging stations shall be constructed and crest stage recorders and staff gauges installed at the locations described in Table 4.1 and shown on Figure 4-1 (in pocket). Permanent, continuously recording streamflow station is proposed Libby Creek in its lower reaches, and staff gages and crest stage recorders are proposed for all locations. Plans will be supplied for the construction of the continuous stage recording site. Staff gage sites and crest stage recorders generally lie both above and below possible disturbed areas within the Libby, Ramsey, Poorman, and Little Cherry Creek drainages on the east side of the Cabinet Mountains. Additional sites are situated within the Rock Creek drainage, because this is the major stream on the west side of the Cabinet Mountains which may likely receive impacts from mining.

Streamflow measurements shall be completed in the field in accordance with frequencies in Table 4-1. Streamflow measurement frequencies are planned to occur approximately twice per month during the rising limb of the annual runoff hydrograph (April through June), and monthly thereafter (July through March). A continuous sediment sampler (ISCO) will be installed adjacent to

the station LB 3000 continuous stage recorder. A grab sample will also be taken for comparison of the ISCO.

The ISCO sampler was removed in October, 1988, and will be reinstalled in March or April of 1989. Freezing conditions would have made the ISCO inoperable and would possibly have crushed the sampling mechanism.

Task A.6 - Water Quality Sampling. The investigator shall undertake a surface-water quality sampling program such that samples are collected in accordance with the schedule of streamflow measurements, as indicated in Table. 4-1. Water quality parameters to be analyzed for are identified in Table 4-2. All initial surface-water quality samples shall be collected for the complete list of parameters shown on Table 4-2. However, the investigator shall periodically review reported water quality data and provide recommendations to U.S.Borax concerning parameters which may be deleted from subsequent sampling episodes.

The water quality sampling frequency described in Table 4-1 provides for characterization of seasonal water quality variations, including both low-flow and high-flow periods. Greater emphasis shall be placed upon characterizing surface-water quality during high-flow periods, customarily late spring and early summer.

The hydrologist will make estimates on the streambed stability and substrata characterization using standard methods. The estimates will be made in conjunction with the surface-water sampling.

Water quality sampling shall be done no later than March or April, 1988, to allow as much time as possible to delineate and sample the rising limb of the spring runoff hydrograph. It is the intent of this sampling program to characterize surface water quality in the study area over a full calendar year.

After a year of baseline data has been collected, the company will review the findings with the agencies. Depending on the findings, the company's schedule for development and the need to characterize the potentially affected hydrologic system, the company will negotiate a monitoring program with the agencies.

A new section, Task A.6a - Winter Revisions to Water Quality Sampling Schedule, has been added. The new Task reflects negotiations with MDSL and USFS to reduce the number of winter sampling locations. The reduction was a result of access and safety conditions because of snow depth and avalanche danger.

TABLE 4-1

SURFACE WATER SAMPLING SITES[a]

LOCATIONS		STREAMFLOW AND WATER QUALITY MONITORING FREQUENCY		
DRAINAGE	SITE NO.	APR-JUN	JUL-MAR	GAUGE TYPE
Upper Rock Creek	EF 200	6	9	N/P[b]
	EF 300	6	9	staff/crest
	EF 400	6	9	staff/crest
	EF 800	6	9	staff/crest
West Fork Rock Creek	WF 20	6	9	staff/crest
Rock Creek (mainstream)	RC 850	6	9	staff/crest
	RC 2000	6	9	staff/crest
Libby Creek	LB 100	6	9	N/P
	LB 200	6	9	staff/crest
	LB 500	6	9	staff/crest
	LB 800	6	9	staff/crest
	LB 2000	6	9	staff/crest
	LB 3000	6	9	continuous/ staff/crest/ ISCO
Ramsey Creek	RA 100	6	9	N/P
	RA 200	6	9	staff/crest
	RA 600	6	9	staff/crest
Poorman Creek	PM 500	6	9	N/P
	PM 1000	6	9	staff/crest
Little Cherry Creek	LC 100	6	9	N/P
	LC 600	6	9	staff/crest
Bear Creek	BC 100	6	9	staff/crest

(a) Sites approximately located on Figure 4-1. Subject to change in the field -- based upon actual site conditions.

(b) N/P indicates no stream gauge planned.

TABLE 4-2

SURFACE-WATER QUALITY PARAMETERS[a]
(mg/l)

FIELD PARAMETERS	COMMON IONS	METALS[b]	OTHERS
pH	Ca	Pb(.001)	Nitrite and Nitrate as N(.01)
Specific Conductivity (SC)	Mg	Cu(.001)	Orthophosphate as P(.005)
Temperature (°C)	Na	Cr	F
	K	Zn	TDS
	CO_3	Cd(.0001)	TSS
	HCO_3	Fe	Turbidity
	Cl	Al	Hardness, as $CaCO_3$
	SO_4	Mn	Alkalinity, as $CaCO_3$
		Hg(.0002)	Ammonia(0.01)
		As	Total Kjeldahl Nitrogen as N(0.2)
		Ag(.0002)	Total Phosphorous as P(.005)
		Mo	

[a] Proposed target minimum detection limits for specific constituents to be analyzed in the laboratory are shown in parenthesis following that parameter. Oil and grease will be analyzed once for each surface water site to establish baseline conditions.

[b] Samples will be collected in the field and analyzed in the laboratory for total recoverable metal concentrations. Total recoverable metals will be analyzed in the laboratory using procedures described in EPA 600/4-79-020.

Task A.6a - Winter Revisions to Water Quality Sampling Schedule. The company met with the agencies to discuss a modified sampling program to be implemented during the winter months. The request was made because of limited access due to snow depths and potential avalanche danger.

The investigator will continue to collect surface-water samples from all locations on the Libby Creek side of the project area. However, during the winter months, snow accumulation and avalanche danger may result in the following sites not being sampled until they are reinstituted in the spring:

(Libby Creek) LB 100, 200, 2000
(Ramsey Creek) RA 100, 200
(Bear Creek) BC 100

Therefore, the winter sampling program on the Libby Creek side will include the following surface water stations:

	Station	Activity
Libby Creek	LB 500	Sampling & gaging
	LB 800	Sampling & gaging
	LB 3000	Sampling & gaging
Ramsey Creek	RA 600	Sampling & gaging
Poorman Creek	PM 500	Sampling & gaging
	PM 1000	Sampling & gaging
Little Cherry Creek	LC 100	Sampling & gaging
	LC 600	Sampling & gaging

Groundwater sampling will continue on the existing schedule on the Libby Creek side of the project area.

On the Rock Creek side, the investigator will permanently drop the following surface water quality sampling locations:

Upper Rock Creek	EF 800
West Fork Rock Creek	WF 20
Rock Creek	RC 850
Rock Creek	RC 2000

Data have been collected on all of these sites by the U.S. Forest Service and/or ASARCO for several years. If it is determined that more than a ventilation adit is required on Rock Creek, the sampling program will be re-evaluated.

During the winter months, the investigator will inspect the remaining sites to determine if access is possible. The following stations may be deleted because of access and safety considerations due to snow accumulation:

Upper Rock Creek EF 200, EF 300, EF 400

Task A.7 - Data Analysis. Both throughout the baseline investigation field activities, and at specific times during the investigation period, the investigator shall ensure that field data are fully and accurately entered into the computerized data base (see Task A.2), water quality analytical reports from laboratories are evaluated for quality assurance, and that all on-going activities are coordinated as completely as possible.

Standard statistical tests shall be run, where appropriate, on available data, and calculations from computer and map exercises shall be checked for input/output errors. Stage-discharge relationships shall be calculated from streamflow measurements made in conjunction with completion of Task A.5.

Trilinear or Piper diagrams shall be prepared to illustrate the chemical character of surface water for all streams. These diagrams shall be compared and contrasted with those prepared for the Groundwater Investigation (see Section 4.2.2, Task B.10).

Annual runoff calculations shall be made, based upon continuous precipitation gauge measurements and continuous streamflow records completed as part of Task A.5, and these shall be compared to statistical measurements of comparable parameters calculated as part of Task A.3. Information will be included on the nearest existing snow course.

4.2.2 Groundwater Hydrology

The groundwater investigation is divided into ten tasks:

- Task B.1 Literature Review and Data Retrieval
- Task B.2 Database Construction
- Task B.3 Aerial Photogeologic Mapping
- Task B.4 Well, Spring, and Adit Inventory
- Task B.5 Near-Surface Geophysical Reconnaissance
- Task B.6 Monitoring Well Construction
- Task B.7 Groundwater Level Monitoring
- Task B.8 Groundwater Quality Sampling
- Task B.9 Aquifer Characterization and Testing
- Task B.10 Data Analysis

Task B.1 - Literature Review and Data Retrieval. Upon commencement of the investigation, the hydrologic specialist shall review all available files of U.S.Borax for pertinent baseline information. Available subsurface data may be pertinent and be obtained and reviewed for relevance.

Additional information concerning ground water resources in the area shall be sought from appropriate state and federal agencies, such as: Montana Department of Natural Resources and Conservation (MDNRC), Montana Department of State Lands (MDSL), Montana Bureau of Mines and Geology (MBMG), Montana Department of Health and Environmental Sciences (MDHES), U.S. Geological Survey

(USGS), U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), U.S. Bureau of Mines (USBM), and U.S. Bureau of Land Management (BLM). This list is not to be considered exhaustive; other federal, state, and local agencies should be contacted for pertinent information if reason exists to do so. Further, private sources shall likewise be contacted for similar information, such as former and present mine property owners. As appropriate, ASARCO's baseline information should be reviewed, summarized and correlated with the Borax data.

A project file shall be developed and a catalog be prepared such that all information is readily identifiable and retrievable. Reports and pertinent data shall be reviewed for subsequent entry into a computerized database.

Task B.2 - Database Construction. During and following execution of Task B.1, the investigator shall construct a computerized data base for entry of all relevant historical and project data to be collected and analyzed during the investigation. Either custom or commercial software shall be appropriate, so long as data entry can be readily performed, corrected, evaluated, and printed.

The computer system and data base to be employed shall be PC IBM-AT or compatible and such that U.S.Borax and its designated recipients may readily retrieve and utilize these project data.

Task B.3 - Aerial Photogeologic Mapping. The investigator shall obtain existing aerial photographs of the study area from U.S.Borax, USFS, U.S. Soil Conservation Service, or other agency or private party, and map major hydrologic and hydrogeologic features for use in subsequent field and office tasks. In addition, major hydrostratigraphic units will be specified and outlined on a map. The information will include both surficial and bedrock units, their respective permeability controls, and their generalized recharge and discharge sites. Aerial photo mapping should be sufficient for this purpose in much of the study area. The hydrology of the tailings impoundment area will require detailed investigation. The mapping shall be completed at a scale consistent with all other maps prepared for this hydrologic investigation. Maximum utilization of existing public information, plus that of U.S.Borax, shall be used to execute this effort.

Task B.4 - Well, Spring, and Adit Inventory. The investigator shall execute an inventory of all wells, perennial springs, and discharging adits within the surface drainages which may be affected by mining facilities (and above the lowermost surface water gaging stations identified in Table 4-1), and within one mile of all potential project surface facilities and tailing disposal sites. As appropriate, ASARCO's baseline information should be reviewed, summarized and correlated with the Borax data.

Initial mapping may be accomplished through records searches of both state and federal agency files, through discussions with persons knowledgeable of the area, and by inspection of the aerial photographic maps prepared as part of Task B.3. Field verification shall be performed to confirm all sites identified by initial efforts. Discharge rates for all perennial springs and discharging adits shall be measured twice during the investigation. These measurements shall coincide with water level measurements made during execution of Tasks B.7 and B.8.

It is likely that no wells will be discovered, and that many springs will be seasonal rather than perennial. Only a few discharging adits are presently known to occur in the area.

Task B.5 - Near-Surface Geophysical Reconnaissance. Following the completion of Tasks B.3 and B.4, the investigator shall execute a near-surface geophysical reconnaissance of selected portions of the study area to better characterize the hydrogeologic conditions of these sites, as well as to better ascertain subsurface lithologic conditions prior to undertaking monitoring well construction and ground water sampling activities (see Tasks B.6, B.7 and B.8). Specific areas to be evaluated during this geophysical reconnaissance are those sites presently being considered for tailings disposal. Geophysical techniques to be employed may include resistivity, seismic, or GPR (ground penetrating radar).

Task B.6 - Monitoring Well Construction. Upon completion of Task B.5 and evaluation of the results, the investigator shall plan and implement a groundwater monitoring well construction program. The program shall emphasize characterization of the hydrogeologic conditions underlying proposed tailing disposal areas, as opposed to the mine facilities areas. All tailing disposal areas still under active consideration at the time of initiation of this task shall be included in this program.

For each tailings disposal area under consideration, the monitoring well construction program shall have as its objective the definition of groundwater flow directions and rates, and delineation of significant aquifers or groundwater-bearing units.

Although the program is subject to better definition based upon additional data which will be available at the time of initiation (specifically, upon completion of Tasks B.3 and B.5), a tentative groundwater monitoring program is outlined in Table 4-3. The investigator shall better define the specifics of the program prior to initiating field activities. The actual program shall generally conform to present MDSL guidelines for groundwater monitoring programs for proposed tailing disposal areas. The agency discipline coordinator will participate in the site selection and construction of the groundwater wells.

All monitoring wells shall be constructed, completed, and developed in accordance with present industry standards prior to taking water level measurements, collecting groundwater quality samples, or undertaking any aquifer tests. Well logs and completion records of the observation wells and the aquifer test wells will be compiled during the study phase.

Task B.7 - Groundwater Level Monitoring. Following the construction of all monitoring wells, the investigator shall initiate a groundwater level measurement program. The depth to static water level will be measured in all monitoring wells or piezometers on a quarterly (once every three months) basis for one year. These measurements shall be recorded and entered into the project database.

All measurements shall be referenced to a known elevation datum, and survey controlled if possible. All measurements shall be taken prior to collecting ground water quality samples being obtained during the same day or site visit.

TABLE 4-3

PRELIMINARY GROUND WATER MONITORING
WELL LOCATIONS

LOCATION (a)	PRESUMED AQUIFER (b)	NUMBER AND TYPE OF WELLS
Little Cherry Site	Qal, Qc, Qgl	1 upgradient and 3 downgradient perimeter wells, and one aquifer test well
Poorman Site	Qc, Qgl	2 upgradient and 4 downgradient perimeter wells, and one aquifer test well

(a) Approximate well locations shown on Figure 4-1.

(b) Key: Qal - alluvium
Qc - colluvium
Qgl - glacial deposits

Task B.8 - Groundwater Quality Sampling. The groundwater quality shall be sampled quarterly from each sampling location established for this investigation. These locations shall include all monitoring wells constructed in the execution of Task B.6, as well as all perennial springs and discharging mine adits identified during the completion of Task B.4.

Groundwater quality samples shall, to the extent possible, be collected during the highest ground water level period of the year (probably early summer), as well as the lowest water level

time of the year (winter). Groundwater quality parameters to be analyzed in the laboratory are identified in Table 4-4. All initial ground water quality samples shall be collected for the complete list of parameters shown on Table 4-4. However, periodic review of reported water quality data and recommendations concerning parameters which may be deleted from subsequent sampling episodes shall be made.

All groundwater quality samples shall be collected, preserved, shipped, and analyzed in accordance with current EPA guidelines, professional standards, and best industry practices.

TABLE 4-4

GROUND WATER QUALITY SAMPLING PARAMETERS[a]
(mg/l)

FIELD PARAMETERS	COMMON IONS	METALS[a]	OTHERS
pH	Ca	Pb(.01)	F
Specific Conductivity (SC)	Mg	Cu(.02)	TDS
Temperature (°C)	Na	Cr	Hardness, as $CaCO_3$
Eh	K	Zn	Alkalinity, as $CaCO_3$
	CO_3	Cd(.001)	Nitrite and Nitrate as N(.01)
	HCO_3	Fe	
	Cl	Al	
	SO_4	Mn	
		Hg(.0002)	
		As	
		Ag(.001)	
		Mo	

(a) Proposed target minimum detection limits for specific constituents to be analyzed in the laboratory are shown in parenthesis following that parameter.

(b) Dissolved metals will be analyzed in the laboratory using procedures described in EPA 600/4-79-020.

Task B.9 - Aquifer Characterization and Testing. Selected groundwater monitoring wells shall be tested to determine, for each tailing disposal area under active consideration by U.S.Borax, common aquifer hydraulic characteristics, including hydraulic conductivity, transmissivity, storativity, and saturated thicknesses. Vertical hydraulic conductivity analyses may also be necessary, based upon preliminary evaluations of hydrogeologic conditions underlying each site.

Based upon subsurface geologic conditions at each site, further consideration shall be given to the utility of defining directional variations of the hydraulic characteristics described above, which may require installation of more than one observation well. Based upon these findings, it may be necessary to undertake more detailed analyses of one or more potential tailing disposal areas.

Task B.10 - Data Analysis. Throughout the duration of the baseline investigation, the investigator shall ensure that field data are fully and accurately entered into the computerized data base (see Task B.2), water quality analytical reports from laboratories are evaluated for quality assurance, and that all on-going activities are coordinated.

Standard statistical tests shall be made where appropriate on available data, and calculations from computer and mapping interpretations shall be checked for input/output errors. Potentiometric maps shall be prepared for, at a minimum, each considered tailing disposal area, and for as much as possible of the potentially affected areas included within the proposed mine area. These maps shall be prepared on the same scale as those used for the Surface-Water Hydrology (see Section 4.2.1).

Trilinear or Piper diagrams shall be prepared to illustrate the chemical character of groundwater for all groundwater-bearing units, springs, and discharging adits. These diagrams shall be compared and contrasted with those prepared for the Surface Water Hydrology (see Section 4.2.1, Task A.7).

Correlations shall be made between groundwater levels measured as part of Task B.7, and surface-water stage measurements made as part of Task A.5 (see Section 4.2.1, Task A.5).

Standard calculations shall include those necessary to reduce all field data obtained in the completion of Task B.9, Aquifer Characterization and Testing.

4.3 REPORTING AND COORDINATION

Vital to the successful execution of the hydrologic baseline investigation is the coordination between and among the hydrology and air quality specialists, U.S.Borax, and appropriate other consultants and regulatory agencies. This section of the

document presents five specific coordination and reporting activities which will enhance the utility and cost-effectiveness of the investigation.

Task C.1 Agency Coordination
Task C.2 Geotechnical Engineering Coordination
Task C.3 Mine and Facilities Engineering Coordination
Task C.4 Interim Reporting
Task C.5 Final Reporting

4.3.1 Task C.1 - Agency Coordination

At the written direction of U.S.Borax, the hydrology specialist may confer periodically with the state and federal regulatory agencies (specifically, MDSL and USFS) to review preliminary data and interpretations, and to evaluate the progress of the investigation. Periodically, recommendations shall be made on how the investigation's objectives may be more effectively attained, either through changes in, or reduction in scope. Examples of such ways in which unnecessary data can be deleted, and unnecessary costs thereby avoided, are reductions in the numbers of water quality samples taken, or parameters analyzed in either the surface-water or groundwater investigations. As U.S. Borax's mine development evaluation progresses, facility sites may be added and/or deleted. The agencies will review and comment on water quality data submittals within 30 days.

4.3.2 Task C.2 - Geotechnical Engineering Coordination

Several tasks within the groundwater investigation, specifically Tasks B.3, B.5, and B.6 (see Section 4.2.2), can play an effective role in focusing early geotechnical investigations necessary for mine planning activities (e.g. tailing disposal area evaluations).

Data and preliminary interpretations resulting from the tasks identified above shall be made available to other engineering and environmental specialists, and agencies. Appropriate coordination between various specialists will reduce duplication of effort and, hence, project costs.

4.3.3 Task C.3 - Mine and Facilities Engineering Coordination

U.S.Borax will necessarily utilize some of the data obtained during the hydrologic investigation for engineering design. Two tasks which must be addressed are surface and subsurface drainage control around the mine plant and tailing disposal area, and development of a process water supply.

4.3.4 Task C.4 -- Interim Reporting

Available data will be summarized and preliminary interpretations made in an interim hydrologic baseline report and made available by U.S.Borax. The report shall make specific statements, where possible, concerning data reliability, areas requiring additional attention or data, and the meeting of project objectives. The interim report shall be presented in an outline similar to that to be used for the final project report.

An appropriate time for the interim report is following initial field activities such as spring runoff surface water sampling, completion of the near-surface geophysical reconnaissance, and upon completion of preliminary mine engineering evaluations (see Section 4.3.3). A proposed project schedule incorporating these interrelated activities is presented in Section 4.4.

4.3.5 Task C.5 - Final Reporting

Upon completion of all field activities, receipt of all laboratory analytical results, and execution of all data analyses, a summary shall be made of the investigation's objectives, scope, methods, data, analyses, conclusions, and quality assurance program results in a final report. The final report shall include such text, figures, tables, and plates necessary to present and portray the data in a form intelligible to other professionals in this or related fields. The final report shall be suitable for inclusion in U.S.Borax's permit application as a technical appendix in support of more general parts of the application.

4.4 INVESTIGATION SCHEDULE

A tentative schedule for this investigation is presented in Figure 4-2. The objective of this proposed schedule is to present the interrelationships between the surface-water and groundwater investigations, as well as propose a time interval during which preparation of the interim report may be most appropriate. Further, the proposed schedule includes the previously described coordination tasks (see Sections 4.3.1 through 4.3.3) to demonstrate where coordination in the mine planning and permitting process may most readily result in time and cost savings.

4.5 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

It is a major objective of this hydrologic baseline data collection program to produce data of reliable and known quality. The following field quality control sample frequencies shall be established and utilized by the hydrology specialist:

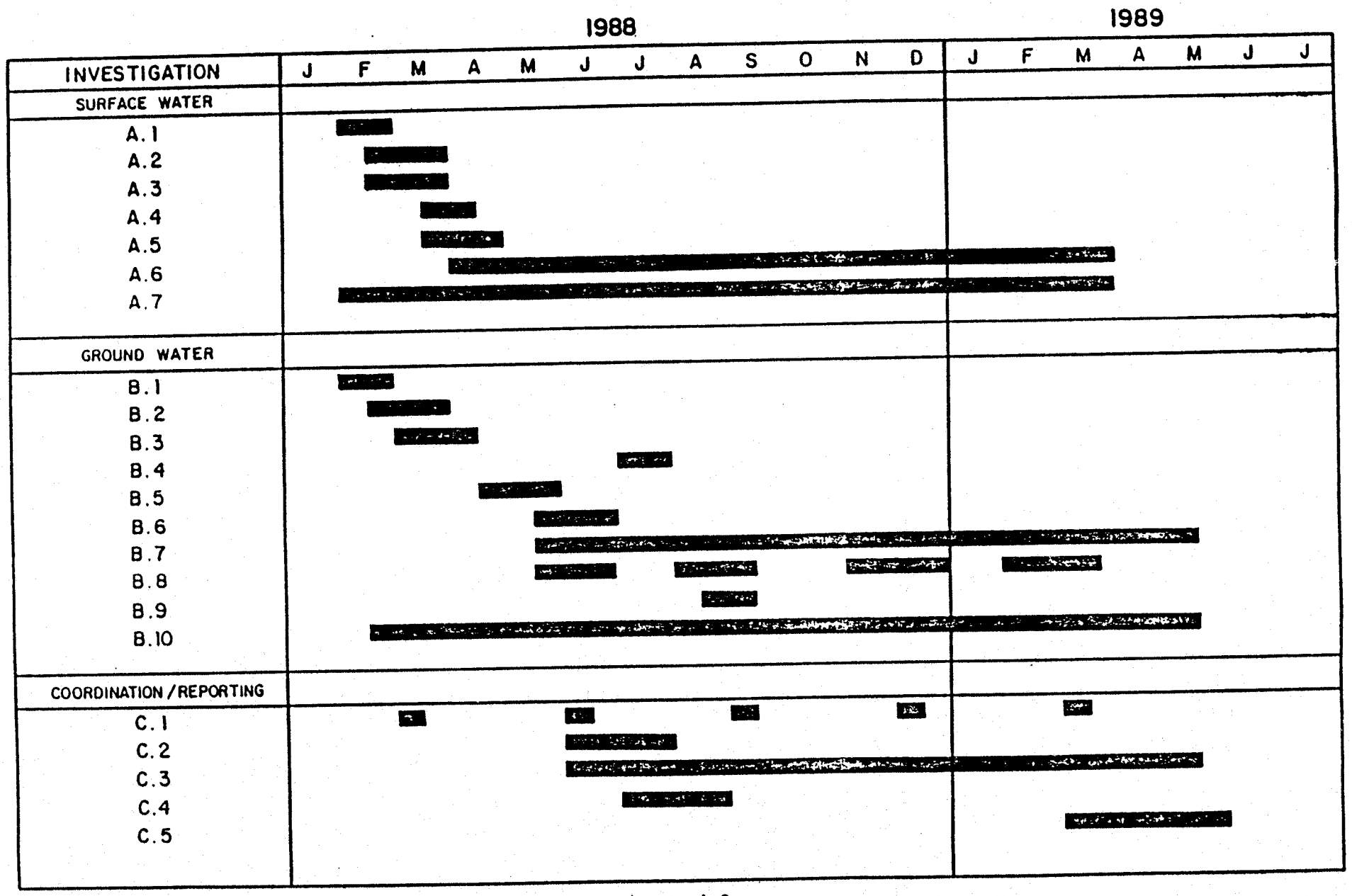


Figure 4-2

TENTATIVE HYDROLOGIC INVESTIGATION SCHEDULE

1. Blind field replicate samples will be inserted into the sample train at a frequency of approximately one in twenty-five samples.

2. Field bottle blanks will be inserted into the sample train at a frequency of approximately one in fifty samples.

3. Field cross contamination blanks will be inserted into the sample train at a frequency of approximately one in fifty samples.

4. Blind field standard samples will be inserted into the sample train at a frequency of approximately one in twenty-five samples.

Approximately ten to twenty percent of all samples turned into the laboratory for analysis will be for quality control (QC) purposes. Water quality samples will be sent only to an analytical laboratory which has its own demonstrated quality control program and which maintains records showing laboratory control procedures. These characteristics of the analytical laboratory shall be demonstrated prior to the initiation of sample analyses.

Three additional practices which shall be followed are to include the use of standard operating procedures for all field tasks, whenever possible (exceptions to this rule should always be noted in field notebooks); appropriate decontamination of all field equipment between individual sample collections; and, the blind placement of all QC samples into the sample train such that the analytical laboratory cannot know which samples are natural and which are for QC purposes.

A specific QA/QC program will be developed by the selected hydrology contractor, and submitted to the agencies for their review and approval.

4.6 REFERENCES

Montana Department of State Lands, 1986, Guidelines for the Preparation of Mine Permit Applications Under the Metal Mine Reclamation Act.

Parrett, C. and Omang, R.J., 1981, "Revised Techniques for Estimating Magnitude and Frequency of Floods in Montana", U.S. Geological Survey Open File Report 81-917.

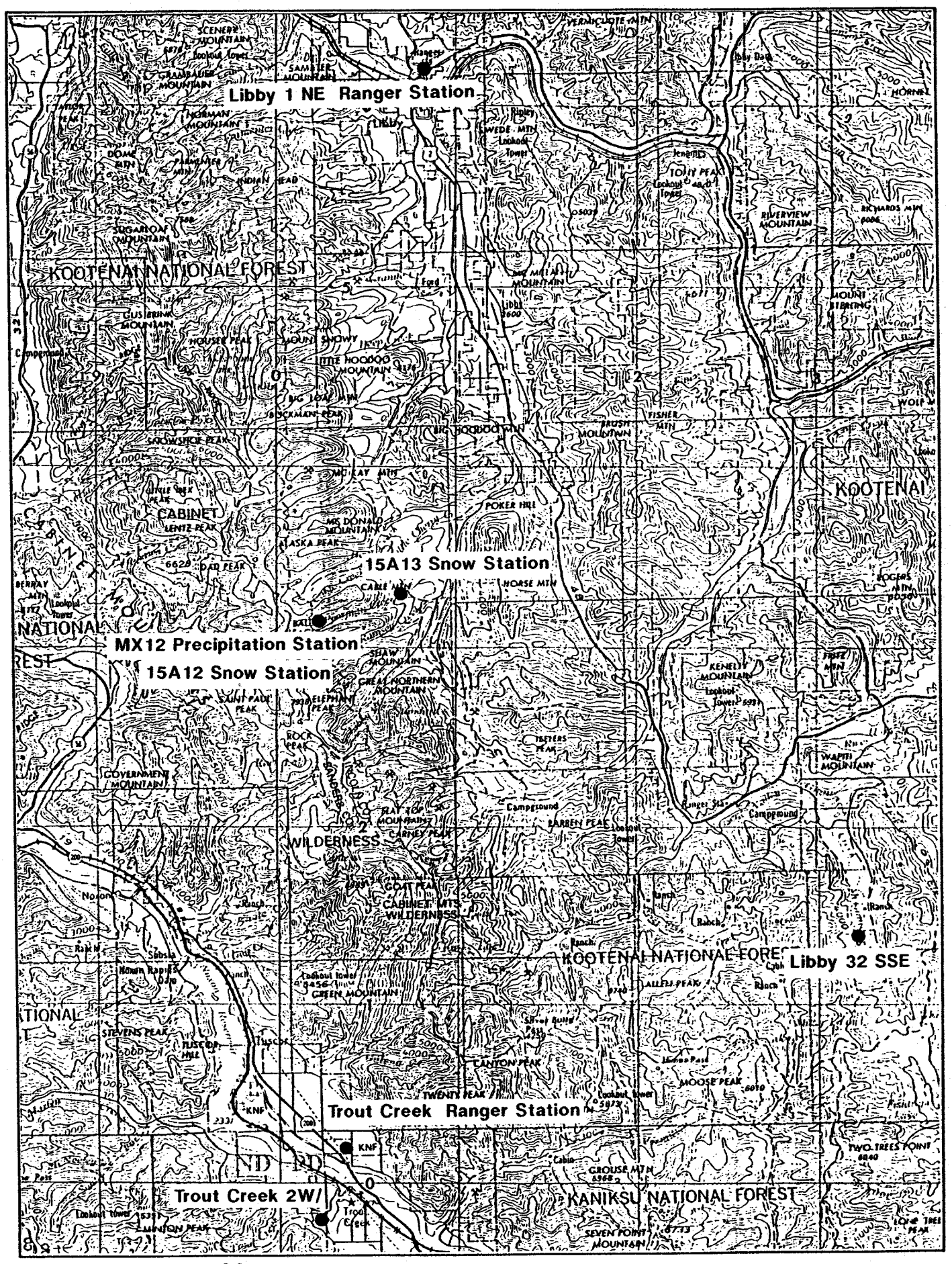
U.S. Forest Service, 1985, Draft Cabinet Mountains Activity Coordination Study.

APPENDIX B

Chen-Northern, Inc.

APPENDIX B

CLIMATE DATA



NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana

Weather Station Location Map
FIGURE B-1

TABLE B-1
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

AVERAGE MONTHLY PRECIPITATION
* MX12, POORMAN CREEK
Sec5 T27N R31W elev. 5100'

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	SUM
1969	5.86	4.38	9.75	11.69	5.70	3.40	2.55	5.54	7.62	0.70	0.14	5.21	62.54
1970	4.00	2.00	5.44	10.80	5.57	5.06	4.83	1.90	2.70	3.03	1.79	4.36	51.48
1971	2.09	9.44	9.44	16.78	7.61	7.10	4.26	4.27	5.40	2.70	4.47	2.37	75.93
1972	2.00	4.21	12.21	16.59	16.80	11.72	3.96	2.58	6.53	2.46	2.04	3.72	84.82
1973	2.87	2.70	8.38	5.44	5.06	4.33	3.37	2.77	4.48	0.27	2.00	4.14	45.81
1974	0.46	8.98	8.30	16.53	10.17	10.36	4.42	3.69	3.46	1.83	1.64	1.67	71.51
1975	0.21	5.56	7.43	10.25	10.66	8.30	2.11	3.37	4.25	1.09	4.36	2.01	59.60
1976	8.38	6.85	10.39	7.25	11.75	6.41	5.00	2.38	4.13	1.32	4.27	1.10	69.23
1977	2.03	4.43	5.28	3.02	3.02	7.04	1.98	6.12	1.48	2.42	3.34	4.08	44.24
1978	1.70	13.42	12.60	7.10	6.12	3.92	4.06	8.52	3.10	5.42	4.67	3.61	74.24
1979	1.20	7.30	9.68	5.38	17.25	6.82	5.74	3.50	2.23	1.96	1.80	1.46	64.32
1980	2.10	2.04	12.74	5.63	4.80	8.50	3.80	5.50	6.75	2.88	3.87	3.00	61.61
1981	4.00	4.42	6.64	4.52	8.14	3.43	10.00	4.96	14.50	1.48	0.42	3.06	65.57
1982	3.66	4.90	5.38	13.07	9.03	8.32	13.86	4.09	4.30	4.52	0.86	2.54	74.53
1983	5.898	7.62	8.04	11.36	5.52	6.96	3.26	2.12	5.74	7.00	0.84	3.78	68.12
1984	3.26	13.10	4.65	9.02	3.44	6.18	4.56	9.70	5.78	0.80	0.76	4.56	65.81
1985	7.20	12.00	13.66	2.38	6.42	3.56	5.08	1.37	6.21	0.10	3.76	8.94	70.68
1986	10.56	14.62	1.66	9.58	10.96	5.62	4.46	6.60	1.88	2.56	2.08	5.35	75.93
1987	4.20	16.80	3.90	6.80	3.70	7.00	3.50	3.30					
AVG	3.77	7.62	8.19	9.12	7.99	6.53	4.78	4.33	5.03	2.36	2.40	3.61	65.89
YRS	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(18)	(18)	(18)	(18)	(18)
1961-1985													
AVG	3.35		8.82	9.22	8.06	6.55	4.87	4.26	5.22	2.35	2.41	3.51	65.30
YRS	(17)		(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)

* Data source: from SCS snow survey data combined with on-site SCS precipitation data.

TABLE B-2

MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA
AVERAGE MONTHLY PRECIPITATION
* TROUT CREEK 2W/TROUT CREEK RANGER STATION
Trout Creek 2W, Lat 47° 50'N Long. 115° 38'W elev. 2485'
Trout Creek Ranger Sta. Lat 47° 52' N Long 115° 37' W elev. 2356'

Year	Total Precip	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1951	36.34	5.42	6.51	1.96	.98	1.67	1.17	.91	1.94	1.41	6.50	3.13	4.74
1962	17.86	3.81	2.30	1.71	.33	1.17	2.78	.49	.74	.48	.26	.37	3.42
1953	37.73	13.14	3.29	1.52	2.76	1.25	1.57	T	1.38	.98	.59	5.04	6.21
1954	36.23	9.66	4.27	2.84	3.26	.43	1.59	1.85	2.72	1.70	2.33	2.50	3.08
1955	37.61	1.68	3.87	3.39	2.39	1.07	2.31	1.48	T	1.65	5.07	7.89	6.81
1956	30.08	3.72	3.73	4.88	.97	2.12	.95	.85	1.11	1.26	E2.57	E1.33	6.59
1957	28.29	2.45	5.15	2.22	1.64	3.71	1.60	.79	.34	.36	2.77	1.27	5.99
1958	--	4.17	3.52	.75	3.87	.81	2.43	1.29	.28	--	--	--	--
1959	35.90	7.14	2.39	E3.26	2.91	2.46	.81	.21	.88	4.01	4.42	5.84	1.57
1960	--	3.09	2.87	3.78	2.47	2.84	.94	--	2.78*	.62	1.14	5.43	1.41
1961	32.18	3.27	6.23	2.09	2.12	5.05	1.94	1.09	.53	1.76	1.93	1.81	4.36
1962	26.20	1.94	1.48	3.81	1.65	3.96	.75	.29	.80	1.35	2.38	4.74	3.05
1963	24.40	1.77	3.88	3.09	1.76	1.09	2.17	.68	.24	1.58	1.67	4.14	2.33
1964	39.00	5.44	1.35	2.67	2.57	1.87	4.23	1.56	3.12	2.08	1.94	3.79	8.38
1965	26.63	4.02	3.56	.03	2.95	1.45	3.34	.70	2.65	2.07	.42	3.20	2.24
1966	27.81	4.82	2.17	3.20	.69	1.70	3.13	.32	1.63	.25	1.69	5.42	2.79
1967	28.41	6.34	2.92	2.50	1.11	1.03	2.79	.23	T	.20	E4.81	2.83	3.65
1968	33.05	2.46	4.24	2.23	1.09	1.61	2.34	.85	2.07	4.48	3.58	3.78	4.32
1969	24.87	7.64	.88	1.53	1.77	1.51	2.81	.32	.00	1.98	1.81	1.09	3.53
1970	32.41	7.25	2.45	2.22	3.25	1.86	1.29	1.57	1.79	1.09	1.98	3.45	4.21
1971	35.85	7.42	2.34	3.51	1.42	1.76	4.01	1.48	1.99	1.07	2.04	3.45	5.36
1972	32.84	7.09	5.73	3.29	2.17	1.16	2.80	1.38	.82	1.55	.86	1.88	4.11
1973	E27.68	3.17	.89	1.40	.91	1.07	2.84	.00	E.41	1.86	1.42	8.03	5.68
1974													
1975	32.78	5.81	4.66	2.80	1.23	1.41	2.12	.77	1.49	.66	2.86	3.33	5.64
1976	25.35	4.21	4.84	2.18	1.45	1.26	1.11	1.05	3.54	.51	1.06	2.13	2.01
1977	26.93	1.57	1.01	2.37	.17	2.46	0.70	1.81	1.65	2.75	1.15	3.79	7.50
1978	28.56	3.49	2.06	1.70	2.25	4.90	1.42	2.40	2.84	1.41	.18	3.05	2.86
1979	25.61	2.44	5.34	1.59	2.15	1.66	.39	1.15	1.71	.65	2.50	.83	5.20
1980	34.22	3.93	1.89	2.93	1.39	4.24	3.19	2.22	1.40	2.43	1.00	3.46	6.14
1981	29.83	.98	4.34	.77	3.09	4.04	4.68	.77	.57	.97	1.61	2.86	5.15
1982	35.58	6.23	5.44	3.88	3.16	1.73	1.38	1.86	1.05	1.18	1.35	4.57	3.80
1983	29.95	4.05	2.71	3.40	.90	1.53	3.21	3.42	1.28	.81	.81	4.99	2.84
1984	30.11	2.35	1.25	2.38	2.16	4.28	1.80	.94	.20	1.62	2.17	5.06	5.90
1985	23.18	.32	2.43	1.46	1.13	2.22	1.92	.00	1.45	3.67	3.69	4.19	.70
1986	28.35	3.45	5.40	2.10	1.37	2.01	1.27	.95	.84	2.94	1.09	5.50	1.43
1987	22.54	1.30	2.04	3.48	1.50	2.19	1.90	2.86	1.58	.21	.02	1.19	4.27
AVG	30.14	4.36	3.31	2.47	1.86	2.11	2.10	1.10	1.33	1.53	2.05	3.58	4.21

* Change of location from Trout Creek 2W to Trout Creek Ranger Station

From Climatological Data Annual Summary, Department of Commerce, National Climatic Data Center, Asheville, North Carolina

TABLE B-3

MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA
AVERAGE MONTHLY PRECIPITATION
YEARS 1951 - 1986
LIBBY 1 NE RANGER STATION
Lat. 48° 24′ N, Long. 115° 32′ W elev. 2080′

Year	Precip	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1951	27.30	3.38	2.55	1.70	.72	1.68	1.56	.86	2.15	2.30	5.18	1.40	3.82
1952	12.16	2.12	.81	.60	.28	.38	3.73	.45	.76	.40	.40	.47	1.76
1953	22.54	6.92	1.89	.76	1.43	1.54	1.21	T	1.25	.42	.19	3.22	3.71
1954	22.80	5.71	1.82	1.28	2.01	.26	1.47	2.40	2.89	1.61	.92	1.22	1.13
1955	23.80	.76	1.79	1.94	1.27	2.18	1.77	1.59	.01	1.84	2.93	3.47	4.25
1956	17.38	2.14	1.81	2.40	.28	2.32	.75	1.23	1.54	.70	1.72	.68	1.81
1957	E17.21	E1.08	2.88	.69	1.14	2.61	1.62	.27	.55	.45	2.63	.52	2.77
1958	19.97	2.44	1.70	1.11	1.39	.68	2.62	.74	.52	.74	.80	5.29	1.94
1959	E23.48	3.27	1.09	.83	1.72	1.68	1.06	.04	1.06	4.25	2.71	E4.87	.90
1960	17.32	.92	1.35	2.01	1.85	1.64	.28	.20	2.19	.56	.74	4.80	.78
1961	24.19	1.73	3.42	.98	2.52	3.19	1.27	1.19	.38	2.48	2.03	1.55	3.45
1962	15.53	.75	1.00	1.47	1.11	2.74	.35	.12	.87	.88	2.33	2.48	1.43
1963	E15.84	.56	1.80	1.12	1.93	.54	2.56	.20	.71	.87	1.35	2.70	E1.50
1964	20.20	2.87	.64	1.10	.41	1.12	.96	1.77	1.66	.91	1.02	2.72	5.03
1965	17.47	2.20	1.31	.39	2.04	1.66	1.69	.29	1.82	1.65	.35	1.88	2.19
1966	20.52	3.34	1.31	1.50	.64	1.87	2.61	.67	1.16	.08	1.38	3.67	2.29
1967	16.89	2.73	1.25	1.33	1.21	1.94	1.84	.28	.02	.40	2.69	1.01	2.19
1968	18.93	2.24	1.55	1.10	.81	.80	1.00	.58	1.48	2.58	1.65	2.36	2.78
1969	17.00	4.52	.70	.86	.61	1.02	4.30	.08	T	1.42	1.01	.38	2.10
1970	18.49	4.04	1.16	.98	.70	1.18	.93	.51	.12	1.23	1.69	2.36	3.59
1971	20.44	3.61	.97	2.01	1.20	1.69	2.12	.84	.94	.88	1.37	1.28	3.53
1972	19.12	2.98	2.39	1.11	1.08	.82	2.95	1.34	.99	.68	1.31	.90	2.57
1973	14.07	1.46	.41	.60	.28	.73	.63	.00	.12	1.13	.62	5.31	2.78
1974	--	4.94	1.32	2.15	.59	.67	1.09	--	.71	--	--	--	2.50
1975	20.77	E3.45	2.87	1.77	.60	.96	.90	.70	1.74	.74	3.56	2.27	1.21
1976	13.95	1.78	3.17	.74	.85	.77	.93	.90	1.94	.40	.66	1.18	.63
1977	15.87	.32	.44	1.43	.29	1.85	.78	1.50	1.29	2.05	.49	2.32	3.11
1978	16.71	1.90	.36	.81	1.25	2.64	.49	2.42	1.43	1.31	.32	1.97	1.81
1979	12.72	.89	2.64	.52	.72	1.04	.18	.40	.68	.38	1.57	.30	2.95
1980	21.73	2.21	.71	1.23	1.16	2.89	2.96	.79	1.23	1.91	.62	1.89	4.13
1981	20.71	1.03	1.68	.28	1.72	3.45	3.38	1.17	1.32	.78	.66	2.63	2.61
1982	25.12	2.50	3.11	2.29	2.60	1.73	2.94	1.28	.90	1.22	1.32	2.47	2.76
1983	17.50	2.40	1.14	1.97	1.05	.50	1.73	2.02	.59	.88	.51	3.28	1.43
1984	19.15	1.05	.37	.79	1.74	2.20	2.64	.09	.76	2.02	2.03	2.89	2.57
1985	15.09	.21	1.21	.73	.44	.60	1.63	.19	.65	3.66	3.07	2.25	.45
1986	18.23	1.92	2.75	.85	.74	1.54	1.48	1.11	.86	2.02	.81	3.63	.52
1987	18.27	1.06	.97	2.07	.57	2.25	1.71	4.67	1.21.	.05	.00	1.02	2.69
AVG	18.84	2.35	1.57	1.23	1.11	1.55	1.68	.92	1.04	1.28	1.46	2.29	2.37

Notes: T = Trace
E = Estimated
From Climatological Data Annual Summary, Department of Commerce, National Data Center, Asheville, North Carolina

TABLE B-4

MONTANA PROJECT

LINCOLN AND SANDERS COUNTIES, MONTANA

AVERAGE MONTHLY PRECIPITATION

AT LIBBY 32 SSE

LAT 47° 58′ N, LONG 115° 14′ W ELEV. 3600′

Year	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1953	27.31	9.36	1.75	1.08	2.62	1.54	1.21	.03	1.12	.79	.38	2.95	4.48
1954	32.05	6.77	4.02	E2.28	3.42	.20	2.22	2.82	2.37	1.77	1.78	2.17	2.23
1955	33.43	.84	3.15	3.44	1.99	1.32	3.12	1.53	T	1.56	4.28	6.14	6.06
1956	24.27	3.44	2.94	3.31	.69	1.76	1.57	.77	1.13	1.08	2.40	1.31	3.87
1957	28.21	1.83	4.37	2.57	1.68	3.03	2.60	1.24	1.18	1.42	2.99	.85	4.45
1958	--	2.17	E2.22	.93	2.14	1.17	3.22	1.72	--	--	--	--	--
1959	--	--	--	--	--		--	--	3.99	2.78	4.74	--	1.28
1960	23.39	1.60	1.79	3.24	2.78	3.33	.64	.13	2.71	.65	1.67	3.92	.93
1961	32.26	2.63	5.49	1.65	3.36	2.90	1.06	1.09	1.33	2.33	2.44	2.81	5.17
1962	23.30	1.83	1.22	2.75	1.84	2.80	.52	.52	1.62	1.42	2.62	3.78	2.38
1963	21.36	1.55	2.69	2.94	1.41	.96	2.44	.03	.28	1.34	1.82	3.81	2.09
1964	32.61	4.57	1.33	2.42	2.40	1.95	3.34	1.29	1.64	1.92	1.73	3.11	6.91
1965	E23.29	2.94	2.29	E.42	2.62	1.45	2.42	.56	1.85	2.84	.48	3.09	2.33
1966	24.84	3.32	2.51	2.14	.70	1.70	2.06	.88	2.69	.54	1.59	4.42	2.29
1967	28.31	4.83	2.94	2.79	1.69	2.44	2.67	.27	.00	.25	5.79	1.99	2.65
1968	28.13	3.16	2.37	1.85	1.63	1.00	1.75	.70	1.82	4.51	2.66	2.00	4.68
1969	22.12	6.78	.73	1.32	1.40	1.27	3.55	.58	T	1.93	1.23	.74	2.58
1970	28.67	4.95	2.36	2.38	2.26	1.48	1.52	1.86	.78	1.80	1.56	3.83	3.89
1971	33.57	7.29	2.50	3.28	1.62	2.57	3.66	1.74	1.52	.58	1.97	2.00	4.84
1972	34.12	6.46	5.68	2.55	2.93	1.50	4.53	1.43	1.07	1.93	1.48	.84	3.72
1973	E18.97	1.70	.25	.86	1.27	1.22	2.12	.13	.51	1.05	1.22	5.52	3.12
1974	27.70	9.16	2.67	3.82	.65	1.41	1.96	1.04	.93	1.32	.09	2.56	2.09
1975	31.58	4.46	4.67	2.35	1.27	1.36	2.78	.71	1.23	.92	3.84	3.14	4.76
1976	22.86	3.31	3.92	1.85	1.04	.84	3.17	1.01	3.19	.40	1.26	2.16	.71
1977	23.53	.60	.83	2.09	.13	1.73	.19	2.02	1.91	2.99	1.25	3.74	6.05
1978	22.79	2.07	1.58	.61	1.36	4.06	1.11	2.41	2.12	1.69	.27	2.56	2.95
1979	18.69	1.74	4.81	1.60	1.34	.67	.26	.80	1.19	.56	1.40	.33	3.99
1980	29.33	3.34	1.00	2.47	.85	4.59	4.74	1.21	1.84	1.92	.86	2.51	4.00
1981	21.47	.74	2.76	.43	1.96	3.14	4.36	.56	.21	.77	.98	1.99	3.57
1982	31.70	4.31	4.72	3.09	2.45	2.43	2.85	1.75	1.01	1.13	.98	3.01	3.97
1983	22.10	3.42	1.68	1.87	.78	1.15	2.60	2.23	1.21	1.09	.69	3.75	1.63
1984	24.42	1.51	.64	1.29	2.14	2.80	3.02	.62	.50	1.22	2.76	3.20	4.72
1985	23.79	.28	2.21	1.44	1.58	1.94	1.82	.05	3.02	3.67	3.95	3.10	.73
1986	--	2.21	--	1.15	.89	1.80	1.10	.50	1.23	2.81	1.18	4.53	.64
1987	18.60	1.10	1.27	2.44	1.48	1.62	1.39	3.16	1.50	.04	.02	1.19	3.39
AVG	26.07	3.42	2.59	2.08	1.72	1.92	2.28	1.10	1.32	1.60	1.84	2.88	3.33

From Climatological Data Annual Summary, Department of Commerce, National Climatic Data Center, Asheville, North Carolina

TABLE B-5
MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA

SNOW SURVEY STATION 15A12
POORMAN CREEK
Sec5, T27N R31W elev. 5100'

	January			February			March			April			May			June		
YEAR	DATE	DEP	SWE	DATE	DEP	SWE	DATE	DEP	SWE	DATE	DEP	SWE	DATE	DEP	SWE	DATE	DEP	SWE
69-1	1/10	89	27.4	2/06	114	39.7	2/24	107	41.7	3/24	109	48.5	4/28	69	35.9	6/02	0	0.0
70-1							3/06	86	28.9	4/03	86	33.3	4/27	84	34.8	5/25	26	12.9
71-1				1/21	69	24.2	2/23	79	34.6	4/02	111	45.0	4/30	86	40.1	5/25	32	17.5
72-1				2/03	108	40.0	2/28	125	52.4	3/31	106	51.1	5/05	91	50.0	6/01	26	14.9
73-1	1/11	43	13.6				3/02	65	21.8	3/30	63	24.5	5/04	35	16.0	6/01	0	0.0
74-1	1/10	57	18.9				2/28	122	40.8	3/28	122	52.8	5/01	99	50.2	5/30	66	35.7
75-1				1/22	69	23.4	2/27	97	35.7	3/27	114	41.3	5/02	87	40.8	5/29	42	23.1
76-1				1/28	57	20.7	2/26	101	31.3	3/31	101	39.3	4/28	77	35.0	5/25	16	8.2
77-1				1/28	30	10.0	2/23	35	11.7	3/31	59	20.5	4/28	20	8.8	6/01	0	0.0
78-1				1/26	80	28.0	2/23	84	31.4	3/31	66	31.6	4/27	60	30.4	5/31	16	9.1
79-1							3/09	83	33.1	4/04	86	35.3	4/25	76	32.8	5/29	3	1.6
80-1	K/26*	34	10.4	1/28	53	17.0	2/25	59	20.5	3/25	77	24.6	4/27	46	19.6	6/05	0	0.0
81-1	1/02	22	8.4	2/03	37	11.4	2/24	43	16.6	4/02	54	19.5	4/27	42	18.8	5/29	0	0.0
82-1	1/06	45	12.5	1/25	70	21.1	2/26	86	36.0	3/25	100	44.2	4/26	94	45.7	6/01	47	25.7
83-1	K/27	52	14.5	1/28	60	22.0	2/25	68	29.4	3/28	79	34.5	4/28	66	30.4	5/25	23	12.1
84-1	K/28	44	10.8	1/26	51	15.3	2/27	59	19.0	3/30	65	24.2	4/25	52	21.5	5/29	25	11.3
85-1	1/09	86	28.4	1/30	78	28.9	2/26	94	35.5	3/25	96	38.5	5/01	59	30.3	6/01	0	0.0
86-1				1/27	54	17.9	3/04	66	24.7	3/27	58	24.1	4/26	36	15.8	5/28	0	0.0
87-1	K/29	43	13.8	2/01	61	18.3	3/08	57	22.1	4/03	52	23.2	5/04	22	10.7	5/30	0	0.0
AVG		51.5	15.9		66.1	22.5		74.2	29.9		78.7	34.5		59.6	29.9		16.8	9.1
YRS		(10)	(10)		(15)	(15)		(19)	(19)		(19)	(19)		(19)	(19)		(19)	(19)

K = denotes December sampling
SWE = Snow Water Equivalent (in.)
DEP = Snow Depth (in.)
Data Source: from SCS snow survey data combined with on-site SCS precipitation data.

TABLE B-6

MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MT
SNOW SURVEY STATION 15A13
CEDAR GROVE (POORMAN TAILINGS SITE)
SEC35 T28N R31W ELEV 3760'

Year/	January			February			March			April			May			Middle of May		
card	date	dep	swe	date	dep	swe	date	dep	swe	date	dep	swe	date	dep	swe	date	dep	swe
69-1	1/10	42	9.6	2/06	53	14.4	2/24	48	14.8	3/24	44	15.4	4/28	4	2.3	5/13	0	0.0
70-1	1/17	20	4.4				3/06	46	13.7	4/03	41	13.8	4/27	29	10.4	5/12	5	2.5
71-1				1/21	41	12.2	2/23	34	12.2	4/02	51	19.0	4/30	35	15.1	5/10	12	5.9
72-1				2/03	53	16.5	2/28	56	19.6	3/31	41	18.2	5/05	20	9.8	5/17	0	0.0
73-1	1/11	6	1.8				3/02	16	4.5	3/30	14	5.3	5/04	0	0.0	5/17	0	0.0
74-1	1/10	31	8.1				3/01	54	16.2	3/28	53	20.5	5/01	27	11.4	5/16	0	0.0
75-1				1/22	31	8.9	2/27	45	14.2	3/27	58	18.2	5/02	33	13.9	5/14	10	4.4
76-1				1/28	22	7.1	2/26	49	13.3	3/31	48	16.7	4/28	27	10.0	5/11	0	0.0
77-1				1/28	8	2.2	2/23	7	2.1	3/31	19	6.4	4/28	0	0.0	5/11	0	0.0
78-1				1/26	36	10.3	2/23	39	12.8	3/31	29	11.8	4/27	20	4.8	5/16	0	0.0
79-1							3/09	40	14.5	4/04	45	15.2	4/25	27	11.2	5/14	0	0.0
80-1							2/25	29	8.2	3/25	38	8.4	4/27	7	2.1			
81-1							2/24	8	2.7	4/02	7	2.3	4/27	0	0.0			
82-1							2/26	35	12.2	3/25	35	12.8	4/26	35	14.3			
83-1	K-27	27	4.7	1/28	25	8.4	2/25	28	9.0	3/28	24	9.4	4/28	0	0.0			
84-1				1/26	22	5.3	2/27	24	5.9	3/30	0	0.0	4/25	0	0.0			
85-1							2/26	48	16.0	3/25	50	17.1	5/01	0	0.0			
86-1							3/04	41	12.2	3/27	32	11.5	4/26	0	0.0			
87-1							3/08	22	7.7	4/03	28	10.6	5/04	0	0.0			

	January		February		March		April		May			Mid-May	
	dep	swe	dep	swe	dep	swe	dep	swe	dep	swe		dep	swe
Avg 1st of Month	25.2	5.72	32.3	9.48	35.2	11.1	35.6	12.2	13.4	5.54	Avg Mid-May	2.45	1.1
yrs	(5)	(5)	(9)	(9)	(19)	(19)	(19)	(19)	(19)	(19)	yrs	(11)	(11)

dep - snow depth (inches)
swe - snow water equivalent (inches)
Data Source: from SCS Snow survey data combined with on-site SCS precipitation data.

TABLE B-7

MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA
EVAPORATION DATA NEAR TROUT CREEK, MONTANA 1985-1986
TROUT CREEK RANGER STATION

Date	Net Evaporation (inches) 1985	Net Evaporation (inches) 1986	Precipitation (inches) 1985	Precipitation (inches) 1986
5-10 (5-9)	--	-.125	--	.78
5-20	1.003	.215	.15	.95
5-24	.474	-.023	0	.37
5-29	.308	1.100	.59	0
6-7	-2.564	.834	3.16	.87
6-17	2.298	1.823	.41	.27
6-28	2.774	1.573	0	.05
7-7	1.936	1.170	0	.26
7-18	2.674	.855	0	.64
7-23	1.313	.968	0	.04
7-27	1.080	.696	0	.06
8-8	2.046	2.804	.57	0
8-13	-.546	1.200	.46	0
9-2	2.220	3.129	.58	.89
9-17	-2.262	.226	3.38	.93
10-10	0.824	.008	.66	1.59
10-23 (10-15)	-0.966	3.70	1.29	0
Total (inches)	+12.612	+16.823	11.25	7.70

Total evaporation corrected for precipitation:

(5-10 to 10-23, 1985) = 12.61 + 11.25 = 23.86 inches
(5-9 to 10-15, 1986) = 16.82 + 7.70 = 24.52 inches

Data Source: Asarco Rock Creek Permit Application

TABLE B-8

MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MONTANA
AVERAGE MONTHLY TEMPERATURES
LIBBY 1 NE RANGER STATION
Lat 48° 24′ N., Long 115° 32′W, elev. 2080

Year	Average Annual Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1951	43.0	22.6	29.0	30.8	44.3	53.5	57.1	67.3	64.1	54.5	43.8	34.2	16.8
1952	45.2	19.5	30.0	35.5	47.4	54.3	59.8	65.3	65.0	58.6	47.2	31.2	28.9
1953	47.0	34.4	33.6	39.2	43.5	52.1	57.7	65.2	66.1	57.8	47.3	35.3	31.1
1954	43.9	19.6	33.0	31.2	41.5	53.1	56.7	65.1	62.8	55.2	41.0	39.1	29.0
1955	42.5	27.2	25.4	29.2	40.3	49.4	60.0	66.3	63.2	56.3	46.4	24.4	21.8
1956	44.7	24.4	22.8	34.5	46.5	55.8	59.8	67.7	65.0	57.0	44.7	30.3	27.3
1957	44.4	11.7	26.3	36.3	45.6	58.1	62.0	65.7	63.2	58.5	42.8	32.8	30.0
1958	47.6	28.9	34.6	37.3	45.5	60.6	64.7	63.5	70.0	58.1	44.9	30.6	27.2
1959	44.2	24.9	27.3	37.3	46.7	50.1	60.1	66.7	62.5	55.4	45.6	26.5	27.2
1960	45.0	19.4	28.1	35.7	45.3	52.7	60.7	70.6	62.9	57.9	46.4	33.7	26.3
1961	44.2	25.1	33.2	37.0	39.6	51.7	65.1	68.9	70.1	49.7	42.3	28.4	19.7
1962	45.8	19.2	30.3	34.8	48.5	52.9	60.0	64.5	64.4	57.3	45.8	38.4	33.3
1963	46.5	15.4	35.9	40.7	46.4	53.3	62.3	65.1	67.6	62.2	48.8	36.0	24.8
1964	44.5	29.5	31.7	34.3	44.1	52.5	60.3	67.3	61.0	53.8	43.5	33.7	20.8
1965	45.3	28.5	31.3	30.0	47.0	51.5	59.7	66.7	67.2	50.9	47.6	35.1	28.3
1966	46.1	26.5	31.8	35.8	44.9	55.1	57.3	65.9	64.4	62.1	45.9	34.0	29.6
1967	47.6	31.9	35.5	35.9	42.5	53.4	61.8	67.5	69.9	64.3	48.5	35.1	25.0
1968	45.4	25.3	33.6	41.4	43.5	52.5	60.8	67.9	64.0	57.6	43.3	34.7	19.9
1969	44.9	14.6	28.9	37.1	47.9	56.6	61.6	63.6	65.1	58.5	42.4	35.2	27.3
1970	45.1	22.3	33.2	36.1	42.3	55.2	64.7	69.0	66.7	52.1	43.0	32.2	23.9
1971	44.5	23.0	31.2	34.1	44.8	55.0	58.2	65.0	69.9	52.5	42.9	35.0	22.0
1972	44.2	19.1	29.2	39.8	42.1	54.7	60.9	63.0	68.3	53.0	44.1	35.9	20.5
1973	45.8	19.4	29.9	40.6	44.3	54.3	60.8	68.9	67.8	57.2	45.4	30.5	29.9
1974	46.2	21.3	34.4	37.3	47.4	50.1	69.3	66.7	64.7	55.9	47.1	36.6	29.1
1975	44.0	24.3	25.8	33.1	40.6	51.3	57.4	70.0	62.2	55.7	44.7	33.0	29.4
1976	--	29.2	31.3	32.7	45.7	55.3	57.2	66.7	64.8	--	--	35.2	29.1
1977	45.8	23.3	34.3	37.4	47.8	51.9	64.3	66.3	66.8	55.0	45.5	32.0	24.7
1978	45.1	25.7	32.0	40.2	46.5	51.0	61.8	66.0	63.4	57.0	46.8	29.7	21.2
1979	45.5	7.3	30.4	39.9	44.5	54.2	62.1	68.4	68.4	58.8	47.9	30.5	33.2
1980	45.6	17.1	32.2	36.3	50.0	56.6	60.0	65.5	61.2	56.9	45.7	35.5	30.3
1981	46.8	32.0	33.1	40.9	46.3	54.4	56.6	65.5	68.3	57.1	43.4	35.4	28.0
1982	45.0	25.4	27.4	39.2	42.5	52.0	63.9	64.5	65.8	56.3	44.4	31.6	26.4
1983	46.1	30.3	34.8	40.7	45.6	54.6	60.6	63.7	69.2	54.1	46.3	38.3	15.1
1984	45.8	27.2	34.5	91.5	46.0	51.5	59.3	68.0	68.3	53.9	43.0	33.4	22.9
1985	44.0	23.8	24.4	36.6	48.2	56.3	61.3	72.1	64.0	52.8	43.2	22.4	22.8
1986	47.4	29.7	30.0	42.2	46.1	57.2	67.0	63.0	70.1	54.3	47.9	32.6	28.2
1987	47.7	24.9	34.2	38.9	49.7	58.2	64.7	66.6	62.8	58.9	45.3	39.2	27.4
Average	45.4	23.6	30.9	36.8	45.1	53.8	60.9	66.6	65.7	56.3	45.1	33.2	25.9

From Climatological Data Annual Summary, Department of Commerce, National Climatic Data Center, Asheville, North Carolina

TABLE B-9

MONTANA PROJECT
LINCOLN AND SANDERS COUNTIES, MT
PROJECT AREA
POTENTIAL EVAPORATION (inches)
PENMAN METHOD

Elevation (ft)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Annual	Modified Annual
3400	0.8	0.8	2.2	3.0	4.8	5.2	7.1	6.2	3.5	1.5	0.9	0.7	36.7	31.0
3700	0.8	0.7	2.2	2.8	4.5	4.9	6.7	5.7	3.2	1.2	0.7	0.6	34.0	29.0
4400	0.8	0.6	2.2	2.7	4.3	4.7	6.4	5.4	3.1	1.2	0.7	0.5	32.6	28.0

(1) Assumes no evaporation in months with a mean temperature $\leq 32^{\circ}$ F.

* Penman Method evaporation estimate by J.M. Caprio, Department of Plant and Soil Science, Montana State University

APPENDIX C

Chen-Northern, Inc.

APPENDIX C

FINAL
QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

FOR THE
MONTANA PROJECT
SANDERS AND LINCOLN COUNTIES, MONTANA

JANUARY, 1989

FINAL

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

FOR THE
MONTANA PROJECT
SANDERS AND LINCOLN COUNTIES, MONTANA

Submitted to:

Noranda Minerals Corporation

Submitted by:

Chen-Northern, Inc.
Helena, Montana 59604

January, 1989

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1.0 INTRODUCTION

A project-specific quality assurance/quality control (QA/QC) program was implemented in conjunction with the hydrological baseline investigations to insure data of known origin and quality were generated. Inherent to Chen-Northern's QA/QC program are sample documentation, sample control, and establishment of a method whereby received data are validated for comparability, completeness, representativeness, accuracy, and precision. In addition, standardized methods were used during all field data collection activities to minimize field-induced errors in the data. Specifics of Chen-Northern's QA/QC program for the Montana Project are presented in this appendix.

2.0 PROJECT DESCRIPTION

The proposed Montana Project involves development of an underground silver and copper mine in Lincoln and Sanders Counties, Montana, approximately 22 miles south of Libby, and 10 miles north of Noxon, Montana. The mine site is located beneath and adjacent to the Cabinet Mountains Wilderness area. The mine is expected to produce a nominal 20,000 tons per day of silver- and copper-bearing ore for a mine life of approximately 20 years. Major features associated with the mine include: mine access and ventilation adits, processing plant, tailing disposal areas, and ancillary facilities.

U.S. Borax submitted a Draft Plan of Study (POS) for collection of environmental baseline data for the Montana Silver Venture to the United States Forest Service (USFS) and Montana Department of State Lands (MDSL) on January 21, 1988. The Final POS was approved in June, 1988. The POS outlines specific tasks to be completed during the baseline investigations to provide sufficient data to support a hard rock mine permit application to the USFS and MDSL. Chen-Northern prepared hydrology and water quality portions of the baseline investigation.

Major components of the hydrology portions of the POS included completing evaluations of surface water and groundwater resources in areas identified as alternative sites for the evaluation adit, production adits, processing plant, tailing disposal, and ancillary facilities.

3.0 DOCUMENTATION/SAMPLE CONTROL

To insure collected samples are tracked from time of collection through to laboratory reporting of analytical results, the following plan will be implemented:

- Each fixed sampling station/site will be assigned a unique identifier and keyed into the project database management system and project base map. Where possible, the existing site identifier system used by U.S. Borax, and continued by Noranda, will be used to key all related data.

- Standardized field forms will be used to record all field activities, measured field parameters, aberrations to standard operating procedures, sampling information, and other pertinent information. These field forms will be photocopied upon return from the field; originals will be placed into the master project file for safekeeping.

- Sampling containers will be labeled with information including: site number; site name; date; time; type analysis; and sampler's initials. Two additional forms will be filled out in the field to cross-reference this type of information for tracking purposes. These forms are a packing list and analysis request form and a chain-of-custody record (Figures 3-1 and 3-2). Copies of these forms will be shipped with the samples to the receiving laboratory. Upon receipt of samples by the laboratory, written notification will be forwarded to the sampling office stating samples received and condition of samples upon arrival. All field forms and laboratory correspondence will be kept in the master project file.

Northern
Engineering and Testing, Inc.

1610 B Street
P.O. Box 4699
Helena, Montana 59601
(406) 443-5210

Packing List and Analysis Request Form

Sampling Office: HELENA	Sampling Date(s):	Ship To:	For Lab Use Only
Sampling Contact: _____ (name)	Date Shipped:		Date Samples Rec'd:
(406) 443-5210 (phone)	Site Name/Code:	Attn:	Received By:

Sample Numbers	Bottle, preservative, analysis	Sample Condition on Receipt at Lab
1.		
2.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		

White – Sample Office; Yellow – Lab Copy; Pink – Return to Sample Office upon receipt if applicable.

Northern Engineering and Testing, Inc.

1610 B Street
P.O. Box 4699
Helena, Montana 59601
(406) 443-5210

CHAIN OF CUSTODY RECORD

Proj. No.	Project Name						No. of Containers	Remarks
Samplers: (Signature)								
Sta.No.	Date	Time	Comp	Grab	Station Location			

Relinquished by: (Signature)	Date/Time	Rec'd by: (Signature)	Relinquished by: (Signature)	Date/Time	Rec'd by: (Signature)
Relinquished by: (Signature)	Date/Time	Rec'd by: (Signature)	Relinquished by: (Signature)	Date/Time	Rec'd by: (Signature)
Relinquished by: (Signature)	Date/Time	Rec'd for laboratory by: (Signature)	Date/Time	Remarks	

White-Sample Office Yellow-Lab Copy Pink-Return to Sample Office with Lab results

- The computerized database for the project will be established using sample site numbers, sampling dates and times, and other information obtained from field books and field forms. Upon receipt of analytical data, data entry personnel will check laboratory sample identifiers against identifiers in the project database to insure accurate data entries are made.

4.0 DATA VALIDATION, REDUCTION, AND REPORTING

The collection of useful and accurate field data demands a thorough and positive quality assurance plan. The overall quality assurance objective for hydrological data generated during this baseline investigation is to ensure that data of known and acceptable quality are provided. In order to meet these objectives, the following QA/QC parameters will be addressed for all data measurements:

- Comparability
- Completeness
- Representativeness
- Accuracy
- Precision

4.1 COMPARABILITY

The objective of the comparability assessment for the Montana Project hydrological baseline investigation is to insure that data developed during the investigation are comparable to existing data either directly or with defined limitations. Thus, existing data were used to plan the baseline investigation, and they will be used with data generated by the baseline investigation if they meet reasonable criteria for acceptability.

Standard Operating Procedures (SOPs; Sub-Appendix A) will also be used to insure comparable data are generated during the baseline investigation. These methods are consistent with the current standards of practice for environmental data collection. In cases where existing data have been collected in a manner different from that in Sub-Appendix A, the comparability of the information will be assessed by a comparison of the two methods. If the two methods provide incompatible results, the existing data will not be used.

Laboratory methods used to analyze samples generated during this baseline investigation will be commensurate with current standards of practice for detection limits agreed upon with the regulatory agencies. In cases where existing data have been obtained through different preparation or analytical methods than those obtained through this baseline investigation, the comparability of the information will be assessed. If the two methods are incompatible, the existing data will not be used.

4.2 COMPLETENESS

Completeness will be assessed for the Montana Project hydrological baseline investigation by comparing the number of valid natural sample results to the number of samples collected and to the number of samples planned. The objective for completeness is that the baseline investigation provide enough of the planned data that project objectives can be met. Completeness will be calculated following data validation and reduction. For this study, a completeness of 75% is proposed. If this completeness percentage is not met, additional sampling may be necessary.

4.3 REPRESENTATIVENESS

The objective in addressing representativeness is to assess whether the information obtained during the investigation accurately represents actual site conditions. For the most part, representativeness is determined by using the following methods:

- Following review of existing data and the Final POS with appropriate regulatory personnel, the baseline investigation can be modified to yield information representative of site conditions.

- Quality control samples will be designed into the field sampling program to provide information on external and internal cross-contamination. Excessive contamination can yield erroneous results which are not representative of site conditions. SOPs identified in Sub-Appendix A contain proper sample collection techniques (compositing, packaging, etc.) and equipment decontamination procedures for obtaining representative samples. Field procedures utilized to assess field sources of contamination include the following:

  * Field duplicate samples will be inserted into the sample train at a frequency of at least one in 25.

  * Field cross-contamination blanks will be inserted into the sample train at a minimum frequency of at least one in 25.

  * Field bottle blanks will be inserted into the sample train at an approximate frequency of at least one in 25.

  * Blind field standard samples will be inserted into the sample train at an approximate frequency of at least one in 25.

Table 4-1 describes the above types of QC samples. Cross-contamination blanks and bottle blanks will be checked to see if analytes are below detection. The blank will be reanalyzed for any analytes above detection if sufficient sample remains and holding times have not been exceeded. If the reanalysis shows the analytes are above detection, the values for those parameters in that sample run will be flagged in the data base. Procedures for field duplicate and blind field standard validation are described in the next section.

TABLE 4-1

DEFINITION OF FIELD QC SAMPLES

1. FIELD DUPLICATES are two samples taken from the same media under similar conditions.

2. FIELD CROSS-CONTAMINATION BLANK is DI water run through decontamination equipment to detect any residual contamination remaining on sampling equipment after decontamination.

3. FIELD BOTTLE BLANK is a sample bottle filled with DI water and inserted into the sample train.

4. BLIND FIELD STANDARDS are certified materials produced by agencies such as EPA or the National Bureau of Standards, or by private laboratories.

4.4 ACCURACY AND PRECISION

Quality control samples will be inserted into the sample train to aid in determining analytical precision and accuracy. This is routine practice in any EPA-certified commercial laboratory. These QC samples, combined with the blind field standards and field duplicates, will be used to determine if accuracy and precision requirements are met. This will be done in two ways. As each sample set is analyzed, the QC sample results will be compared with expected precision and accuracy. Reanalysis will be performed when criteria are not met, provided sufficient quantity of sample is available and holding time has not been exceeded. This will provide immediate corrective action in the laboratory or field procedures.

Accuracy is a measure of bias in the system. Precision is a measure of the variation in repetitious determinations of a parameter. Three types of QC samples will be used to assess laboratory accuracy and precision:

1. Blind Field Standards (BFS) -- These are certified materials produced by agencies such as EPA and the National Bureau of Standards (NBS). These samples are submitted blind to the laboratory along with the natural samples. Although the laboratory can most likely recognize the BFS, they do not know which certified material it is. Accuracy statements can be generated by comparing laboratory results to the mean certified result and applying statistical methods. Blind field standards will be used to evaluate the accuracy of the analyses.

2. Laboratory Natural Matrix Spikes (Pre-spike) -- These are spikes prepared in the laboratory by splitting a sample and spiking one portion with a known amount of the analyte(s) of interest. The spiked sample result and sample result are compared, and the amount of spike recovered is calculated. The spike recovery is the measure of accuracy. Use of this type of QC sample is routine in most certified laboratories, although the results are not reported or included in the project data base.

3. Laboratory Duplicate Analyses -- These are single sample digestants/extractants which are simply analyzed twice. These samples are used by the laboratory to evaluate the precision of the analyses. The resulting data are handled like the Natural Matrix Spike QC samples described above.

Field duplicates will also be collected. These are samples taken in the field under similar conditions to a previous sample; e.g., at the same point and soon after the natural sample. Field duplicates are a measure of natural variation in the system being sampled and are not used to prepare precision statements.

Laboratory quality control criteria will apply to all data as the individual parameters are being run. Laboratory spikes and duplicate samples are inserted into the sample train at a frequency of 10 percent (1 in 10). Analytical results of the laboratory spikes and duplicates must be within the laboratory acceptance criteria, or the samples in that run will be rerun. Laboratory acceptance criteria for precision and accuracy are contained in Table 4-2. If a particular sample parameter does not meet the criteria and there is insufficient sample remaining to reanalyze, data will be reported with a statement to that effect and will be flagged in the data base.

Surface water data for field duplicates will not be assessed for precision criteria shown in Table 4-2. Blind field standards will be evaluated with respect to the 95% confidence interval provided by the supplier. Data from a field run that do not meet these criteria will be flagged in the data base.

The accuracy statement will be made on the basis of all blind field standards analyzed during the sampling. For each parameter of each analysis, the measured value will be divided by the known value to obtain the relative percent difference (RPD). The mean and standard deviation for the RPD's for each parameter will then be calculated, and a statement for each parameter in the following form will be made:

TABLE 4-2

LABORATORY QUALITY CONTROL ACCEPTANCE CRITERIA FOR PRECISION AND ACCURACY

	Precision		Accuracy	
Parameter	Range of Concentration mg/L	Range of Duplicate mg/L	Lower Concentration Limit % Recovery	Upper Concentration Limit % Recovery
Alkalinity	10 - 50	1	90	110
	50 - 100	5	90	110
	100 - 500	10	90	110
	500 - 1000	30	90	110
Aluminum	0.1 - 1.0	0.1	96	114
	1 - 5	0.2	88	107
Ammonia as N	0.1 - 1.0	0.1	90	110
	1.0 - 10.0	0.7	-	-
Arsenic	0.005 - 0.010	0.002	90	113
	0.010 - 0.050	0.005	81	115
	0.050 - 0.100	0.010	89	113
Cadmium	0.0001 - 0.005	0.0006	80	120
	0.005 - 0.010	0.002	89	102
	0.010 - 0.050	0.005	88	105
	0.050 - 0.100	0.010	88	104
Calcium	1 - 10	1	90	110
	10 - 50	2	95	113
	50 - 100	4	95	105
	100 - 500	10	95	104
	500 - 1000	20	-	-
Chloride	1 - 10	1	88	114
	10 - 50	3	92	109
	50 - 100	5	88	106
	100 - 1000	20	97	110
Chromium	0.02 - 0.10	0.01	94	108
	0.1 - 1.0	0.05	93	105
Copper	0.001 - 0.02	0.005	80	120
	0.02 - 0.10	0.01	95	109
	0.1 - 1.0	0.05	91	113
Fluoride	0.02 - 0.1	0.05	80	120
	0.1 - 0.5	0.1	87	103
	0.5 - 1.0	0.1	93	101
	1 - 5.0	0.2	87	103
	10 - 50	1	87	107
Iron	0.05 - 1.0	0.04	93	111
	1 - 5	0.1	93	108
	5 - 10	0.4	92	110
	10 - 50	1.0	92	106
Lead	0.001 - 0.02	0.008	80	120
	0.02 - 0.10	0.01	85	105
	0.1 - 1.0	0.05	91	104
	1.0 - 10	0.40	-	-

TABLE 4-2 (continued)

QUALITY CONTROL ACCEPTANCE CRITERIA FOR PRECISION AND ACCURACY

	Precision		Accuracy	
Parameter	Range of Concentration mg/L	Range of Duplicate mg/L	Lower Concentration Limit % Recovery	Upper Concentration Limit % Recovery
Magnesium	1 - 10	1	93	108
	10 - 50	2	93	108
	50 - 100	4	96	108
	100 - 500	10	93	108
	500 - 1000	20	-	-
Manganese	0.02 - 0.10	0.01	76	101
	0.1 - 0.5	0.05	91	118
	0.5 - 1.0	0.10	91	113
	1.0 - 5.0	0.6	91	105
	5 - 10	0.7	-	-
	10 - 50	1.0	-	-
Mercury	0.0002 - 0.0005	0.0005	80	120
	0.0005 - 0.002	0.0005	90	115
	0.002 - 0.006	0.001	90	110
	0.006 - 0.02	0.010	90	108
Molybdenum	0.05 - 0.10	0.01	91	103
	0.1 - 1.0	0.10	-	-
Nitrate + Nitrite as N	0.01 - 0.05	0.04	80	120
	0.05 - 0.10	0.03	94	113
	0.1 - 0.5	0.04	94	104
	0.5 - 5.0	0.10	94	106
Total and Ortho-Phosphate as P	0.005 - 0.01	0.005	80	120
	0.01 - 0.10	0.02	93	107
	0.1 - 0.5	0.1	92	106
	0.5 - 1.0	0.2	92	106
Potassium	1 - 10	0.5	94	105
	10 - 50	3	94	105
Silver	0.0002 - 0.02	0.0008	80	120
	0.02 - 0.1	0.01	88	112
	0.1 - 1.0	0.05	87	129
Sodium	1 - 10	1	-	-
	10 - 100	2	81	112
	100 - 500	10	95	110
	500 - 1000	20	90	110
Sulfate	1 - 50	4	80	112
	50 - 100	8	81	103
	100 - 500	20	84	109
	500 - 1000	50	85	103
	1000 - 5000	100	95	106
Total Dissolved Solids	0 - 100	10	-	-
	100 - 500	33		
	500 - 1000	59		
	1000 - 5000	86		
	5000 - 10000	370		
Total Kjeldahl Nitrogen as N	0.2 - 1	0.2	85	115
	1 - 5	0.5		

TABLE 4-2 (continued)

QUALITY CONTROL ACCEPTANCE CRITERIA FOR PRECISION AND ACCURACY

	Precision		Accuracy	
Parameter	Range of Concentration mg/L	Range of Duplicate mg/L	Lower Concentration Limit % Recovery	Upper Concentration Limit % Recovery
Total Suspended Solids	1 - 10	2	-	-
	10 - 50	5		
	50 - 100	15		
	100 - 500	68		
	500 - 1000	196		
Turbidity (NTU units)	0.1 - 1	0.1	No Spikes	
	1 - 5	0.5 NTU		
	5 - 10	1.0 NTU		
Zinc	0.02 - 0.1	0.01	95	110
	0.1 - 1.0	0.05	95	109
	1 - 10	0.3	95	103

Notes: (a) Detection limit is for surface water parameters.
Detection limit is greater for some groundwater parameters.

"The accuracy of (parameter) is (mean) % ± (1.96 x S.D.) %"

If the RPD's are assumed to have a normal distribution, a range of 1.96 standard deviations corresponds to 95% of the data.

Precision Statement

Groundwater and surface water data generally have separate accuracy and precision statements reflecting the different parameters, methods, and analyses used for the sampling. No precision statements will be made on field duplicates of surface water samples, although such statements can be generated for groundwater quality data after a sufficient number of samples have been collected and analyzed. Precision statements based upon the type of field duplicate samples being collected are meaningless, because sampling procedures preclude the collection of truly duplicate samples.

No RPD's will be calculated for parameters below detection limit. For parameters near the detection limit, the precision statements may give very large ranges of relative precision.

5.0 SAMPLING PROCEDURES AND FIELD MEASUREMENTS

The objectives of sampling procedures and field measurements are to obtain samples and measurements that are representative and comparable. Trace levels of contaminants from external sources must be eliminated through the use of experienced field personnel, proper sampling techniques, appropriate sampling equipment, and adequate decontamination.

Field measurements and sampling will be performed in accordance with EPA-accepted procedures. Source materials for developing procedures may be chosen from, but need not be limited to:

- Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA 600/4-82-029)

- Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020, Revised March 1983)

- National Handbook of Recommended Methods for Water-Data Acquisition, U.S. Department of the Interior, 1985 (Revised), 2 volumes.

- Standard Methods for the Examination of Water and Wastes, American Public Health Association (1985).

Details of field measurements and sampling procedures are described in the Standard Operating Procedures (SOP) contained in Sub-Appendix A. The following field measurements will be recorded during this study:

- Water
  - pH
  - Eh (ground water)
  - SC
  - Temperature
  - Stream flow (surface water)
  - Static water level (groundwater wells)

Each field measurement will have a protocol included in the SOPs. The protocols include:

- Standard Operation Procedures
- Calibration methods and frequency
- Standardization procedures

The following field observations will be noted during the Investigation:

- Date
- Time
- Sampling Crew
- Weather Conditions
- Site Description
- Sample Inventory

6.0 SAMPLE CUSTODY

6.1 DOCUMENTATION AND CHAIN OF CUSTODY

A required part of any sampling and analytical program is maintaining the integrity of the sample from collection to data reporting. This includes the ability to trace the possession and handling of samples from the time of collection, through analysis, and final disposition. This documentation of the sample's history is referred to as "chain of custody." The components of the chain of custody (a field log book, chain-of-custody record) and the procedures for their use are described in the following sections.

A sample is considered to be under a person's custody if it is:

- In a person's physical possession
- In view of the person after he has taken possession

A person who has samples under custody must comply with the procedures described in the following sections.

To establish the documentation necessary to trace sample possession from the time of collection, a chain-of-custody record will be filled out and accompany every sample. A chain-of-custody record is illustrated in Figure 3-2.

The record will contain the following minimum information:

- Station location (tied to a sampling location)
- Signature of collector(s)
- Date and time of collection

- Project name and number
- Number of containers
- Name of shipper (remarks)
- Date shipped (remarks)
- Signatures of people involved in the chain of possession
- Inclusive dates and times of possession

In order to maintain chain-of-custody, each person in custody of the sample will sign, date, and note time on the form.

6.2 FIELD LOG BOOK AND FORMS

All information pertinent to the field activities or sampling effort will be recorded in a log book or equivalent standardized forms. As a minimum, entries in a log book will include the following:

- Location and description of the sampling point
- Identification of sampling crew members
- Number and volume of sample taken
- Sample type taken (e.g., natural, duplicate, blind field standard, blanks)
- Sampling methodology
- Sample preservation

- Date and time of collection
- Weather conditions
- Collector's sample identification number(s)
- Sample distribution and how transported (e.g., name of the laboratory)
- Field observations
- Any field measurements
- Deviations from SOPs

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a log book or standardized form. However, records will contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory.

6.3 SAMPLE DELIVERY TO THE LABORATORY

The sample will be delivered to the laboratory for analysis in time to perform requested analyses within the specified allowable holding times. The sample will be accompanied by the chain-of-custody record and an appropriate sample analysis request sheet. The sample will be delivered to the person in the laboratory authorized to receive samples (laboratory sample custodian). The laboratory sample custodian signs the chain-of-custody record and retains custody of the samples. The custodian also inspects the condition on arrival of the samples and notes any problems. Samples will be shipped in watertight coolers, adequately packed to avoid damage under normal handling.

7.0 EQUIPMENT OPERATION, MAINTENANCE, CALIBRATION, AND STANDARDIZATION

All field equipment used during this project will be operated, maintained, calibrated and standardized in accordance with accepted practices. The following equipment will be used in the field:

- pH meter (for determination of pH)
- SC meter (for determination of specific conductivity)
- Eh meter (for determination of redox potential of groundwater)
- Thermometer (for determination of water temperature)
- Stream flow meters (for determination of stream flow)

Each piece of field equipment will have a protocol package described in detail in the appropriate SOP (Sub-Appendix A) that contains:

- Standard operating procedures
- Routine preventive maintenance procedures
- Calibration methods, frequency, and description of calibration solutions

The above information will, in general, conform to the manufacturer's recommended procedures or will explain the deviation from said procedures.

8.0 ANALYTICAL PROCEDURES

Analytical procedures will follow methods listed in Table 8-1. Parameter detection limits for specific parameters in ground and surface water samples are contained in Tables 8-2 and 8-3.

TABLE 8-1

ANALYTICAL METHODS

Parameter	Method	Field Preservation	Maximum Holding Time
Alkalinity	Titrimetric, EPA Method 310.1	Cool, 4°C	14 days
Aluminum	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Arsenic	Hydride, AA, EPA 206.3	HNO_3 to pH <2	6 months
Cadmium	Furnace, AA, EPA 213.2	HNO_3 to pH <2	6 months
Calcium	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Chloride	Titrimetric, Mercuric Nitrate, EPA Method 215.1	Cool, 4°C	28 days
Chromium	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Copper	Furnace, AA, EPA 220.2	HNO_3 to pH <2	6 months
Fluoride	Potentiometric, Ion Selective Electrode, EPA 340.2	None	28 days
Hardness	Calculated	-	-
Iron	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Lead	Furnace, AA, EPA 239.2	HNO_3 to pH <2	6 months
Magnesium	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Manganese	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Mercury	Cold Vapor, Manual, EPA 245.1	HNO_3 to pH <2	6 months
Molybdenum	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Nitrogen:			
Ammonia	Colorimetric, Titrimetric, Distillation procedure, EPA 350.2	H_2SO_4 to pH <2	28 days
Kjeldahl	Colorimetric, Titrimetric, Potentiometric, EPA 351.3	H_2SO_4 to pH <2	28 days
Nitrate + Nitrite	Colorimetric, EPA 353.2	H_2SO_4 to pH <2	28 days
Oil & Grease	Gravimetric, Separatory Funnel Extraction, EPA 413.1	Cool, 4°C H_2SO_4 to pH <2	28 days

TABLE 8-1 (continued)

ANALYTICAL METHODS

Parameter	Method	Field Preservation	Maximum Holding Time
pH	Electrometric, EPA 150.1	None	Immediate
Phosphorus:			
Ortho	Colorimetric, Automated Ascorbic Acid, EPA 365.1	H_2SO_4 to pH <2 Cool, 4°C	28 days
Total	Colorimetric, Ascorbic Acid, Single Reagent, EPA 365.2	H_2SO_4 to pH <2 Cool, 4°	28 days
Potassium	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Silver	Furnace, AA, EPA 272.2	HNO_3 to pH <2	6 months
Sodium	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months
Specific Conductivity	EPA 120.1	Cool, 4°C	28 days
Total Dissolved Solids	Gravimetric at 180°C, EPA 160.1	Cool, 4°C	7 days
Total Suspended Solids	Gravimetric at 103-105°C, EPA 160.2	Cool, 4°C	7 days
Sulfate	Gravimetric, EPA 375.3	Cool, 4°C	28 days
Turbidity	Nephelometric, EPA 180.1	Cool, 4°C	48 hours
Zinc	Direct Aspiration, ICP, EPA 200.7	HNO_3 to pH <2	6 months

TABLE 8-2

SURFACE WATER QUALITY PARAMETERS [a]
MG/L

FIELD PARAMETERS	COMMON IONS	METALS [b]	OTHERS
pH (s.u.)	Ca (1)	Pb (.001)	Nitrite and Nitrate as N (.01)
Specific Conductivity (umhos/cm)	Mg (1)	Cu (.001)	Orthophosphate as P (.005)
Temperature (^{o}C)	Na (1)	Cr (.02)	F (.05)
	K (1)	Zn (.02)	TDS (1)
	CO_3 (1)	Cd (.0001)	TSS (1)
	HCO_3 (1)	Fe (.05)	Turbidity (0.1 NTU)
	Cl (1)	Al (0.1)	Hardness, as $CaCO_3$ (1) [c]
	SO_4 (1)	Mn (.02)	Alkalinity, as $CaCO_3$ (1)
		Hg (.0002)	Ammonia (0.05)
		As (.005)	Total Kjeldahl Nitrogen as N (0.2)
		Ag (.0002)	Total Phosphorous as P (.005)
		Mo (.05)	

(a) Proposed target minimum detection limits for specific constituents to be analyzed in the laboratory are shown in parenthesis following that parameter. Oil and Grease were analyzed once for each surface water site to establish baseline conditions.

(b) Samples will be collected in the field and analyzed in the laboratory for total recoverable metal concentrations. Total recoverable metals were analyzed in the laboratory using procedures described in EPA 600/4-79-020.

(c) Hardness is calculated from the concentrations of calcium and magnesium in samples by the equation:

$$(Ca\ mg/L)(2.497) + (Mg\ mg/L)\ (4.118) = mg/L\ Hardness\ as\ CaCo_3.$$

Therefore the contribution of calcium to hardness is 2.497 and contribution of magnesium to hardness is 4.118 the sum of the contributions is hardness as $CaCo_3$. If the measurable concentrations of either or both concentrations of calcium or magnesium are less than detection, the value for hardness will also be less than the calculated value. If both Ca + mg are <1 mg/L, the calculated value for hardness <6.

TABLE 8-3

GROUNDWATER QUALITY PARAMETERS [a]
MG/L

FIELD PARAMETERS	COMMON IONS	METALS [b]	OTHERS
pH (s.u.)	Ca (1)	Pb (.01)	F (.05)
Specific Conductivity (umhos/cm)	Mg (1)	Cu (.02)	TDS (1.0)
Temperature (^{o}C)	Na (1)	Cr (.02)	Hardness, as $CaCO_3$ (1) [c]
Eh	K (1)	Zn (.02)	Alkalinity, as $CaCO_3$ (1)
	CO_3 (1)	Cd (.001)	Nitrite and Nitrate as N (.01)
	HCO_3 (1)	Fe (.05)	
	Cl (1)	Al (.1)	
	SO_4 (1)	Mn (.02)	
		Hg (.0002)	
		As (.005)	
		Ag (.001)	
		Mo (.05)	

(a) Proposed target minimum detection limits for specific constituents to be analyzed in the laboratory are shown in parenthesis following that parameter.

(b) Dissolved metals were analyzed in the laboratory using procedures described in EPA 600/4-79-020.

(c) Hardness is calculated from the concentrations of calcium and magnesium in samples by the equation:

$$(Ca\ mg/L)(2.497) + (mg\ mg/L)\ (4.118) = mg/L\ Hardness\ as\ CaCo_3.$$

Therefore the contribution of calcium to hardness is 2.497 and contribution of magnesium to hardness is 4.118 the sum of the contributions is hardness as $CaCo_3$. If the measurable concentrations of either or both concentrations of calcium or magnesium are less than detection, the value for hardness will also be less than the calculated value. If both Ca + mg are <1 mg/L, the calculated value for hardness <6.

8.1 QUALITY CONTROL POLICIES - LABORATORY

This section describes the quality control policies implemented by Chen-Northern's Billings Analytical Laboratory for internal quality assurance/quality control procedures. The descriptions are excerpts from Northern's Laboratory Manual and include the quality control routine for analytical methods, quality control acceptance criteria for precision data, and flow diagrams for quality control performance evaluation.

Policies which are implemented by the chemical laboratory to achieve and support the quality objectives are listed in this section. Details for implementing these policies appear in later sections of this manual.

Administrative and technical review of laboratory reports and records to assure validity and uniformity is provided by the assigned QA coordinator, the technician generating the data, and the laboratory manager.

Complete and current analytical methods and procedures and analytical instrument operating instructions are made available to laboratory personnel. Data and calibration records are updated upon their generation by laboratory personnel.

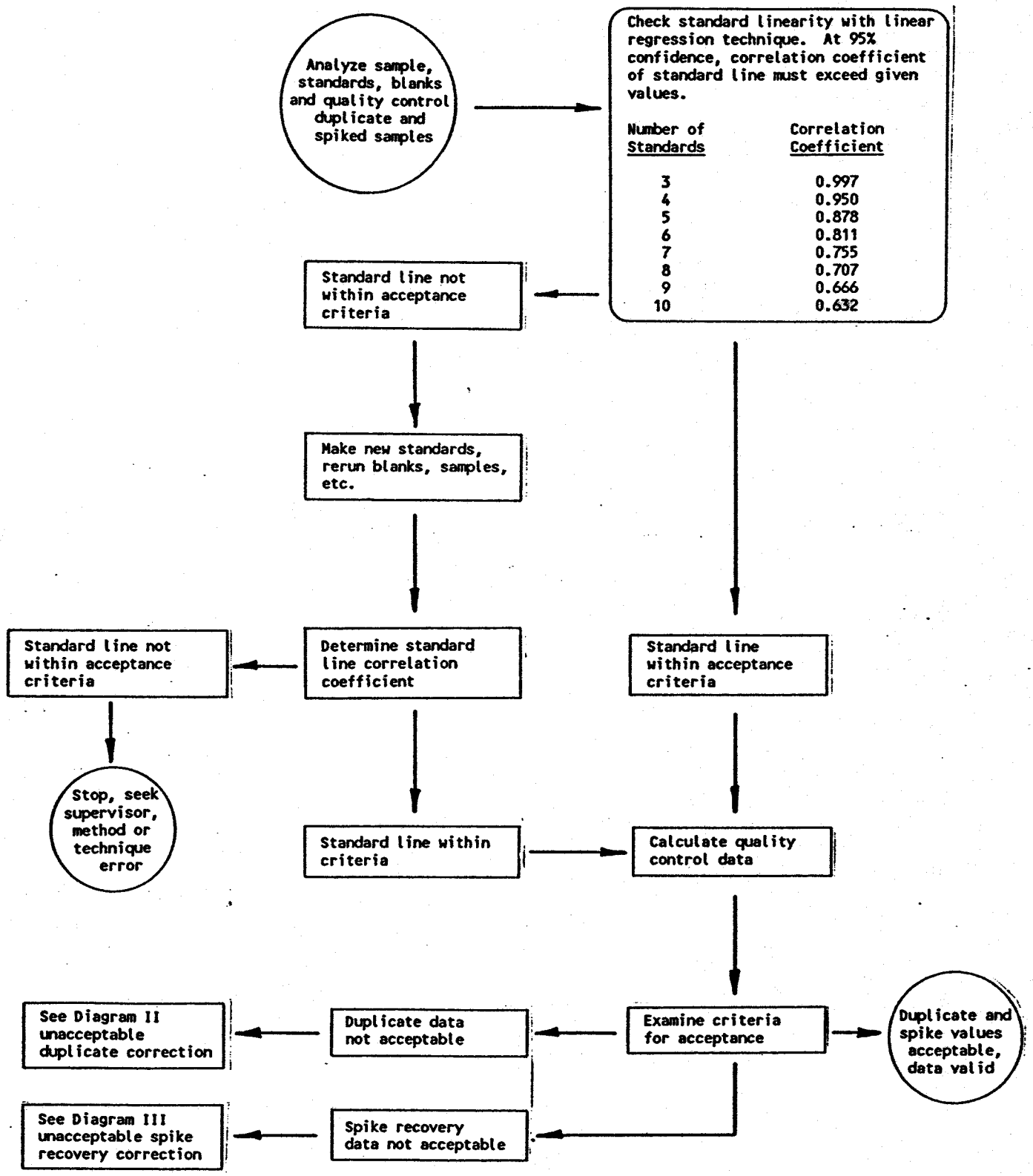
Only skilled and trained personnel are employed. The equipment used in the laboratory is maintained and calibrated on a regular basis as described by the method used for quantification of the analyte of interest. All chemicals, reagents, and precision equipment used in the laboratory are certified or standardized and documented on a regular basis.

Flow diagrams in Figures 8-1 A through C indicate the quality control routing used by Chen-Northern. These flow diagrams govern the actions of the technician as they analyze samples for any parameter. A generalized rule for all tests includes the following salient points:

1. Standards shall be run with any number of samples to be analyzed. In the event more than 20 samples are analyzed in one batch, the standards shall be verified after each set of 20 analyses.

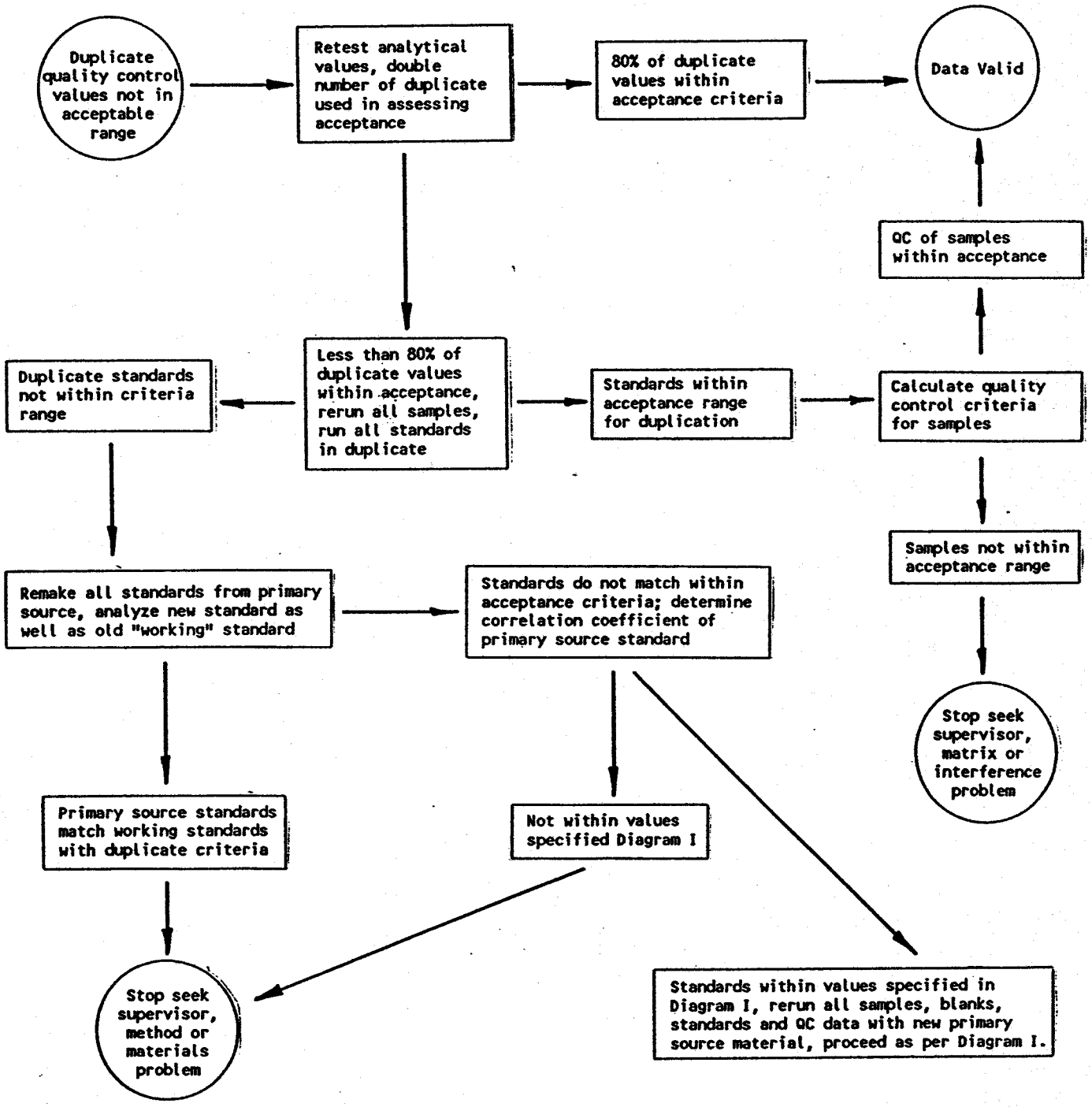
QUALITY CONTROL ROUTING - FLOW DIAGRAM 8-1 A

QUALITY CONTROL PERFORMANCE EVALUATION -- DIAGRAM I



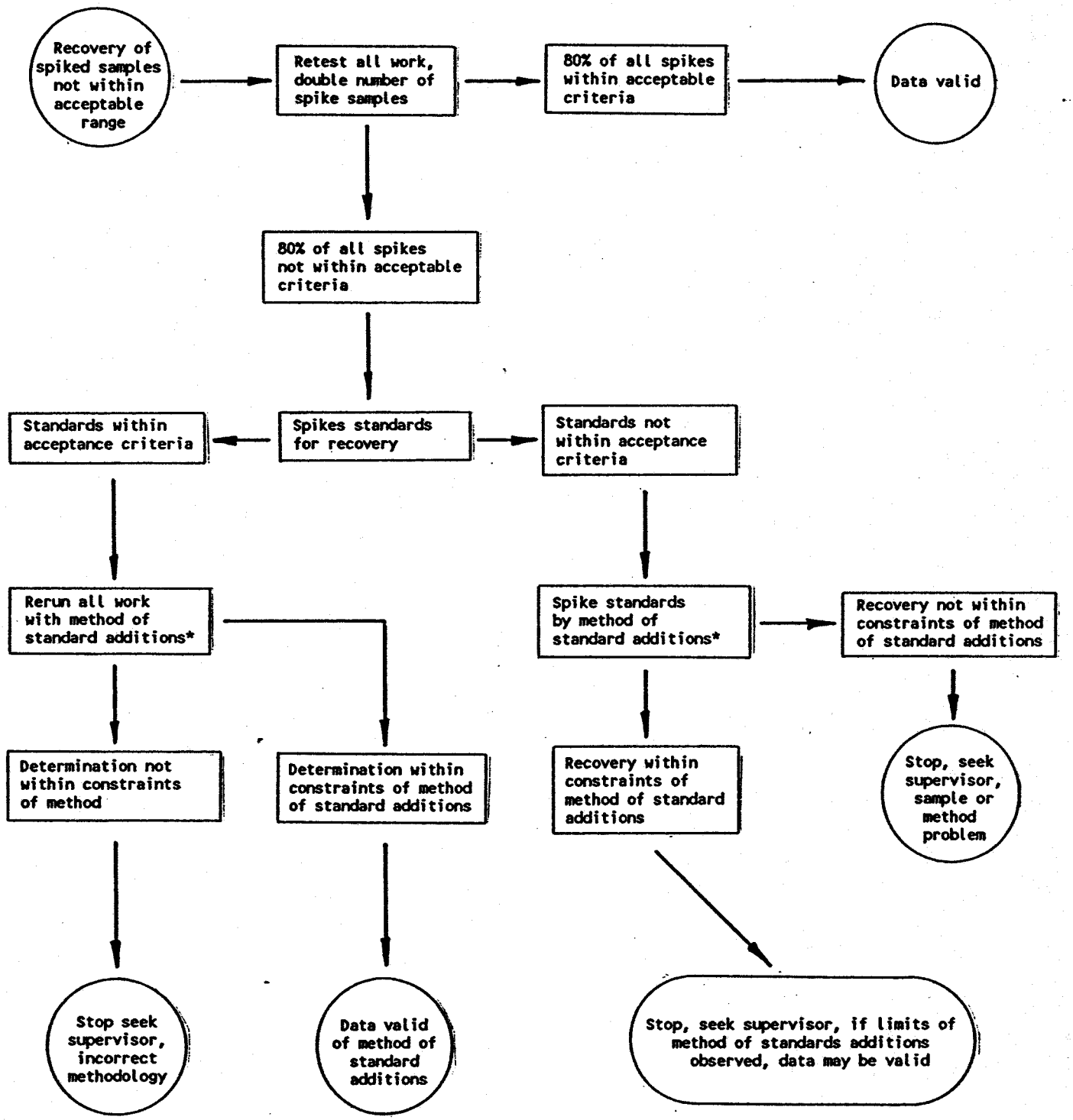
QUALITY CONTROL ROUTING - FLOW DIAGRAM 8-1 B

QUALITY CONTROL PERFORMANCE EVALUATION -- DIAGRAM II
COLLECTION OF UNACCEPTABLE DUPLICATE VALUE DATA



QUALITY CONTROL ROUTING - FLOW DIAGRAM 8-1 C

QUALITY CONTROL PERFORMANCE EVALUATION -- DIAGRAM III
CORRECTION OF UNACCEPTABLE SPIKE RECOVERY DATA



*Method of standard addition can be found in EPA 600/4-79-020, page metals-12, part 8.5

2. Each batch shall include 10% duplicate analyses, 10% spike analyses and at least one standard reference material. Reference material concentration recoveries shall be compared to accuracy acceptance criteria.

3. All raw data such as tare weights, titration volumes, absorbances, peak heights, fiber counts, etc. will be recorded in the laboratory notebook. Correlation coefficients, slopes and y intercepts shall be recorded for Beer's Law curves used for data generation.

4. Dates and technician initials shall be recorded with raw data. Notes of unusual circumstances or special sample treatments shall be entered into the lab notebook.

5. Raw data shall be converted to concentration units by using the calculations given in the appropriate written method. Deviations from this shall be recorded.

In an effort to verify control and to demonstrate capability as an analytical laboratory, Chen-Northern subscribes to the following quality audit programs.

- EPA - SDWA Drinking Water Supply Audit
- EPA - NPDES Wastewater Source Audit
- NIOSH - PAT Program - Asbestos
- EPA - Asbestos Identification Audit
- AMAX Coal Company - Soil Analysis Round Robin
- AMAX Coal Company - Coal Analysis Round Robin
- Utah State University - Soil Analysis Round Robin
- Office of Surface Mining - Soil Analysis Round Robin
- State of Montana DSL - Soil Analysis Round Robin

Quality control acceptance criteria for precision and accuracy are generated using data produced in Chen-Northern laboratory. For precision, the acceptable range of duplicate concentrations is determined by

calculation of critical differences of data produced in the past. Using the following equation, a critical difference or "Range of duplicate" is established for each range of concentration of any particular analyte.

$$\text{Critical Difference} = \frac{1}{n} \sum_{i=1}^{n} X_{i1} - X_{i2} \times 3.27$$

Where: (X_1) is the natural sample value and
(X_2) is the duplicate sample value.

For accuracy, the upper and lower confidence levels are calculated by using the following equation for each range of concentration for any particular analyte.

$$100\% \pm (1.965 \times \text{Standard Deviation})$$

DEFINITION OF TERMS

Range: The range is the boundary of lowest to highest values to which a statement pertains.

Rc: Critical range; the maximum allowable difference between a sample value and its duplicate value.

LCL: Lower control limit; the smallest acceptable percent recovery allowed for a spiked sample.

UCL: Upper control limit; the highest acceptable percent recovery allowed for a spiked sample.

Example: A sample is analyzed for calcium. Values determined were 33.4 and 35.0. Is this within acceptable duplicate criteria?

From the quality control statement on the range of 10-50 the maximum allowable difference in calcium duplicate is 1.3. Since the difference of these values is 1.6 ppm, the sample determinations are not acceptable.

Example: A sample is determined for dissolved arsenic content. This value is 0.011 ppm. The sample is spiked to a total concentration of 0.020 and 0.017 ppm is recovered. Is this acceptable?

In the range 0.010 to 0.050, the lowest percent recovery allowed is 88 percent (on a dissolved determination); the highest percent recovery allowed is 126 percent.

$$\frac{0.017}{0.020} \times 100$$

is 85 percent recovery and determination does not meet with the acceptance criteria of the QC table.

9.0 DATABASE MANAGEMENT SYSTEMS (DBMS) QUALITY ASSURANCE

Water quality data generated from the project will be entered into a DBMS after data validation. It will use existing DBMS software (Knowledgeman) and an IBM PC AT or compatible microcomputer. QA/QC protocols will be developed outlining data entry and verification, test program(s), and data security.

After data are entered, they will be proofed by a person familiar with the data. Corrections will be made, and the corrected output will be proofed.

The milliequivalent calculations for common ions will be generated by the database and compared with those from the laboratory to insure no errors in data transcription have occurred. The database will also be used to generate ranges of values. These ranges will be inspected for reasonableness as another check on data entry.

10.0 REFERENCES

American Public Health Association, 1985. Standard Methods for the Examination of Water and Wastewater. Washington, D.C.

EPA, 1979. Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020, Revised March 1983).

EPA, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029).

EPA, No date. Laboratory Data Validation: Functional Guidelines for Evaluating Inorganics Analysis, Office of Emergency and Remedial Response.

SUB-APPENDIX A

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE
STREAMFLOW MEASUREMENT; WADING TECHNIQUE

1. Visually check wading rod, current meter (pygmy or AA types), and headsets for damage. Repair damage to equipment and replace batteries in headsets as necessary.

2. Evaluate reach of stream to determine type of meter necessary to make flow measurement. For shallow, low velocity streams, use a pygmy-type current meter; for relatively deep, higher velocity streams, use a standard AA-type meter.

3. Perform spin test on selected meter; the cups on the pygmy meter should spin continuously for at least 30 seconds; on the AA meter, the cups should spin for at least two minutes. If the current meter fails the spin test, lubricate and adjust as necessary to achieve desired results.

4. Attach current meter and head set to wading rod. Check the electric connection between the current meter and headset by spinning cups on the current meter and listening for clicks in the head phone. Adjust equipment as necessary such that a clear click is heard upon every revolution of the cups.

5. Anchor surveyor's tape tautly across the stream perpendicular to the direction of streamflow and attach on either side of the stream. Provide at least one foot of clearance between the water surface and surveyor's tape.

6. Divide the cross-section of the stream into 20 to 30 partial sections based on values noted on the surveyor's tape denoting edge of water on each side of the stream. Concentrate partial flow measurement sections in areas of the stream cross-section containing the majority of flow so that no one section contains more than 5% of the flow.

7. Person wading in stream calls out to data recorder on shore the location of the first measuring point with respect to the surveyor's tape. Person in stream measures water depth at that vertical, using wading rod, to the nearest one-hundredth of a foot, if possible.

8. Data recorder calls out height(s) above the streambed at which velocity measurements are to be made. If the water is more than 2.5 feet deep, measurements should be made at 20 and 80 percent of the water column height. For water columns less than 2.5 feet deep, a single measurement of velocity at 40 percent of the water column height will suffice. Person wading adjusts height of current meter on the wading rod accordingly.

9. Person wading stands downstream of the surveyor's tape, facing upstream, holding the wading rod vertical in the water with the current meter facing directly into the current. Person should not stand directly behind the meter but either to the left or right so as not to influence velocity readings.

10. Person wading counts clicks at each vertical for a minimum of 40 seconds and calls final tally of both number of clicks and time to data recorder. Click count should correlate with velocity chart provided with each meter.

11. Repeat procedure at each vertical.

12. Data recorder reduces data on-site and records other appropriate information on the field form.

STANDARD OPERATING PROCEDURE
STREAMFLOW MEASUREMENT; BRIDGE METHOD

1. Visually check proper working order of all equipment necessary for a bridge measurement of stream discharge using a crane and reel including the crane, reel, cable, base, and standard AA meter. Replace or repair parts as necessary.

2. Perform spin test on current meter in accordance with SOP-01. Attach current meter to cable and check for an electric connection between headset and current meter. Adjust as necessary to obtain a definable click in the headphone upon each revolution of the current meter's cups.

3. Stretch a surveyor's tape along the downstream edge of the bridge at a location which is readily visible.

4. Divide the cross-section of the stream into 20 to 30 partial sections. Concentrate partial sections in areas of greatest flow.

5. Move current meter and crane to first measuring point at the midpoint of the first partial section. Lower meter to water surface and note depth on reel. Lower meter to streambed and subtract difference to calculate depth of water column.

6. Data recorder calls out height(s) at which velocity measurements are to be made. If the depth of water is greater than 2.7 feet, measurements should be made at 20 and 80 percent of the water column height. For water columns less than 2.7 feet deep, a single measurement of velocity at 40 percent of the water column height is adequate. Adjust depth of current meter accordingly.

7. Weights are attached below the current meter to keep the meter relatively vertical. Different size weights are used based on stream velocities, ranging from 30#c to 100#c.

8. Person measuring streamflow counts clicks at each vertical for a minimum of 40 seconds and calls final tally of number of clicks and corresponding time to data recorder.

9. Adjust calculated velocity for the angle the bridge makes to the stream at each vertical, if applicable.

10. Repeat procedure at each vertical.

11. Data recorder reduces data on-site and records other pertinent information on field form.

STANDARD OPERATING PROCEDURE
SURFACE WATER SAMPLING

EQUAL DISCHARGE INTEGRATED SAMPLING

1. Visually check DH-48 or D-74 sediment sampler for damage. Replace or repair parts as necessary.

2. Decontaminate all parts of sediment sampler utilized including nozzle, body, gasket, sample bottle, and handle using the procedure outlined in SOP-11.

3. Following streamflow measurement, and utilizing the same tag line or surveyor's tape stretched across the stream, divide the stream into four or more sections of equal discharge based on stream gaging results. At the mid point of each equi-discharge section, lower the sediment sampler into the stream with one continuous motion making sure the sample handle is vertical. Lower the sediment sampler to the streambed at a rate based on the rating curve for the nozzle size used and the velocity of the stream. The sample bottle should be just under half full upon encountering the streambed. Raise the sampler at a rate similar to the descent rate. The sample bottle should not be completely full upon removal from the stream. Pour contents of sediment sample bottle into a churn splitter or into an appropriately sized compositing container.

4. Repeat procedure for the other equal discharge sections identified, composite collected samples into the churn splitter.

5. Mix composite sample in the churn splitter and fill total metals and acid soluble metals first.

6. Fill out appropriate field form documenting sample location, time, and other pertinent information prior to leaving sampling site.

GRAB SAMPLING

1. Decontaminate sampling container in accordance with SOP-11.

2. Locate sampling site at a point in the stream exhibiting greatest flow and/or highest velocity.

3. Submerge sample container at sampling point such that mouth of container is under water surface 2 to 3 inches if possible. Allow container to fill partially; rinse container by shaking and discharge this water. Repeat this procedure three times.

4. Collect sample and transfer into compositing container. Transfer water from compositing container into sampling bottles.

5. Fill out appropriate field form(s) documenting sample location, time, and other pertinent information prior to leaving sampling site.

SURFACE SAMPLING

1. This sampling procedure is to be used when sampling for organic constituents that float on top of water (e.g. oil and grease).

2. Decontaminate sampling container in accordance with SOP-11. The sampling container should be a wide mouth jar.

3. Submerge the sampling container in such a manner that leaves the mouth of the container 1/2 out of the water. Wait for container to fill.

4. Transfer directly into sampling bottles.

5. Fill out appropriate field form(s) documenting sampling location, time and other pertinent information prior to leaving the sampling site.

STANDARD OPERATING PROCEDURE
FIELD SAMPLE FILTRATION

1. Vacuum-type Filtration apparatus will be decontaminated in accordance with SOP-11.

2. Visually inspect filtration equipment for damage. Replace parts or repair equipment as necessary.

3. Place 10-15 milliliters of 10% dilute nitric acid into filter apparatus containing 0.45 micron filter. Apply vacuum, discard filtered solution.

4. Repeat above procedure three times using sample water. Discard filtrate. If unable to repeat three times, use a pre-filter before using the 0.45 micron filter.

5. Fill filter vessel with sample water and apply vacuum. Use small quantities of filtered water to rinse sample container three times.

6. Fill sample container to appropriate level with filtered sample and mark level with permanent marker. Add appropriate preservative, if necessary. Invert sample container several times to insure complete sample - preservative mixing.

7. Place sample container into cooler; package and ship in accordance with SOP-09.

8. If extremely turbid sample water is obtained, use same procedure utilizing pre-filter (usually 3.0 micron) followed by 0.45 micron filtration.

9. Decontaminate all equipment in accordance with SOP-11 following use.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF ELECTRICAL CONDUCTANCE

Field Procedure

1. Check red line and zero point on meter. Adjust as necessary.

2. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

3. Place water sample in decontaminated glass beaker.

4. Rinse probe with DI water and place conductivity probe in sample water.

5. Immerse conductivity probe in sample so that vent hole is submerged. Move probe around in sample to displace any air bubbles. Turn instrument on to appropriate scale for sample analyzed. Multiply reading by the correct multiplier from the dial and record to the nearest ten microsemins/centimeter. Measure sample temperature to nearest 0.5^{o}C from conductivity meter. Record temperature.

6. Remove probe from sample and rinse probe with DI water.

Instrument Calibration

At the beginning and end of each day of sampling, determine cell constant in the field.

1. Rinse probe with deionized water.

2. Measure conductivity of two KCl solution standards which bracket expected sample values.

3. Measure temperature of both KCl solution standards.

4. Calculate cell constant for each standard and average the two values. The cell constant is the ratio of the computed conductivity to the measured conductivity of the standard KCl solution. Use this averaged constant and measured field temperatures and conductivities to calculate conductivity at 25°C for each sample taken during the day.

Maintenance

1. Store meter in its case during transport. If stored for long periods of time, immerse probe in distilled water.

2. Check batteries before taking meter into the field. Carry spare batteries and screwdriver.

3. Inspect conductivity electrodes on a monthly basis for cracks or other damage.

4. If platinum black has flaked off, a sharp end point cannot be achieved or readings are erratic. Return probe to factory so it can be replatinized.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH

Field Procedures

1. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

2. Rinse pH electrode with deionized water.

3. Check meter using standard that is nearest the expected pH. If not within 0.1 pH units re-calibrate meter using appropriate standards.

4. Fill beaker with sample water.

5. Immerse electrode and temperature probe in sample while swirling the sample to provide thorough mixing. Turn on meter. Electrode filler level should be 1/2-inch above sampling surface level. Read pH to nearest 0.1 unit once the reading has stabilized.

6. Record sample pH. Note any problems such as erratic readings.

7. Rinse probe with DI water and store according to manufacturer's directions.

Instrument Calibration

1. Calibrate pH meter in the field at the beginning of each day of field work when pH will be measured, or when the standard check is out of acceptable bounds. Calibrate using following procedure:

   - Rinse pH electrode and temperature probe with distilled water.

   - Immerse electrode and temperature probe in beaker of commercial calibration solution of pH at or below that expected for the samples.

   - Calibrate meter to appropriate pH.

   - Remove electrode and temperature probe from solution, rinse with distilled water, air dry.

   - Immerse electrode and temperature probe in second calibration solution having a pH 2 to 3 units higher or lower than the first, calibrate meter to solution.

- Measure pH of one of the calibration solutions. If measured value differs from expected value by more than 0.1 units, obtain fresh calibration solutions and recalculate. If discrepancy persists, begin trouble-shooting procedures following meter operating instructions: check batteries, connections, etc. If meter checks out, inspect combination electrode. Clean and refill as necessary.

Maintenance

1. Store meter in its case with electrode immersed in a pH 7 buffer solution.

2. Inspect electrode weekly.

   - Plug of filler hole should be firmly seated when meter is stored for a week or more.

   - Check glass electrode for cracks or scratches.

3. Check batteries each time meter is used. Carry a spare battery pack and a screwdriver into the field in the pH meter case.

4. Check pH meter monthly with a pH meter tester and adjust as necessary.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF WATER TEMPERATURE

1. Carry two NBS-calibrated thermometers inside cases, into the field.

2. Check thermometer for cracks or gaps in the mercury. Do not use thermometers if either cracks or gaps are visible.

3. When possible, measure temperature of surface water at midstream submersing the thermometer for approximately one minute or until temperature stabilizes.

4. When in situ temperature measurements are not possible, draw sample of at least 200 mL into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about 1 minute).

6. Record temperature to nearest 0.5^{o}C in field log book or on field data sheet.

7. Rinse thermometer with deionized water.

8. On a quarterly basis, check field thermometers against a NBS-certified laboratory thermometer. Agreement should be within 0.5^{o}C.

STANDARD OPERATING PROCEDURE
SAMPLE PACKAGING AND SHIPPING

All samples collected should be packaged and/or shipped utilizing the following procedures.

Packaging

1. Place each labelled sample bottles in a zip lock bags and then in a high quality cooler containing two large containers of recently frozen blue ice (where applicable), making sure the cooler drain plug is taped shut both inside and outside.

2. Position the sample bottles upright and surround the samples with noncombustible, absorbent, cushioning material for stability during transport.

3. Place the laboratory/sampling paperwork in a ziplock bag and tape it to the inside lid of the shipping container (see Shipping Papers).

4. Close and seal the cooler with at least two signed and dated custody seals and sealer tape. Tape cooler shut utilizing fiberglass tape.

5. Secure Air Bill to cooler and ship via express air service.

6. Notify project manager of shipment.

Marking/Labeling

7. Use abbreviations only where specified.

8. Place the following information either hand printed or in label form, on the outside container:

   - Laboratory name and address (on Air Bill)

   - Return cooler to: (name and address)

9. Secure "This End Up" and "Fragile" stickers clearly on top of the shipping container. Put upward pointing arrows on all four sides of the container. No other marking or labeling is required.

Shipping Papers

10. No DOT shipping papers are required. All field samples, (natural and QC), will be documented with the following forms. These forms will be placed in ziplock bags and taped to the inside lid of the same cooler as the samples to which they pertain.

    - Chain-of-custody form
    - Special Analytical Service (where applicable)
    - Inorganic Traffic Reports (where applicable)
    - Organic Traffic Reports (where applicable)

STANDARD OPERATING PROCEDURE
FIELD FORMS

All pertinent field survey and sampling information shall be recorded on a field form during each day of the field effort and at each sample site. The field crew leader shall be responsible for ensuring that sufficient detail is recorded on the field forms. No general rules can specify the extent of information that must be entered on the field form. However, field forms shall contain sufficient information so that someone can reconstruct all field activity without relying on the memory of the field crew. All entries shall be made in indelible ink weather conditions permitting. Each day's or site's entries will be initialed and dated at the end by the author. All corrections shall consist of line-out deletions which are initialed.

At a minimum, entries on the field sheet shall include:

- Date and time of starting work and weather conditions.
- Names of field crew leader and team members
- Project name or type
- Description of site conditions and any unusual circumstances.
- Location of sample site, including map reference, if relevant
- Equipment ID numbers
- Details of actual work effort, particularly any deviations from the field operations plan or standard operating procedures
- Field observations
- Any field measurements made (e.g., pH)

For sampling efforts, specific details for each sample should be recorded. In addition to the items listed above, the following general information should be included on the field form during the sampling efforts:

- Type and number of samples collected
- Sampling method, particularly deviations from the standard operating procedures

Strict custody procedures shall be maintained with the field forms utilized. While being used in the field, field forms shall remain with the field team at all times. Upon completion of the field effort, field forms shall be filed in an appropriately secure manner in Northern's Helena office. Photocopies of the original field forms will be used as working documents.

STANDARD OPERATING PROCEDURE
EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with mine/mill tailings, soil, or water. During field sampling activities, sampling equipment will become contaminated after it is used. Sampling equipment must be decontaminated between sample collection points if it is not disposable.

Field personnel must wear disposable examination gloves while decontaminating equipment at the project site. Change gloves between every sample. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone approximately 15 feet upwind from the sampling area. This area will be designated by the field crew leader.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. The general decontamination sequence for field equipment includes: wash with Liquinox or its equivalent; DI water rinse; dilute nitric acid rinse; DI water rinse; rinse with sample water three times.

4. Rinse equipment with methanol in place of the nitric rinse if sampling for organic contamination. Follow with a DI water rinse.

5. Decontaminated equipment that is to be used for sampling organics should be wrapped in aluminum foil if not used immediately.

6. Clean outside of sample container after filling.

Alternatively, field equipment can be decontaminated by steam cleaning, rinsing with dilute nitric acid, and rinsing with deionized water.

All disposable items (e.g., paper towels, examination gloves, wash cloths) should be deposited into a garbage bag and disposed of in an approved landfill. Contaminated wash water does not have to be collected.

If vehicles used during sampling become contaminated, wash both inside and outside as necessary.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

2-gallon plastic tubs
5-gallon plastic water-container
5-gallon carboy DI water
1-gallon cube of 10% HNO_3
Paper towels
Liquinox (soap)
Hard bristle brushes
Garbage bags
Latex gloves
Squeeze bottles
Methanol

STANDARD OPERATING PROCEDURE
SAMPLE DOCUMENTATION

The purpose in filling out field documents is to provide enough information to reconstruct the sampling event without relying on the memories of the field crew. It is the responsibility of the DCO to assure field documents contain sufficient detail, and are correct. All entries will be made in indelible ink weather conditions permitting and all corrections will consist of initialed line-out deletions.

Documents to be completed for each sample generated during this investigation are:

- Field Form
- Chain-of-Custody Form
- EPA Sample Tags
- Custody Seal
- SAS Packing Lists
- Sample Identification Matrix Forms
- Organic Traffic Report (if applicable)
- Inorganic Traffic Report (if applicable)

Responsibility for the completion of these forms will be with each field crew leader.

STANDARD OPERATING PROCEDURE
QC SAMPLES

QC samples do not have any unique identifying codes that would enable the contract lab or others to bias these samples in any way. There are, however, differences in blank and standard samples which might separate them from the rest of the sample train. The sampling team will strive for uniformity in sampling technique to limit sampling error. The QC samples will be identified only on the SAMPLE IDENTIFICATION MATRIX. The codes on the matrix sheet are as follows.

N - Natural Sample
R - Replicate - Duplicate Sample
BB - Bottle Blank
WB - Cross Contamination Blank
BFS- Blind Field Standard
KB - Kimwipe Blank
TB - Travel Blank

In general, QC samples will be inserted into the sample train on a one in twenty basis or one per day per sampling crew, whichever results in more QA/QC samples.

1. A duplicate sample will be a second sample taken from the same media at the same time.

2. A bottle blank will be deionized water placed directly into the sample bottles. It is preferable to fill bottle blank off-site.

3. A cross contamination blank will be deionized water run through all sampling equipment or a Kimwipe wiped over decontaminated equipment and then placed into sample bottles.

4. A field standard will be an EPA approved standard prepared in the laboratory and entered into the sample train.

5. A Kimwipe blank will be a Kimwipe obtained directly from its packaging and inserted into a sample container.

6. A travel blank will be a ultra pure water sample prepared at the analytical laboratory and shipped to the sampling team; the blank must travel in a cooler with the sampling team when sampling for volatile organic compounds.

Each field crew leader will be responsible for all QC samples prepared by that crew.

STANDARD OPERATING PROCEDURE
MONITORING WELL CONSTRUCTION

1. Arrive on-site with properly sized drilling equipment and materials for site conditions. All drilling equipment and materials should be properly decontaminated prior to its arrival on-site. Decontamination usually includes steam - or hot water-cleaning methods.

2. Drilling muds or drilling solutions of any kind are not to be used during drilling activities in conjunction with monitoring well construction. Acceptable drilling techniques include air-rotary, cable tool, or hollow-stem auger. If unconsolidated material is encountered, it may be necessary to drive steel casing during drilling to maintain borehole integrity. It is suggested threaded steel casing be used in lieu of welding joints together to minimize this source of potential well contamination. Hydraulic jacks or the drill rig can be used to pull back the steel casing following emplacement of plastic casing.

3. A detailed lithologic log shall be completed during drilling activities. Water bearing characteristics of the formations should also be denoted on the log. In addition, details of monitoring well construction should also be described on the well log including total depth, perforated interval, sizes and types of construction materials, etc.

4. Seven- or ten-inch outside diameter hollow-stem augers can used in drilling shallow exploration drill holes in many situations. Care is taken to avoid contamination due to oil and grease from the drill rig and split spoon sampler. Appropriate decontamination of the drill rig between drill holes is performed. Soil and sediment samples are collected using a standard 1.4 inch inside diameter split spoon sampler and a 140 pound drive hammer. The number of blows necessary to obtain an 18 inch length of sample is recorded on the exploration log. Appropriate decontamination of the split spoon sampler is accomplished between samples.

   Either a single- or multi-completion monitoring well can be constructed in a single borehole where hollow-stem auger drilling is not used. Backfill chemically-inert silica sand to above the perforated interval and emplace a bentonite plug above the sand following installation of factory-screened and blank PVC (stainless steel or PTFE for organics) well casing into the borehole. Where appropriate, begin pulling temporary steel casing out of borehole. Emplace silica frac sand about any other perforated sections in the borehole; install bentonite plugs above and below perforated sections. Backfill remaining well annulus with a bentonite slurry or with grout to the surface.

5. Place locking well protector over PVC casing(s) after outer steel casing has been removed from the borehole if necessary. Place bentonite plug below bottom of well protector; grout well protector in place and lock with high quality lock.

STANDARD OPERATING PROCEDURE
MONITORING WELL DEVELOPMENT

1. Visually inspect all well development equipment for damage - repair as necessary.

2. Decontaminate all stingers, air hoses, surge blocks, etc. by scrubbing with brush and Liquinox solution, rinsing with dilute nitric acid solution, and rinsing with deionized water.

3. If using compressed air method for well development, make certain compressor utilized does not produce air laden with hydraulic fluid for lubricating purposes. This may affect the integrity of the monitoring well for producing viable water quality data.

4. Develop well by using surging techniques (surge block or bailer) followed by well evacuation. Repeat this procedure until evacuated water is visibly clean and essentially sand-free. In most cases, evacuated water can be disposed of on-site.

5. During evacuation process, collect water samples for field determinations of temperature, specific conductivity, and pH. Continue developing well until field parameters stabilize to within $\pm$5% on three consecutive measurements.

6. Report field observations and volume of water removed on standard form.

STANDARD OPERATING PROCEDURE
GROUND WATER SAMPLIING

1. Inspect all sampling equipment for damage upon arriving on-site. Repair equipment as necessary.

2. Decontaminate sampling equipment by scrubbing with brush and Liquinox, solution, rinsing with dilute nitric acid, and rinsing with deionized water.

3. Sampling domestic wells:

   a. Turn-on household fixture (preferably outside faucet) and allow well to discharge for 5 to 10 minutes. Be certain discharge point is on the well-side of any water conditioning device or screen.

   b. Monitor field parameters periodically during discharge period. When field parameters are within plus or minus five percent over three consecutive readings, the well is ready for sampling.

   c. Fill sample containers and add sample preservatives as appropriate. Do not collect samples through rubber hoses. Samples should be collected directly from hydrant or faucet. Perform field parameter tests.

   d. Field filter sample water in accordance with SOP-04 if appropriate. Add preservations as appropriate.

   e. Complete field forms in accordance with SOP-10.

4. Sampling monitoring wells:

   a. Evacuate monitoring wells with bailer or pump; monitor field parameters for consistency during evacuation process. Remove a minimum of three bore volumes of water from the monitoring well.

   b. Following well evacuation, install decontaminated bladder pump into or above perforated zone in well; commence pumping and monitor field parameters for consistency using field parameter box. Alternatively, a decontaminated bailer may use to collect the sample. Well is ready for sampling when field parameters are within plus or minus five percent on three consecutive readings.

   c. Field filter sample water in accordance with SOP-04 if appropriate. Add sample preservatives as appropriate; fill out field forms in accordance with SOP-10.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF GROUND WATER LEVEL

1. Check well probe prior to leaving for field for defects. Repair as necessary. Make certain the well probe, a decimal tape measure and extra batteries are in the carrying case.

2. Measure all wells (monitoring and domestic) from the top of the well casing on the north side or from a designated measuring point, as appropriate. Measure and record distance from measuring point to ground level.

3. Obtain a depth to water from measuring point to the nearest hundredth of a foot. Record data on appropriate field forms.

4. Decontaminate well probe between each measurement by scrubbing with Liquinox and brush, then rinsing with deionized water.

5. Calibrate well probe to a steel tape prior to and following each data gathering episode. Note any corrections to well probe measurements on field forms. Adjust reported data as necessary.

STANDARD OPERATING PROCEDURE
GAGING STATION OPERATION

1. Open recorder housing and visually inspect recorder, float, pulley, and counterweight. Note on field forms or in log book any irregularities observed.

2. Perform check of electronic recorder by initiating internal check mode and observing response in accordance with manufacturer's recommendations. Note irregularities. Record final reading on recorder.

3. Remove data storage module (DSM) and store in carrying case.

4. Pull recorder, platform, pulley, float, and cable out of well. Backflush stilling well with several buckets of water. Observe connecting pipe in stream for the presence of a silt cloud in the water which indicates a hydraulic connection exists. If not observable, use sewer snake or other means to remove blockage in connecting pipe.

5. Reinstall recorder apparatus. Replace batteries in recorder and insert fresh DSM.

6. Record new settings of recorder on DSM and in log book.

7. Initiate internal check on recorder and correct any malfunctions.

8. Lock recorder housing before leaving the site.

STANDARD OPERATING PROCEDURE
AQUIFER TESTING

Pumping Tests

1. Measure water levels in the pumping well and all observation wells daily for several days prior to the test to document water table fluctuation. It is preferable to install a continuous water level recorder to obtain this information.

2. Arrive on-site with all necessary equipment decontaminated and in good repair.

3. Set-up equipment; insure discharge hose/piping is directed away from test area such that the discharge will not influence the test. Obtain any necessary sanitary sewer or other discharge permits.

4. Choose pump size based on expected well yield reported from previous pumping tests or from the well development logs. It is important to stress the aquifer during the pumping test yet have enough available drawdown for the expected duration of the test.

5. Obtain water level data prior to the test in the pumping well and in all observation wells. Record all data on standardized field forms.

6. Begin trial pumping test by maintaining a constant discharge rate and measuring drawdown in the pumping well with an electric well probe or a pressure transducer. Determine if pumping rate is appropriate for the length of the test. Adjust discharge rate as necessary. Terminate trial test and allow water levels to recover to prepumping elevations.

7. Prepare for constant discharge test by coordinating all personnel involved. Collect water level data every 30 seconds for the first five minutes of the test, every minute for the next five minutes, every two minutes for minutes 10 through 20 of the test, every five minutes for minutes 20 through 40, every 10 minutes for minutes 40 through 60, every 15 minutes for minutes 60 through 100, every 30 minutes for minutes 100 through 1000, and every 60 minutes for the remainder of the test. Following termination of the constant discharge test, collect water level recovery data in a sequence similar to that above with the most frequent measurements obtained early in the recovery tests.

8. During the constant discharge test, obtain measurements of discharge periodically and record on field forms. Adjust discharge as necessary to maintain consistency. Measure field parameters, including pH, SC, and temperature at the time of discharge measurements.

9. Record all data on standard field forms and plot drawdown and recovery curves in the field in accordance with methods described in Lohman (1972) or other appropriate techniques as conditions or aquifer type warrant. Note any irregularities in the test on field forms.

10. Upon completion of aquifer testing, decontaminate all equipment prior to exiting the project area.

Reference:

Lohman, S.W. 1972. Ground Water Hydraulics. U.S. Geological Survey Professional Paper 708. Washington.

Slug Testing

1. Arrive on-site with all equipment decontaminated and in good repair.

2. Insert pressure transducer (if applicable) into well to be tested and allow to stabilize. Measure and record static water level prior to initiation of test.

3. Perform test by either withdrawing a known volume of water or inserting a cylinder of know dimensions. Record water level recovery data at frequent intervals on a standardized field form. Measurement frequency should continuously initially, decreasing to every five minutes after approximately 15 minutes into the test. It is preferable to use a continuously recording pressure transducer to record recovery data as data obtained early in the test are typically the most valuable data for slug testing. Record data until recovery is about 95 percent complete.

4. Analyze recorded data in the field in accordance with procedures described in U.S. Department of the Navy (1974), Hvorslev (1951) and/or any other appropriate techniques for the type aquifer being tested.

5. Note any irregularities in test procedures on the field forms.

6. Decontaminate all field equipment prior to leaving each site.

References:

U.S. Department of the Navy. 1974. Naval Facilities Engineering Command

Hvorslev, J.M. 1951. Time lag and soil permeability in ground water observations. Bulletin 36. U.S. Corps of Engineers, Waterways Exp. Sta., Vicksburg, MS.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF REDOX POTENTIAL (Eh)

1. Calibrate instrument in accordance with manufacturer's recommendations daily or more frequently if conditions warrant.

2. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

3. Rinse Eh electrode with deionized water.

4. Fill beaker with sample water; minimize agitation.

5. Immerse electrode in sample and allow several minutes for the probe to equilibrate with the water.

6. Turn on meter. Obtain reading to nearest ten millivolts.

7. Record reading on standardized field forms or in the field book. Note any problems such as erratic readings.

8. Rinse probe with deionized water and store according to manufacturer's directions.

STANDARD OPERATING PROCEDURE
FIELD SURVEYING

1. Identify locations of USGS or NGS benchmarks proximal to the study area.

2. Establish at least two bench marks on or near the study area; these are typically established by driving a spike into a telephone pole or by clearly marking a permanent landmark.

3. Establish the relationship between bench marks established near the study area and any identified USGS or NGS benchmarks both vertically and horizontally.

4. Establish horizontal control points throughout the area of interest at key locations. Establish relationship between control points using the direct and reverse horizontal and vertical angle methods.

5. Survey desired points (e.g. soil sample locations, monitoring well measuring points) using the direct and reverse horizontal and vertical angle methods. Obtain an accuracy of plus or minus 0.1 feet vertically and plus or minus one foot horizontally.

6. Record all data collected in a standardized format in the project field book.

STANDARD OPERATING PROCEDURE
SURFACE GEOPHYSICAL FIELD METHODS

Electromagnetics (EM)

1. Arrive on-site with all necessary equipment in good working order.

2. Establish grid for subsequent profiling by using appropriate flagging and a tape measure. Grid density should be commensurate with detail desired from the profiling survey.

3. Calibrate EM instrument in accordance with manufacturer's directions. Background electrical values should be measured outside known or suspected contaminant areas.

4. Using an EM31-D, or its equivalent, begin profiling transects by continuously monitoring instrument readout. Stop at first flagged station, note and record instrument reading and station number on standardized field forms or in field book. Proceed with the transect repeating the process at other flagged stations. Note any anomalous instrument readings between flagged stations on field forms.

5. At each flagged station, obtain sounding measurement by rotating the coil apparatus 90 degrees. Note and record these values on the field form.

6. If utilities are present at the project site (e.g. power lines, buried linear features), make certain to note the location of these features and any anomalous EM readings resulting from the structures on the field form.

Resistivity Surveys

1. Arrive on-site with all necessary equipment to perform a field resistivity survey.

2. Establish resistivity traverse grid as described under EM, above.

3. Choose electrode spacing array in accordance with the project site and commensurate with project objectives. The three commonly used arrays include the Wenner, Schlumberger, and dipole-dipole.

4. Calibrate equipment in accordance with manufacturer's recommendations. As with the EM method, background values should be measured outside known or suspected contaminant areas.

5. Setup equipment at the first flagged site and emplace potential electrodes at desired locations and spacings. Inject current into ground.

6. Obtain readings from voltmeter and record. Calculate and plot apparent resistivities in the field as an immediate quality control check of data collected.

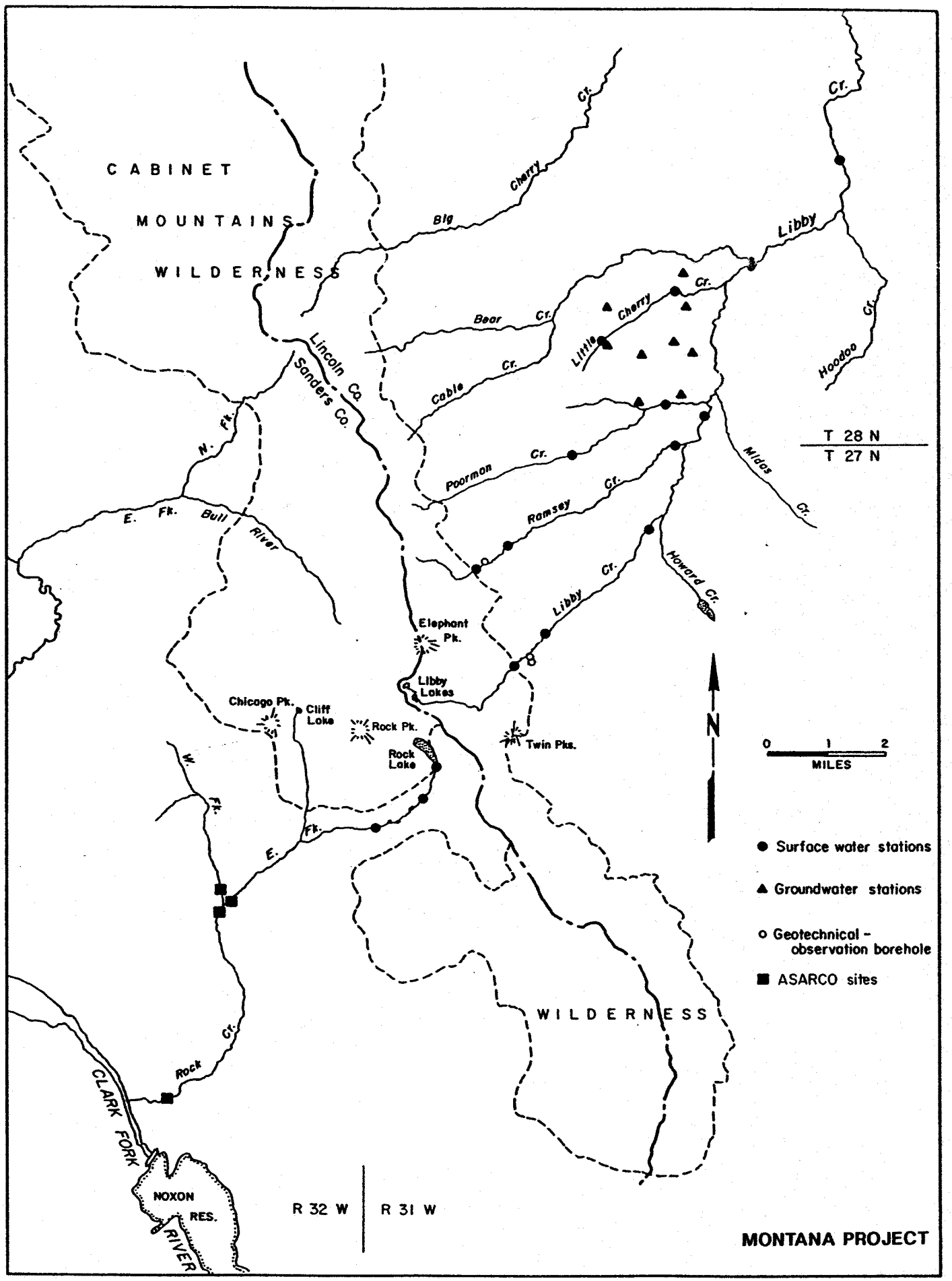
7. Repeat procedure at each station to obtain a resistivity profile of the project area.

8. To perform sounding surveys, vary the spacing of the electrodes at each site. Record data and make field determinations of apparent resistivity values.

9. Note any irregularities encountered both in resistivity values generated and in any utilities present within the study area.

Chen-Northern, Inc.

APPENDIX D



NORANDA MINERALS CORP.
MONTANA PROJECT

Water Resources Map
FIGURE D-1

APPENDIX D-1

HISTORIC FLOW DATA

US BORAX FLOW DATA (1986-1988)

Corresponding Sites		Dates			
Northern	US Borax	2/12/88	9/19/87	6/2/87	7/8/86
EF-200	RC-200	NA	1E	80E	50E
EF-300	RC-300	NA	10E	80E	67E
EF-400	RC-400	NC	35E	125E	96E
NO SITE	RC-600	NA	50E	170E	150E
WF-20	WF-20	NF	1-2E	30E	18E
RC-850	RC-850	NM	50	190E	160E
EF-800	RC-800	NM	50	190E	160E
LB-200	LB-200	NM	35E	--	--
LB-500	LB-500	NM	40E	--	--
LB-800	LB-800	S	60E	--	--
RA-200	RA-200	S	30E	--	--
RA-600	RA-600	S	30 - 35E	--	--
LC-	LC-200	NF	4-5E	--	--
PM-1000	PM-1000	S	--	--	--

* All recorded values are in cubic feet per second
NA - Not accessible due to deep, wet snow
NF - No water flowing
NM - Not measured due to difficulties in moving equipment on snowmobiles
S - Sampled but not measured for flow
E - Estimated flow
-- Site not visited

This data presented to Northern from U.S. Borax April, 1988

STREAMFLOW MEASUREMENTS OF ROCK CREEK BY HYDROMETRICS AND THE US FOREST SERVICE

DATE	NORTHERN SITES HYDROMETRICS SITES	STREAMFLOW (Cubic feet per second) RC-2000 (RC-1)	RC-850 (RC-3)	RC-2000 (ERC-1)	WF-20 (WRC-2)	NORTHERN SITES USFS SITES	RC-850 NO. 6	WF-20 NO. 17a
08/17/79					4			
09/19/80							22	
11/04/81							12	
09/24/82							4	
06/20/83		145 P						
09/15/83							22	
09/20/83		2.0 P						6
09/23/83								
09/26/84					0.4 B			
11/14/84		0.5 P	15.6 P		0.7 E			
12/03/84								
02/21/85		0	0.5 P	3.0 P	0			
02/27/85		0	Flow	Flow				
04/05/85		0						
04/08/85		Flow						
04/10/85		41.6 PC	160 E	155 P	17.6 P			
05/01/85					36 M			
05/14/85		191 M	158 M	112 M	30 M			
05/30/85		183 M	217 M	174 C	44 M			
06/13/85		194 M	208 M		29 M			
06/27/85		44 M	57 M	42 M	10 M			
08/08/85		3.1 M	3.3 M	2.8 M	1.6 M			
08/28/85		1.9 P	1.4 P		0.4 P			
09/21/85		18 M	50 M		1.0 M			
10/16/85		15 P	56 M	52 M	0.25 P			
11/20/85		8 R	25 R		3.5 R			
03/05/86		99 P	88 P		17 P			
04/09/86		159 M	100 M		27 M			
08/20/86		1.2 M	0.5 E	0.7 E	0.4 B			

Notes: (1) Flows on 06/20/83 and 09/23/83 measured by ASARCO; all other flows by Hydrometrics, unless otherwise noted.
(2) P = Pgymy meter; PC = Price current meter; M = Marsh-McBirney meter; C = Calculated; B = Bucket & watch; E = Estimated;

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST

Station Name: Little Cherry Creek
Watershed No.: 17010101 10

Location: SW SE S23 T28N R31W
Station No.: 5-C-2

Date	Discharge	Stage	Previous Crest	Time
05/21/62		.51	1.46	1200
04/24/63	2.43	.31	1.55	1500
04/30/63	4.53	.40	.41	1045
05/06/63	4.22	.42	.42	1310
05/13/63	3.31	.47	.52	1003
05/20/63	3.07	.40	.46	1115
05/27/63	2.15	.36	.40	0835
06/03/63	3.86	.28	.36	1100
06/10/63	2.81	.24	.28	1300
06/17/63	1.76	.15	.24	1445
06/28/63	.82	.12	.15	1045
09/05/63	.25	.11	.15	1100
05/13/64	10.88	.88	.89	1150
05/18/64	15.04	1.3	1.7	1000
05/27/64	10.47	.80	1.5	
06/01/64	10.10	.74	.80	1115
06/08/64	11.30	.84	.84	1000
06/15/64	6.07	.71	.90	1015
06/22/64	1.79	.54	.71	1130
07/08/64	.57	.34	.54	1100
08/12/64	.4	.25	.34	1100
09/11/64	.17	.19	.25	1020
11/30/64	11.87	.7	.7	1000
05/14/65	9.80	1.14	1.18	1400
05/19/65	5.40	.99	1.14	1300
06/02/65	4.20	.78	.99	0915
06/16/65	5.00	.73	.86	1045
06/30/65	3.18	.87	.92	1015
07/15/65	1.30	.34	.87	1545
07/26/65	1.54	.35	.44	0910
08/18/65	.94	.30	.35	1000
09/29/65	.48	.28	.33	1430

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST

Station Name: Bear Creek
Watershed No.: 17010101 10

Location: SW S22 T28N R31W
Station No.: 5-C-1

Date	Discharge	Stage	Previous Crest	Time
11/07/60	16.2		1.62	1200
04/24/63	32.7	.13	.99	1400
04/30/63	78.75	.34	.35	1130
05/06/63	49.84	.26	.39	1245
05/13/63	79.05	.28	.54	0925
05/20/63	84.3	.42	.49	1030
05/27/63	109.2	.50	.7	0855
06/03/63	74.8	.33	.5	1120
06/10/63	75.5	.46	.56	1240
06/17/63	69.0	.3	.38	1430
06/28/63	15.53	.13		1020
09/02/63	9.92	.18	.37	1100
09/05/63	4.99	.68	.75	1200
05/13/64	101.12	2.13		1115
05/18/64	169.85	2.44	2.64	0925
05/27/64	60.6	1.90	2.77	1025
06/01/64	229.55	2.30	2.34	1040
06/08/64		2.50	2.50	0930
06/15/64	137.4	2.11	2.52	0945
06/22/64	108.04	1.96	2.11	1245
07/08/64	65.23	1.59	2.03	1115
08/02/64	10.6	.93	1.62	1100
09/11/64	6.25	.85	.93	1045
11/30/64	52.48	1.7	1.7	1500
05/12/65	205.79	2.16	2.16	1445
05/20/65	191.51	2.5	2.7	1000
05/28/65	223.65	2.28	2.32	1430
06/16/65	63.66	1.93	2.51	1115
06/30/65	37.95	1.63	2.00	0930
07/15/65	26.05	1.38	1.66	1415
07/26/65	13.31	1.14	1.20	0900
08/18/65	12.74	.99	1.14	0930
09/29/65	9.83	.98	.99	1415

APPENDIX D-2

HISTORIC WATER QUALITY DATA

ABC LABORATORIES, INC.
EAST 4922 UNION AVE.
SPOKANE, WA 99212

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REPORT TO: U.S. Borax
P.O. Box 75128, Sanford Station
Los Angeles, CA 90075
Attn: Steven Carpenter

DESCRIPTION: Perform analyses as directed by letter of 6/13/86. ABC LABORATORIES, INC. is certified by the Washington Department of Social and Health Services which administers the drinking water program for the E.P.A.

LAB. NO. 1992-86
DATE: July 7, 1986

Submitted samples identified as:

West Fork Rock Creek	WF-10*	6/17/86
West Fork Rock Creek	WF-20*	6/17/86
Rock Creek	200*	6/17/86
Rock Creek	300*	6/17/86
Rock Creek	400*	6/17/86
Rock Creek	600*	6/17/86
Rock Creek	800*	6/17/86
Rock Creek	850*	6/17/86

*Samples will be identified by this number in this report.

A SAMPLES

TESTS and TEST DATES	WF-10A	WF-20A	200-A	300-A
Aluminum, Al, mg/L, 7/1/86	<.1	<.1	<.1	<.1
Arsenic, As, mg/L, 6/19/86	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L, 6/20/86	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L, 6/18/86	16.4	16.3	2.8	3.4
Chromium, Cr, mg/L, 6/27/86	<.010	<.010	<.010	<.010
Copper, Cu, mg/L, 6/25/86	<.010	<.010	<.010	<.010
Iron, Fe, mg/L, 6/24/86	<.05	<.05	<.05	<.05
Lead, Pb, mg/L, 6/20/86	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L, 6/19/86	3.37	3.29	0.27	0.33
Mercury, Hg, mg/L, 6/30/86	<.0010	<.0010	<.0010	<.0010
Silver, Ag, mg/L, 6/24/86	<.010	<.010	<.010	<.010
Sodium, Na, mg/L, 6/18/86	0.9	0.8	0.1	0.3
Vanadium, V, mg/L, 6/27/86	<.1	<.1	<.1	<.1
Zinc, Zn, mg/L, 6/20/86	<.010	<.010	<.010	<.010
Manganese, Mn, mg/L, 6/24/86	<.010	<.010	<.010	<.010
Selenium, Se, mg/L, 6/24/86	<.005	<.005	<.005	<.005
Molybdenum, Mo, mg/L, 7/1/86	<.1	<.1	<.1	<.1
Nickel, Ni, mg/L, 6/25/86	<.010	<.010	<.010	<.010

TESTS and TEST DATES	440-A	600-A	800-A	850-A
Aluminum, Al, mg/L, 7/1/86	<.1	<.1	<.1	<.1
Arsenic, As, mg/L, 6/19/86	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L, 6/20/86	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L, 6/18/86	3.6	3.3	3.6	5.7
Chromium, Cr, mg/L, 6/27/86	<.010	<.010	<.010	<.010
Copper, Cu, mg/L, 6/25/86	<.010	<.010	<.010	<.010
Iron, Fe, mg/L, 6/24/86	<.05	<.05	<.05	<.05
Lead, Pb, mg/L, 6/20/86	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L, 6/19/86	0.30	0.35	0.27	0.72
Mercury, Hg, mg/L, 6/30/86	<.0010	<.0010	<.0010	<.0010
Silver, Ag, mg/L, 6/24/86	<.010	<.010	<.010	<.010
Sodium, Na, mg/L, 6/18/86	0.5	0.6	0.7	1.5
Vanadium, V, mg/L, 6/27/86	<.1	<.1	<.1	<.1
Zinc, Zn, mg/L, 6/20/86	<.010	<.010	<.010	<.010
Manganese, Mn, mg/L, 6/24/86	<.010	<.010	<.010	<.010
Selenium, Se, mg/L, 6/24/86	<.005	<.005	<.005	<.005
Molybdenum, Mo, mg/L, 7/1/86	<.1	<.1	<.1	<.1
Nickel, Ni, mg/L, 6/26/86	<.010	<.010	<.010	<.010

SAMPLES B

TESTS and TEST DATES	WF-10B	WF-20B	200-B	300-B
pH, 6/19/86	7.48	7.42	6.57	6.71
Total Dissolved Solids, mg/L 6/27/86	40	38	6	8
Specific Conductance, umhos/cm 6/23/86	65	60	5	10
Alkalinity as $CaCO_3$, mg/L 6/19/86	34	33	4	5
Acidity, 6/19/86	3	3	3	3
Chloride, Cl, mg/L, 6/26/86	<1	<1	<1	<1
Sulfate, SO_4, mg/L, 6/25/86	3	3	<1	<1
Carbonate, CO_3, mg/L, 6/19/86	0	0	0	0
Bicarbonate, HCO_3, mg/l 6/19/86	41.5	40.3	4.9	6.1
Nitrate, NO_3-N, mg/L 6/19/86	<.2	<.2	<.2	<.2
Nitrite, NO_2-N, mg/L 6/19/86	<.01	<.01	<.01	<.01
Orthophosphate, as P, mg/L 6/23/86	<.01	<.01	<.01	<.01
Fluoride, F, mg/L, 6/27/86	<.2	<.2	<.2	<.2
Potassium, K, mg/L, 6/19/86	0.3	0.2	0.0	0.0
Sodium absorption ratio, 7/3/86	0.0124	0.0111	0.0035	0.0096

TESTS and TEST DATES	400-B	600-B	800-B	850-B
pH, 6/19/86	6.79	6.78	6.81	7.01
Total Dissolved Solids, mg/L 6/27/86	10	8	9	13
Specific Conductance, umhos/cm 6/23/86	10	10	5	15
Alkalinity as $CaCO_3$, mg/L 6/19/86	5	5	5	9
Acidity, 6/19/86	3	3	3	3
Chloride, Cl, mg/L, 6/26/86	<1	<1	<1	<1
Sulfate, SO_4, mg/L, 6/25/86	<1	1	1	2
Carbonate, CO_3, mg/L, 6/19/86	0	0	0	0
Bicarbonate, HCO_3, mg/l 6/19/86	6.1	6.1	3.7	3.7
Nitrate, NO_3-N, mg/L 6/19/86	<.2	<.2	<.2	<.2
Nitrite, NO_2-N, mg/L 6/19/86	<.01	<.01	<.01	<.01
Orthophosphate, as P, mg/L 6/23/86	<.01	<.01	<.01	<.01
Fluoride, F, mg/L, 6/27/86	<.2	<.2	<.2	<.2
Potassium, K, mg/L, 6/19/86	0.2	0.5	0.1	0.1
Sodium absorption ratio, 7/3/86	0.0156	0.196	0.0219	0.0364

SAMPLES C

TESTS and TEST DATES	WF-10C	WF-20C	200-C	400-C
Turbidity, NTU, 6/30/86	0.4	0.5	0.5	0.4
Setteable Solids, mg/L 6/27/86	<.01	<.1	<.1	<.1
Suspended Sediments, mg/L 6/25/86	1	<1	<1	<1

TESTS and TEST DATES	400-C	600-C	800-C	850-C
Turbidity, NTU, 6/30/86	0.5	0.4	0.3	0.4
Setteable Solids, mg/L 6/27/86	<.01	<.1	<.1	<.1
Suspended Sediments, mg/L 6/25/86	1	<1	<1	<1

Respectfully submitted
ABC LABORATORIES, INC.

W.E. Burkhardt
Manager

ABC LABORATORIES, INC.
EAST 4922 UNION AVE.
SPOKANE, WA 99212

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REPORT TO: U.S. Borax
P.O. Box 75129 Sanford Station
Los Angeles, CA 90075
Attn: Steve Carpenter

DESCRIPTION: Perform analyses as directed by leter of 5/18/87. ABC Laboratories, Inc. is certified by the Washington Department of Social and Health Services which administers the drinking water program for the E.P.A.

LAB. NO. 30231-87
P.O.# 03-M988757383-000
DATE: June 24, 1987
SAMPLE REC'D: June 3, 1987

Submitted samples identified as:

West Fork Rock Creek	WF-20*
Rock Creek	200*
Rock Creek	300*
Rock Creek	400*
Rock Creek	600*
Rock Creek	800*
Rock Creek	850*

*Sample will be identified by this number in this report.

A SAMPLES

TESTS and TEST DATES	WF 20A	200A	300A	400A
Aluminum, Al, mg/L 6/5/87	<.05	<.05	<.05	<.05
Arsenic, As, mg/L 6/11/87	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L 6/8/87	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L 6/15/87	7.2	0.93	1.17	1.11
Chromium, Cr, mg/L 6/18/87	<.010	<.010	<.010	<.010
Copper, Cu, mg/L 6/23/87	<.010	<.010	<.010	<.010
Iron, Fe, mg/L 6/9/87	<.05	<.05	<.05	<.05
Lead, Pb, mg/L 6/23/87	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L 6/9/87	2.99	0.33	0.33	0.24
Manganese, Mn, mg/L 6/12/87	<.010	<.010	<.010	<.010
Mercury, Hg, mg/L 6/17/87	<.0010	<.0010	<.0010	<.0010
Molybdenum, Mo, mg/L 6/5/87	<.05	<.05	<.05	<.05
Silver, Ag, mg/L 6/15/87	<.010	<.010	<.010	<.010
Sodium, Na, mg/L 6/15/87	0.8	0.1	0.4	0.4
Zinc, Zn, mg/l 6/12/87	<.010	<.010	<.010	<.010

U.S. Borax
Lab No. 30231-87
Page 2

TESTS and TEST DATES	600A	800A	850A
Aluminum, Al, mg/L 6/5/87	<.05	<.05	<.05
Arsenic, As, mg/L 6/11/87	<.010	<.010	<.010
Cadmium, Cd, mg/L 6/8/87	<.002	<.002	<.002
Calcium, Ca, mg/L 6/15/87	0.89	1.03	2.20
Chromium, Cr, mg/L 6/18/87	<.010	<.010	<.010
Copper, Cu, mg/L 6/23/87	<.010	<.010	<.010
Iron, Fe, mg/L 6/9/87	<.05	<.05	<.05
Lead, Pb, mg/L 6/23/87	<.010	<.010	<.010
Magnesium, Mg, mg/L 6/9/87	0.19	0.25	0.87
Manganese, Mn, mg/L 6/12/87	<.010	<.010	<.010
Mercury, Hg, mg/L 6/17/87	<.0010	<.0010	<.0010
Molybdenum, Mo, mg/L 6/5/87	<.05	<.05	<.05
Silver, Ag, mg/L 6/15/87	<.010	<.010	<.010
Sodium, Na, mg/L 6/15/87	0.3	0.3	0.4
Zinc, Zn, mg/l 6/12/87	<.010	<.010	<.010

B SAMPLES

TESTS and TEST DATES	WF 20B	200B	300B	400B
pH 6/4/87	7.32	6.50	6.60	6.62
Specific Conductance umhos/cm 6/4/87	70	10	10	10
Turbidity, NTU, 6/10/87	0.5	0.3	0.3	0.4
Chloride, Cl, mg/L 6/17/87	2	<1	1	<1
Fluoride, F, mg/L 6/19/87	<.2	<.2	<.2	<.2
Potassium, K, mg/L 6/22/87	0.33	0.11	0.22	0.06
Sulfate, SO_4, mg/L 6/18/87	3	<1	1.5	<1
Total Hardness, $CaCO_3$, mg/L 6/15/87	30.3	3.7	4.3	3.8
Total Phosphorous, as P, mg/L 6/5/87	<.01	0.016	<.01	<.01
Ortho-phosphate, as P, mg/l 6/5/87	<.01	<.01	<.01	<.01
Total Alkalinity, as $CaCO_3$, 6/5/87	31	4	5	5
Carbonate, CO_3, mg/L 6/5/87	0	0	0	0
Bicarbonate, HCO_3, mg/L	38	5	6	6
Nitrite, NO_2-N, mg/L 6/4/87	<.01	<.01	<.01	<.01
Nitrate, NO_3-N, mg/L 6/4/87	<.2	<.2	<.2	<.2
Total Kjeldahl Nitrogen, N, mg/L, 6/4/87	<.1	0.11	0.11	<.1
Total Suspended Solids, mg/L 6/8/87	<1	<1	<1	1
Total Dissolved Solids, mg/L 6/8/87	41	10	6	11

TESTS and TEST DATES	600B	800B	850B
pH 6/4/87	6.60	6.60	7.03
Specific Conductance umhos/cm 6/4/87	10	10	20
Turbidity, NTU, 6/10/87	0.3	0.3	0.3
Chloride, Cl, mg/L 6/17/87	<1	<1	1
Fluoride, F, mg/L 6/19/87	<.2	<.2	<.2
Potassium, K, mg/L 6/22/87	0.19	0.12	0.09
Sulfate, SO_4, mg/L 6/18/87	1.5	1.6	1.5
Total Hardness, $CaCO_3$, mg/L 6/15/87	3.0	3.6	9.1
Total Phosphorous, as P, mg/L 6/5/87	<.01	0.012	0.013
Ortho-phosphate, as P, mg/l 6/5/87	<.01	<.01	<.01
Total Alkalinity, as $CaCO_3$, 6/5/87	4	5	11
Carbonate, CO_3, mg/L 6/5/87	0	0	0
Bicarbonate, HCO_3, mg/L	5	6	13
Nitrite, NO_2-N, mg/L 6/4/87	<.01	<.01	<.01
Nitrate, NO_3-N, mg/L 6/4/87	<.2	<.2	<.2
Total Kjeldahl Nitrogen, N, mg/L, 6/4/87	<.1	0.11	<.1
Total Suspended Solids, mg/L 6/8/87	<1	<1	<1
Total Dissolved Solids, mg/L 6/8/87	12	12	21

Respectfully submitted
ABC LABORATORIES, INC.

W.E. Burkhardt
Manager

ABC LABORATORIES, INC.
EAST 4922 UNION AVE.
SPOKANE, WA 99212
509-534-0161
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REPORT TO: U.S. Borax
P.O. Box 75128 Sanford Station
Los Angeles, CA 90075

DESCRIPTION: Perform tests as directed on twelve submitted samples.
LAB. NO. 30623-87
DATE: Oct. 19, 1987

TESTS	#1	#2	#3	#4
Aluminum, Al, mg/L	<.05	<.05	<.05	<.05
Arsenic, As, mg/L	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L	1.21	1.07	1.34	1.21
Chromium, Cr, mg/L	<.010	<.010	<.010	<.010
Copper, Cu, mg/L	<.010	<.010	<.010	<.010
Iron, Fe, mg/L	<.05	<.05	<.05	<.05
Lead, Pb, mg/L	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L	0.39	0.34	0.50	0.41
Manganese, Mn, mg/L	<.010	<.010	<.010	<.010
Mercury, Hg, mg/L	<.0010	<.0010	<.0010	<.0010
Molybdenum, Mo, mg/L	<.05	<.05	<.05	<.05
Silver, Ag, mg/L	<.010	<.010	<.010	<.010
Sodium, Na, mg/L	0.7	0.3	0.6	0.5
Zinc, Zn, mg/L	<.010	<.010	<.010	<.010
pH	6.70	6.50	6.70	6.70
Conductivity, umhos/cm	15	10	15	15
Turbidity, NTU	0.4	0.4	0.3	0.5
Chloride, Cl, mg/L	0.9	1	0.9	0.8
Fluoride, F, mg/L	<.1	<.1	<.1	<.1
Potassium, K, mg/L	0.32	0.15	0.20	0.23
Sulfate, SO_4, mg/L	<.5	2	1.5	2
Total Hardness, mg/L	4.6	4.3	5.4	4.7
Total Phosphate, PO_4-P, mg/L	<.01	<.01	<.01	<.01
Ortho Phosphate, PO_4-P, mg/L	<.01	<.01	<.01	<.01
Total Alkalinity, mg/L	8	5	7	6
Carbonate, CO_3, mg/L	0	0	0	0
Bicarbonate, HCO_3, mg/L	0	0	0	0
Nitrite, NO_2-N, mg/L	<.01	<.01	<.01	<.01
Nitrate, NO_3-N, mg/L	<.2	<.2	<.2	<.2
Total Kjeldahl Nitrogen, N, mg/L	<.1	<.1	<.1	<.1
Total Suspended Solids, mg/L	<1	<1	<1	<1
Total Dissolved Solids, mg/L	8	10	14	8

U.S. Borax
Lab No. 30623-87
Page 2

TESTS	#5	#6	#7	#8
Aluminum, Al, mg/L	<.05	<.05	<.05	<.05
Arsenic, As, mg/L	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L	0.88	2.17	1.82	1.44
Chromium, Cr, mg/L	<.010	<.010	<.010	<.010
Copper, Cu, mg/L	<.010	<.010	<.010	<.010
Iron, Fe, mg/L	<.05	<.05	0.95	<.05
Lead, Pb, mg/L	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L	0.30	0.81	0.48	0.35
Manganese, Mn, mg/L	<.010	<.010	<.010	<.010
Mercury, Hg, mg/L	<.0010	<.0010	<.0010	<.0010
Molybdenum, Mo, mg/L	<.05	<.05	<.05	<.05
Silver, Ag, mg/L	<.010	<.010	<.010	<.010
Sodium, Na, mg/L	0.2	0.8	0.6	0.7
Zinc, Zn, mg/L	<.010	<.010	<.010	<.010
pH	6.75	6.80	6.60	6.60
Conductivity, umhos/cm	10	25	20	15
Turbidity, NTU	0.6	0.3	0.5	0.3
Chloride, Cl, mg/L	2.4	2	1.5	1.7
Fluoride, F, mg/L	0.1	0.1	0.1	<.1
Potassium, K, mg/L	0.13	0.75	0.27	0.27
Sulfate, SO_4, mg/L	<.5	1	0.8	1
Total Hardness, mg/L	3.4	8.8	6.5	5.0
Total Phosphate, PO_4-P, mg/L	<.01	<.01	<.01	<.01
Ortho Phosphate, PO_4-P, mg/L	<.01	<.01	<.01	<.01
Total Alkalinity, mg/L	4	12	9	8
Carbonate, CO_3, mg/L	0	0	0	0
Bicarbonate, HCO_3, mg/L	0	0	0	0
Nitrite, NO_2-N, mg/L	<.01	<.01	<.01	<.01
Nitrate, NO_3-N, mg/L	<.2	<.2	<.2	<.2
Total Kjeldahl Nitrogen, N, mg/L	<.1	<.1	<.1	<.1
Total Suspended Solids, mg/L	<1	<1	<1	<1
Total Dissolved Solids, mg/L	7	20	14	16

U.S. Borax
Lab No. 30623-87
Page 3

TESTS	#9	#10	#11	#12
Aluminum, Al, mg/L	<.05	<.05	<.05	<.05
Arsenic, As, mg/L	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L	1.14	4.65	8.55	3.11
Chromium, Cr, mg/L	<.010	<.010	<.010	<.010
Copper, Cu, mg/L	<.010	<.010	<.010	<.010
Iron, Fe, mg/L	<.05	<.05	<.05	<.05
Lead, Pb, mg/L	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L	0.52	1.67	4.01	2.37
Manganese, Mn, mg/L	<.010	<.010	<.010	<.010
Mercury, Hg, mg/L	<.0010	<.0010	<.0010	<.0010
Molybdenum, Mo, mg/L	<.05	<.05	<.05	<.05
Silver, Ag, mg/L	<.010	<.010	<.010	<.010
Sodium, Na, mg/L	0.6	0.9	0.9	2.1
Zinc, Zn, mg/L	<.010	<.010	<.010	<.010
pH	6.70	7.05	7.85	7.00
Conductivity, umhos/cm	15	40	75	60
Turbidity, NTU	0.3	0.4	0.4	0.6
Chloride, Cl, mg/L	0.7	0.7	0.9	0.9
Fluoride, F, mg/L	<.1	<.1	<.1	<.1
Potassium, K, mg/L	0.31	0.28	0.45	0.55
Sulfate, SO_4, mg/L	1.5	1	1.5	<.5
Total Hardness, mg/L	5.0	18.5	37.8	17.5
Total Phosphate, PO_4-P, mg/L	<.01	<.01	<.01	0.025
Ortho Phosphate, PO_4-P, mg/L	<.01	<.01	<.01	<.01
Total Alkalinity, mg/L	8	20	39	31
Carbonate, CO_3, mg/L	0	0	0	0
Bicarbonate, HCO_3, mg/L	0	0	0	0
Nitrite, NO_2-N, mg/L	<.01	<.01	<.01	<.01
Nitrate, NO_3-N, mg/L	<.2	<.2	<.2	<.2
Total Kjeldahl Nitrogen, N, mg/L	<.1	<.1	<.1	<.1
Total Suspended Solids, mg/L	<1	<1	<1	<1
Total Dissolved Solids, mg/L	13	24	44	46

SAMPLE IDENTIFICATION

#1 Rock Creek 800
#2 Ramsey Creek 200
#3 Ramsey Creek 600
#4 Libby Creek 200
#5 Rock Creek 200
#6 Rock Creek 300
#7 Rock Creek 400
#8 Rock Creek 600
#9 Libby Creek 500
#10 Libby Creek 800
#11 West Fork Rock Creek WF-10A
#12 Little Cherry Creek 200

Respectfully submitted
ABC LABORATORIES, INC.

W.E. Burkhardt
Manager

ABC LABORATORIES, INC.
EAST 4922 UNION AVE.
SPOKANE, WA 99212

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REPORT TO: U.S. Borax
P.O. BOx 75128 Stanford Station
Los Angeles, CA 90075
Attn: Steve Carpenter

DESCRIPTION: Perform analyses as directed on submitted sample. ABC Laboratories, Inc. is certified by the Washington Department of Social and Health Services which administers the drinking water program for the E.P.A.

LAB. NO. 31104-88
P.O. # 02 M988857113-000
DATE: Feb. 29, 1988
SAMPLE REC'D: Feb. 11, 1988

SAMPLE IDENTIFICATION
#1 Ramsey Creek 200
#2 Ramsey Creek 600
#3 Rock Creek 850
#4 Libby Creek 200
#5 Libby Creek 500
#6 Libby Creek 800
#7 Poorman Creek (1000)

TESTS-A SAMPLES	#1	#2	#3	#4
Aluminum, Al, mg/L	<.05	<.05	<.05	<.05
Arsenic, As, mg/L	<.010	<.010	<.010	<.010
Cadmium, Cd, mg/L	<.002	<.002	<.002	<.002
Calcium, Ca, mg/L	1.02	1.02	1.00	0.96
Chromium, Cr, mg/L	<.010	<.010	<.010	<.010
Copper, Cu, mg/L	<.010	<.010	<.010	<.010
Iron, Fe, mg/L	<.05	<.05	<.05	<.05
Lead, Pb, mg/L	<.010	<.010	<.010	<.010
Magnesium, Mg, mg/L	0.58	0.63	0.47	0.46
Manganese, Mn, mg/L	<.010	<.010	<.010	<.010
Mercury, Hg, mg/L	<.0010	<.0010	<.0010	<.0010
Molybdenum, mg/L	<.05	<.05	<.05	<.05
Silver, Ag, mg/L	<.010	<.010	<.010	<.010
Sodium, Na, mg/L	1.5	1.0	0.5	0.7
Zinc, Zn, mg/L	<.010	<.010	<.010	<.010

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U.S. Borax
Lab No. 31104-89
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TESTS-A SAMPLES	#5	#6	# 7
Aluminum, Al, mg/L	<.05	<.05	<.05
Arsenic, As, mg/L	<.010	<.010	<.010
Cadmium, Cd, mg/L	<.002	<.002	<.002
Calcium, Ca, mg/L	0.86	3.85	3.3
Chromium, Cr, mg/L	<.010	<.010	<.010
Copper, Cu, mg/L	<.010	<.010	<.010
Iron, Fe, mg/L	<.05	<.05	<.05
Lead, Pb, mg/L	<.010	<.010	<.010
Magnesium, Mg, mg/L	0.57	1.78	1.23
Manganese, Mn, mg/L	<.010	<.010	<.010
Mercury, Hg, mg/L	<.0010	<.0010	<.0010
Molybdenum, mg/L	<.05	<.05	<.05
Silver, Ag, mg/L	<.010	<.010	<.010
Sodium, Na, mg/L	0.8	1.2	0.6
Zinc, Zn, mg/L	<.010	<.010	<.010

TESTS-B SAMPLES	#1	#2	#3	#4
pH	6.40	6.30	6.31	6.15
Conductivity, umhos/cm	25	20	20	20
Turbidity, NTU	1.0	1.0	0.7	0.4
Chloride, Cl, mg/L	2	1	2	2
Fluoride, F, mg/L	<.2	<.2	<.2	<.2
Potassium, K, mg/L	0.20	0.20	0.20	0.14
Sulfate, SO4, mg/L	1	1.5	<.5	2
Total Hardness, CaCO3, mg/L	4.9	5.1	4.4	4.3
Total Phosphate, as P, mg/L	<.01	<.01	<.01	<.01
Ortho-phosphate, as P, mg/L	<.01	<.01	<.01	<.01
Total Alkalinity, as CaCO3, mg/L	7	6	6	4
Carbonate, CO3, mg/L	0	0	0	0
Bicarbonate, HCO3, mg/L	9	7	7	5
Nitrite, NO2-N, mg/L	<.01	<.01	<.01	<.01
Nitrate, NO3-N, mg/L	0.2	<.2	<.2	0.3
Total Kjeldlahl Nitrogen N, mg/L	0.11	<.1	<.1	0.14
Total Suspended Solids, mg/L	1.6	0.4	0.4	<.2
Total Dissolved Solids, mg/L	21	28	18	14

U.S. Borax
Lab No. 31104-89
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TESTS-B SAMPLES	#5	#6	#7
pH	5.92	6.50	6.70
Conductivity, umhos/cm	20	35	30
Turbidity, NTU	0.7	0.7	0.5
Chloride, Cl, mg/L	2	2	2
Fluoride, F, mg/L	<.2	<.2	<.2
Potassium, K, mg/L	0.16	0.24	0.26
Sulfate, SO4, mg/L	1	<.5	<.5
Total Hardness, CaCO3, mg/L	4.5	17.0	13.3
Total Phosphate, as P, mg/L	<.01	<.01	<.01
Ortho-phosphate, as P, mg/L	<.01	<.01	<.01
Total Alkalinity, as CaCO3, mg/L	5	17	14
Carbonate, CO3, mg/L	0	0	0
Bicarbonate, HCO3, mg/L	6	21	17
Nitrite, NO2-N, mg/L	<.01	<.01	<.01
Nitrate, NO3-N, mg/L	<.2	<.2	<.2
Total Kjeldlahl Nitrogen N, mg/L	<.1	<.1	0.11
Total Suspended Solids, mg/L	<.2	<.2	0.2
Total Dissolved Solids, mg/L	9	26	21

Respectfully submitted
ABC LABORATORIES, INC.

W.E. Burkhardt
Manager

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST

Station Name: Little Cherry Creek
Watershed No.: 17010101 10

Location: SW SE S23 T28N R31W
Station No.: 5-C-2

Date	Discharge	Stage	Previous Crest	Time
05/21/62		.51	1.46	1200
04/24/63	2.43	.31	1.55	1500
04/30/63	4.53	.40	.41	1045
05/06/63	4.22	.42	.42	1310
05/13/63	3.31	.47	.52	1003
05/20/63	3.07	.40	.46	1115
05/27/63	2.15	.36	.40	0835
06/03/63	3.86	.28	.36	1100
06/10/63	2.81	.24	.28	1300
06/17/63	1.76	.15	.24	1445
06/28/63	.82	.12	.15	1045
09/05/63	.25	.11	.15	1100
05/13/64	10.88	.88	.89	1150
05/18/64	15.04	1.3	1.7	1000
05/27/64	10.47	.80	1.5	
06/01/64	10.10	.74	.80	1115
06/08/64	11.30	.84	.84	1000
06/15/64	6.07	.71	.90	1015
06/22/64	1.79	.54	.71	1130
07/08/64	.57	.34	.54	1100
08/12/64	.4	.25	.34	1100
09/11/64	.17	.19	.25	1020
11/30/64	11.87	.7	.7	1000
05/14/65	9.80	1.14	1.18	1400
05/19/65	5.40	.99	1.14	1300
06/02/65	4.20	.78	.99	0915
06/16/65	5.00	.73	.86	1045
06/30/65	3.18	.87	.92	1015
07/15/65	1.30	.34	.87	1545
07/26/65	1.54	.35	.44	0910
08/18/65	.94	.30	.35	1000
09/29/65	.48	.28	.33	1430

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST

Station Name: Bear Creek
Watershed No.: 17010101 10

Location: SW S22 T28N R31W
Station No.: 5-C-1

Date	Discharge	Stage	Previous Crest	Time
11/07/60	16.2		1.62	1200
04/24/63	32.7	.13	.99	1400
04/30/63	78.75	.34	.35	1130
05/06/63	49.84	.26	.39	1245
05/13/63	79.05	.28	.54	0925
05/20/63	84.3	.42	.49	1030
05/27/63	109.2	.50	.7	0855
06/03/63	74.8	.33	.5	1120
06/10/63	75.5	.46	.56	1240
06/17/63	69.0	.3	.38	1430
06/28/63	15.53	.13		1020
09/02/63	9.92	.18	.37	1100
09/05/63	4.99	.68	.75	1200
05/13/64	101.12	2.13		1115
05/18/64	169.85	2.44	2.64	0925
05/27/64	60.6	1.90	2.77	1025
06/01/64	229.55	2.30	2.34	1040
06/08/64		2.50	2.50	0930
06/15/64	137.4	2.11	2.52	0945
06/22/64	108.04	1.96	2.11	1245
07/08/64	65.23	1.59	2.03	1115
08/02/64	10.6	.93	1.62	1100
09/11/64	6.25	.85	.93	1045
11/30/64	52.48	1.7	1.7	1500
05/12/65	205.79	2.16	2.16	1445
05/20/65	191.51	2.5	2.7	1000
05/28/65	223.65	2.28	2.32	1430
06/16/65	63.66	1.93	2.51	1115
06/30/65	37.95	1.63	2.00	0930
07/15/65	26.05	1.38	1.66	1415
07/26/65	13.31	1.14	1.20	0900
08/18/65	12.74	.99	1.14	0930
09/29/65	9.83	.98	.99	1415

STREAMFLOW MEASUREMENTS OF ROCK CREEK BY HYDROMETRICS AND THE US FOREST SERVICE

DATE	NORTHERN SITES HYDROMETRICS SITES	STREAMFLOW (Cubic feet per second) RC-2000 (RC-1)	RC-850 (RC-3)	EF-800 (ERC-1)	WF-20 (WRC-2)	NORTHERN SITES USFS SITES	RC-850 NO. 6	WF-20 NO. 17a
08/17/79					4			
09/19/80							22	
11/04/81							12	
09/24/82							4	
06/20/83		145 P						
09/15/83							22	
09/20/83		2.0 P						6
09/23/83								
09/26/84					0.4 B			
11/14/84		0.5 P	15.6 P		0.7 E			
12/03/84								
02/21/85		0	0.5 P	3.0 P	0			
02/27/85		0	Flow	Flow				
04/05/85		0						
04/08/85		Flow						
04/10/85		41.6 PC	160 E	155 P	17.6 P			
05/01/85					36 M			
05/14/85		191 M	158 M	112 M	30 M			
05/30/85		183 M	217 M	174 C	44 M			
06/13/85		194 M	208 M		29 M			
06/27/85		44 M	57 M	42 M	10 M			
08/08/85		3.1 M	3.3 M	2.8 M	1.6 M			
08/28/85		1.9 P	1.4 P		0.4 P			
09/21/85		18 M	50 M		1.0 M			
10/16/85		15 P	56 M	52 M	0.25 P			
11/20/85		8 R	25 R		3.5 R			
03/05/86		99 P	88 P		17 P			
04/09/86		159 M	100 M		27 M			
08/20/86		1.2 M	0.5 E	0.7 E	0.4 B			

Notes: (1) Flows on 06/20/83 and 09/23/83 measured by ASARCO; all other flows by Hydrometrics, unless otherwise noted.
(2) P = Pgymy meter; PC = Price current meter; M = Marsh-McBirney meter; C = Calculated; B = Bucket & watch; E = Estimated;

US FOREST SERVICE -- KANIKSU NATIONAL FOREST

Station Name: Rock Creek
Watershed No.: 1701021330
Station No.: KN 7006
Location: SE S22 T26N R32W
District: D-7

Date	12/23/74	05/29/75	07/30/75	10/08/75	04/27/76	05/14/76	07/15/76	09/08/76	05/03/77	06/21/77	08/25/77	11/03/77
Time												
00010-Water (°C)	1	7	11.5	9	5	5	10	10	6	9	9	4
00020-Air (°C)	-9	23	15	10	11	12	23	24	12.5	15	10	8
00061-Discharge (cfs)	1.68	255	31	14	125		102	12	252	46.6	2.2	20.6
00065-Stage							2.08	1.38	2.58	1.36	.93	1.58
00076-Turbidity		1.6	.6	.23	.5	3	.12	.22	.44	.13	.15	.45
00095-Conductivity	26	27	30	30	33	20	51	30	18	25	20	18
00300-D.O.	11	9	10.2	9.6	11	10	13	10	12	10.8	10	10.2
00400-pH (field)	6.5	6.6	6.55	6.6	6.8	6.7	7.5	7.6	7.4	7.1	6.9	7.5
00403-pH (lab)												
00410-Alkalinity	20	10	20	15	30	15	10	20	25	38	51	21
00620-Nitrates	1.2				1	.75						
00650-Phosphates												
00900-Hardness	10	10	10	10	15	15	5	12	25	21	22	15
31613-Fecal Col.												
70301-Dis. Solids		31		48	48	31	31	47	31	12		130
80154-Susp. Sed.		4.6	.3	2	2	25	4		2	1.01		0

US FOREST SERVICE -- KANIKSU NATIONAL FOREST (continued)

Station Name: Rock Creek
Watershed No.: 1701021330
Station No.: KN 7006
Location: SE S22 T26N R32W
District: D-7

Date	04/10/78	06/08/78	06/26/78	07/24/78	08/15/78	09/13/78	10/11/78	03/26/79	05/11/82	08/31/84
Time									1500	0900
00010-Water (°C)	5	7	8	11	9	10	7.5	3	4	10
00020-Air (°C)	17	18	17	19	12	12.5	13	3	20	15
00061-Discharge (cfs)	59.5	195.3	149.3	37.9	13.68	41.7	7.12	43.62	145.6	4.80
00065-Stage	2.78	3.23	2.18	1.38	1.08	1.38	.93	1.48	1.40	.2
00076-Turbidity	.9	1.1	1.5	.51	.561	.49	.37	.71	2.1	.53
00095-Conductivity	35	26	19	37	34	27	36	34	55	36
00300-D.O.	13	12	12	10	9	10	10	12	12	10
00400-pH (field)	7.8	7.4	7.2	7.2	7.6	7.6	7.4	7.2	7.8	
00403-pH (lab)								7.6		
00410-Alkalinity	34	17	34	34	51	34	34	34	51	
00620-Nitrates									<.05	
00650-Phosphates									<.5	
00900-Hardness	17	17	17	17	34	17	17	17	34	
31613-Fecal Col.										
70301-Dis. Solids	21	12	14	21	23	16	26	15	42	23
80154-Susp. Sed.	<.001	3.8	1.0	1.0	5.5	1.8	.1	0	.001	.002

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST

Station Name: Cherry Creek
Watershed No.: 1701010110
Station No.: KN 5000
Location: SW S27 T29 R31W
District: D-5

Date	11/15/74	06/03/75	08/06/75	10/06/75	05/06/76	06/28/76	09/01/76	12/10/76	04/27/77	06/22/77
Time										
00010-Water (°C)	2	7	11.5	8	3	6	10	2	3.5	10
00020-Air (°C)	2	20	26		18	23	10	2	9.5	23
00061-Discharge (cfs)	10.6	520	41	61	256	132	36	16	212	46
00065-Stage	4.28	6.78	4.78	4.98	5.53	5.13	4.48		5.73	4.83
00076-Turbidity	.4	2.2	.6	.47	55	.25	.21	.14	.45	.92
00095-Conductivity	65	35	48	56	40	45	50	60	38	50
00300-D.O.	11	9.4	9.5	9.6	11	10	9	10	13	11
00400-pH (field)	6.9	6.8	6.8	6.8	6.9	7.6	7.7	7.4	7.5	7.6
00403-pH (lab)										
00410-Alkalinity	20	10	20	20	30	20	30	68	34	34
00620-Nitrates										
00650-Phosphates										
00900-Hardness	30	15	15	15	20	20	20	51	17	34
31613-Fecal Col.										
70301-Dis. Solids					48	45	56	42	26	50
80154-Susp. Sed.		6.47	.4	.8	0			0	.939	2.06

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST (continued)

Station Name: Cherry Creek
Location: SW S27 T29 R31W
Watershed No.: 1701010110
Station No.: KN 5000
District: D-5

Date	08/15/77	10/14/77	03/03/78	05/26/78	06/12/78	06/15/78	07/13/78	08/14/78	09/25/78	10/25/78
Time	1300	1000	0945	1630	1445	1350	1500	1105	1255	1145
00010-Water (°C)	13	5	2	7	8	7	16	12	9	2
00020-Air (°C)	17	4	2	19	21	9	21	15	15	4
00061-Discharge (cfs)	9.1	22.4	23	117.1	3.24	154.5	80.2		33.2	12.4
00065-Stage	4.87	4.18	5.28	6.08	2.58	6.28	5.78	5.18	5.28	5.08
00076-Turbidity		.31	.66	3.5	3.0	1.8	.19	.33	.45	.31
00095-Conductivity		50	45	40	97	37	37	50	52	64
00300-D.O.		12	11	10	9	10	10	10	10	14
00400-pH (field)	7.8	7.7	7.0	6.75	8.0	7.5	8.0	8.0	7.5	7.5
00403-pH (lab)										
00410-Alkalinity	5.1	45	68	51	86	34	51	34	51	51
00620-Nitrates										
00650-Phosphates										
00900-Hardness	51	51	51	51	68	68	51	68	68	86
31613-Fecal Col.										
70301-Dis. Solids	70	41	37	33	81	32	29	39	44	47
80154-Susp. Sed.		1.85	.5	1.8	2	6.6	1.5	.5	4.0	.1

US FOREST SERVICE -- KANISKU NATIONAL FOREST

Station Name: Libby Creek
Watershed No.: 1701010110
Station No.: KN 5000
Location: NE S11 T27N R31W
District: D-5

Date	11/15/74	06/03/75	08/06/75	10/06/75	06/30/76	08/24/76	08/26/76	11/22/76	04/26/77	06/16/77
Time										
00010-Water (°C)	3	5	10	7	6.5	9.5	8.5		5	9.5
00020-Air (°C)	3	14	23	7	21.5	25	17.5	-1	13.5	23
00061-Discharge (cfs)	1.48	219.5	8.87	26.2	90		20	1.36	106	28
00065-Stage	.68	2.08	.98	1.33	1.83	1.08	.98	.88	1.93	1.28
00076-Turbidity	.35	3.5	.5	.3	.35		.75	.26		.9
00095-Conductivity	16	11	15	15	9.5		14.5	16		10
00300-D.O.	10	9.2	9.2	10.2	10	13	13	11	11	10
00400-pH (field)	5.8	6.45	6.5	6.5	7.7	7.6	7.6	7.7	7.4	7.5
00403-pH (lab)										
00410-Alkalinity	15	2	2	5	10	10	10	10	17	17
00620-Nitrates										
00650-Phosphates	.7									
00900-Hardness	20	2	10	2	7	10	10	5	17	17
31613-Fecal Col.										
70301-Dis. Solids					17	23	21	17	20	22
80154-Susp. Sed.		10.2	1.0	.3	0			0	4.08	0

US FOREST SERVICE -- KOOTENAI NATIONAL FOREST (continued)

Station Name: Libby Creek
Location: NE S11 T27N R31W
Watershed No.: 1701010110
Station No.: KN 5000
District: D-5

Date	08/15/77	08/18/77	10/14/77	03/15/78	05/25/78	06/13/78	07/25/78	08/17/78	09/26/78	10/17/78
Time			1440	1015	1250	1155	1440	1400	1250	1320
00010-Water (°C)	11	12	5	1	4	5	14	10	8	6
00020-Air (°C)	13.5	20	5.5	4	9	14	28	23	24	11
00061-Discharge (cfs)	.45	13	2.9	8	78.38	90.2			13	3.43
00065-Stage	.38	1.18	.68	1.58	1.84	2.53		1.18	.98	.68
00076-Turbidity		.48	.42	2.0	.89	.23	.471	.26	.3	.2
00095-Conductivity		12	11	13	12.5	11	13	17.5	11	26
00300-D.O.	8	10	12	11	11	11	10	9	11	12
00400-pH (field)	6.5	7.2	7.0	6.5	7.5	7.0	7.0	6.5	7.0	7.5
00403-pH (lab)										
00410-Alkalinity	34	17	17	51	34	34	17	34	34	34
00620-Nitrates										
00650-Phosphates										
00900-Hardness	17	17	17	68	51	51	17	34	34	51
31613-Fecal Col.										
70301-Dis. Solids		10	10	11	15	8	10	12	11	13
80154-Susp. Sed.		0	0	<.1	2.5	2.1	.2	.9	1.9	.1

US FOREST SERVICE DATA -- KOOTENAI NATIONAL FOREST

Station Name: Cliff Lake
Watershed No.: _____ Station No.: _____
Location: Site 4
District: _____

Date	08/06/79	08/09/79	08/20/79	08/22/79	09/18/79	11/09/79	02/07/80	07/24/80	08/14/80	06/04/81
Time	1130	1200			1100	1300	1400	1400	1400	
Water (°C)	12.5	18	18.5	18.5	13	1	8.5	20	17	
Air (°C)	13.5	16			14.5	-6	21.5	19	14	
Discharge	0				0	0	1.1	.72	0	
Stage	.6	5.4	.25	.3	.35	.09		.75	.2	1.6
Turbidity	.93	.57				.26	.42	.42	.43	
Conductivity	27	26				19.9	21	15.5	18	
D.O.	8	<8			9	8	9	9	8	
Color										
pH (lab)	7.1					6.7				
SAR										
Ca							5.5		1.8	
Mg							.5		.6	
Na										
K							.3		.3	
Fe		<.07				.02	.03		<.02	
Mn										
Al										
Sr										
Pb		<.05				<.04	<.01		<.04	
Cu		<.01				.013	<.01		<.01	
Zn		<.01				<.003	.07		<.01	
Ni										
HCO_3										
CO3										
SO4										
Cl										
NO3										
F								<.05	<.5	
PO4										
SiO2								3	<.5	
Carb (hd)										
Noncarb (hd)										
Alkalinity										
TDS	11						8	119	11	
pH (field)	7.6	7.1			7.3	7.3	6.8	7.6	7.5	
Alkalinity (field)	17	17			17	<17	17	17	17	
Hardness (field)	17	17			17	<17	17		17	
TSS	.002							.0002	.0095	
Cd		<.01				.006	<.01		<.01	
As		<.1				.2	<.1		<.1	
Ag		.01				<.002	<.01		<.01	
Oil & grease										
Strentium										<5
Titanium										
Vanadium										
Zirconium										
Boron										
Chromium										
Lithium										
Molybdenum										

US FOREST SERVICE DATA -- KOOTENAI NATIONAL FOREST

Station Name: Cliff Creek
Location: See below
Watershed: S2 T26N R32W
Station No.: --
District:

Site 5 -- DA BA (11/05/82)

Date	07/20/79	08/10/79	09/06/79	07/02/80	09/11/80	09/24/80	08/19/81	11/05/82
Time	1400	1130	1230	1300	1330	1210	1230	1230
Water (^oC)	7.5	10	8.5	8.5	9.5		11	4
Air (^oC)	24	18.5	14	23	19.5		19.5	5
Discharge	2.56	1.7	.05	1.05	2.4		2.8	
Stage	1.65	.75	.45	.45	.6		.4	
Turbidity	.34	.82	.69	.42	.35	3.6	.52	.41
Conductivity	18	17	25	21	13	19	9.5	11
D.O.	10		9	9	10		10	
Color								
pH (lab)		6.7						
SAR								
Ca							.9	1.0
Mg							.1	.1
Na							.5	
K							<.1	<.1
Fe		.15					.012	.019
Mn							<.001	.001
Al								<.03
Sr								
Pb		<.01					<.04	<.04
Cu		<.01					.006	<.002
Zn		<.01					<.004	.011
Ni								<.01
HCO_3								
CO3								
SO4								
Cl							<1	
NO3								
F								
PO4								
SiO2								
Carb (hd)								
Noncarb (hd)								
Alkalinity								
TDS	4	6		8	5	11	6	
pH (field)	7.0	7.0		6.8	6.4		7.1	7.5
Alkalinity (field)	17	34	17	17	17			17
Hardness (field)	17	17	17	17	17		17	17
TSS	.0011	.0015		.0003	.0001	.0003	.001	
Cd		.01					.004	<.002
As		<.1					<.1	
Ag		<.01					<.002	<.002
V								<.001
ZR								<.003
CR								<.002
Li								<.02
MO								.006
SR								.003
Ti								

US FOREST SERVICE DATA -- KOOTENAI NATIONAL FOREST

Station Name: Cliff Lake
Watershed No.: _____ Station No.: _____
Location: Site 4
District: _____

Date	07/23/81	08/19/81	10/23/81	07/08/82	09/23/82	09/31/83
Time	1200	1330	1100	1400	1200	1200
Water (°C)	10	15.5	+2	0	11	19
Air (°C)	15.5	21	-2.5	8	59F	22
Discharge	.76	0	0	3.5		0
Stage	1.61	1.18	.72	.9	1.21	.9
Turbidity	2	1.9	.42	.78	1.3	.48
Conductivity	18	17	16.5	25	21	15.5
D.O.	9	8	11	12	9	9
Color						
pH (lab)	5.08					
SAR						
Ca			1.8		1.6	
Mg			.5		.4	
Na			.3		.2	
K			.1		.1	
Fe			<.002		.003	
Mn			<.001		<.001	
Al					.014	
Sr					<.04	
Pb			<.04		<.002	
Cu			.003		<.004	
Zn			<.004		<.01	
Ni						
HCO_3						
CO3						
SO4						
Cl						
NO3						
F						
PO4						
SiO2			1.3		1.5	
Carb (hd)					5.6	
Noncarb (hd)						
Alkalinity						
TDS	12	10	11	9	12	
pH (field)	7.5		7.4	7.1	7.0	
Alkalinity (field)	40		17			
Hardness (field)	17		17			
TSS		.004	.001	.016	.003	
Cd			.003		<.002	
As			.1		<.4	
Ag			<.002		<.002	
Oil & grease						
Strentium					.005	
Titanium					<.001	
Vanadium					<.001	
Zirconium					<.003	
Boron					.02	
Chromium					<.002	
Lithium					<.002	
Molybdenum					.02	

US FOREST SERVICE DATA -- KOOTENAI NATIONAL FOREST

Station Name: Cliff Creek
Location: See below
Watershed:
Station No.:
District:

Date	Rocky Basin Upper Reach ASARCO Chicago Peaks 07/20/82	Site 22 Borax -- D-7 Site A 07/11/83	Site B 07/11/83	Site C (Lake) 07/11/83
Time	1300	1430		
Water (°C)	6.5	7		
Air (°C)	68F	20		
Discharge	~5.4	1.21		
Stage	~.8	.3		
Turbidity	.38	92	6.5	65
Conductivity	9	19	14	24
D.O.		8		
TDS	3			
pH (field)		7.4		
TSS				
Dissolved Solids		11	5	16
Susp. Sed.	.004	.094	.008	.115

SUMMARY OF WATER QUALITY ANALYSIS - DATA COLLECTED BY - USFS & ASARCO
FOR NORTHERN SAMPLING SITE WF-20

NORTHERN SAMPLING SITE	WF-20	WF-20	WF-20
SAMPLE DATE	09/20/83	02/15/84	06/13/84
SAMPLING SITE	USFS	WRC-2 HYDROMETRICS	WRC-2 HYDROMETRICS
SAMPLE NUMBER	NO. 17A		
PHYSICAL PARAMETERS			
WATER TEMPERATURE (FIELD) (C)	6.5	3.3	
SPEC. COND. (UMHOS/CM) LAB	75	90	15
PH FIELD	7.9		
PH LAB		8.0	7.6
TURBIDITY (NTU) LAB	0.65	0.28	0.60
TOTAL SUSP. SOLIDS	0.001	<1.0	2.5
TDS MEAS. @ 180 DEG. C	68		
OXYGEN (O) DISS	11		
FLOW (CFS)	2.52		
STAGE (FT)	0.3		
COMMON IONS			
TOTAL HARDNESS AS CACO3	51	28.5	21.2
CALCIUM (CA)	9.3	5.8	4.7
MAGNESIUM (MG)	3.9	3.4	2.3
SODIUM (NA)	1.0	1.0	0.8
POTASSIUM (K)	0.2	0.30	0.20
SULFATE (SO4)		<10	<10
CHLORIDE (CL)		<0.66	<0.66
FLUORIDE (F)		<0.10	<0.13
NUTRIENTS			
NITRATE + NITRITE AS N		<0.05	<0.05
KJELDAHL NITROGEN AS N		0.23	0.30
ORTHO-PHOSPHATE (PO4-P)		<0.02	<0.02
PHOSPHORUS (P) TOTAL		<0.02	0.07
AMMONIA (NH3 AS N)		0.10	0.27
TOTAL PHOSPHATE (PO4)			
TRACE ELEMENTS			
ALUMINUM (AL) TOTAL REC.	0.08	<0.03	0.05
ANTIMONY (SB) TOTAL REC.		<0.08	<0.08
ARSENIC (AS) TOTAL REC.		<0.007	<0.010
BARIUM (BA) TOTAL REC.		<0.05	<0.03
BORON (B) TOTAL REC.	<0.02		
CADMIUM (CD) TOTAL REC.	<0.002	<0.003	<0.003
CHROMIUM (CR) TOTAL REC.		<0.02	<0.02
COBALT (CO) TOTAL REC.		<0.02	<0.02
COPPER (CU) TOTAL REC.	0.002	<0.008	<0.008
IRON (FE) TOTAL REC.	<0.002	0.08	<0.10
LEAD (PB) TOTAL REC.	<0.04	<0.02	<0.02
LITHIUM (LI) TOTAL REC.	<0.002		
MANGANESE (MN) TOTAL REC.	<0.001	<0.008	<0.008
MERCURY (HG) TOTAL REC.		<0.50	<0.5
SILVER (AG) TOTAL REC.		<0.008	<0.008
STRONTIUM (SR) TOTAL REC.	0.019		
VANADIUM (V) TOTAL REC.	<0.001		
ZINC (ZN) TOTAL REC.	<0.003	0.040	<0.02

SUMMARY OF WATER QUALITY ANALYSIS (CONTINUED)

NORTHERN SAMPLING SITE	WF-20	WF-20	WF-20
SAMPLE DATE	09/20/83	02/15/84	06/13/84
SAMPLING SITE	USFS	WRC-2 HYDROMETRICS	WRC-2 HYDROMETRICS
SAMPLE NUMBER	NO. 17A		
OTHER PARAMETERS			
OIL AND GREASE		<1.0	<1.0
SILICA (S102)	7.7		

ALL QUANTITIES IN MILLIGRAMS PER LITER UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

Noranda Site WF-20

SITE NAME	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2
SAMPLE DATE	11/14/84	04/11/85	04/24/85	05/01/85	05/01/85	05/09/85	05/14/85	05/23/85	05/30/85	06/13/85
LAB	ASARCO	ASARCO	WQB/EL	ASARCO	EL	WQB/EL	ASARCO	WQB/EL	ASARCO	ASARCO
REMARKS					SPLIT					
SAMPLE NUMBER		8504-17		8505-34	8505-38		8505-50		8505-66	8506-83
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	2	5	4.4	6	5	4.2	5	6.0	7	9
SPEC. COND. (UMHOS/CM) LAB	55	50		68	69		70		50	55
PH LAB	7.7	7.1		7.8	7.1		7.8		7.8	7.9
TURBIDITY (NTU) LAB	0.23	0.55		0.55	4.1		0.29		0.36	0.31
TOTAL SUSP. SOLIDS	<1.0	3.2		4.3	4		1.2		<1.0	<1.0
TDS MEAS. @ 180 DEG. C		45		43	42		75		40	47
FLOW (CFS)	0.7	18	12	36	36	15	30	30	44	29
STAGE (FT)	-	0.60	0.57	0.78	0.78	0.82	0.80	1.1	0.95	0.85
COMMON IONS										
TOTAL HARDNESS AS CACO3		30	37	31	35	35	35	21	24	27
CALCIUM (CA)	8.1	7.4		7.6	8		8.3		5.8	6.3
MAGNESIUM (MG)	3.6	2.9		3.0	3		3.4		2.3	2.8
SODIUM (NA)	0.80	0.90		0.90	1		0.90		0.70	0.80
POTASSIUM (K)	0.30	0.30		0.30	<1		0.30		0.20	0.30
ALKALINITY AS CACO3 (LAB)		32		31	35		34		25	31
BICARBONATE (HCO3) (LAB)	41	39		38	52		41		31	38
CARBONATE AS CO3 (LAB)		<1.0		<1.0	0		<1.0		<1.0	<1.0
SULFATE (SO4)	<10	4.5		3.7	2		6.3		3.0	<2.0
CHLORIDE (CL)	1.6	<0.66		2.6	1		<1.0		<1.0	<2.0
FLUORIDE (F)	<0.13	<0.13		<0.13	0.03		<0.13		<0.13	<0.13
NUTRIENTS										
NITRATE + NITRITE AS N		0.022		12	0.030		0.060		<0.010	1.5
KJELDAHL NITROGEN AS N		0.18		0.020	<0.05		<0.010		<0.010	<0.010
ORTHO-PHOSPHATE (PO4-P)		<0.010		<0.010	0.004		<0.010		<0.010	<0.010
PHOSPHORUS (P) TOTAL		<0.010		0.050	0.006		<0.010		<0.010	0.010
AMMONIA (NH3 AS N)		0.10		<0.010	<0.05		<0.010		<0.010	<0.010
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.	0.090 (D)	0.12		0.088	0.061		0.023		0.035	0.006
ANTIMONY (SB) TOTAL REC.	<0.080 (D)	<0.010		<0.010			<0.010		<0.010	<0.010
ARSENIC (AS) TOTAL REC.	<0.008 (D)	<0.001		<0.001	<0.001		<0.001		<0.001	<0.001
BARIUM (BA) TOTAL REC.	<0.040 (D)	<0.060		<0.060			<0.060		<0.060	<0.060
BORON (B) TOTAL REC.		<0.010		<0.010			<0.010		<0.010	0.040
CADMIUM (CD) TOTAL REC.	<0.003 (D)	0.0004		0.0003	0.0019		<0.0001		0.0004	0.0011
CADMIUM (CD) ACID SOL.			0.0002			0.0018		0.0039		
CHROMIUM (CR) TOTAL REC.	<0.030 (D)	<0.020		<0.020	<0.01		<0.030		<0.030	<0.030
COBALT (CO) TOTAL REC.	<0.020 (D)	<0.030		<0.030			<0.020		<0.020	<0.020
COPPER (CU) TOTAL REC.	<0.008 (D)	<0.001		0.010	0.010		0.003		<0.001	<0.002

(D) Dissolved.

All quantities in milligrams per liter unless otherwise noted. Blank indicates parameter not tested.

Output Date: 02-24-1

HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO [illegible]EK

SITE NAME	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2
SAMPLE DATE	11/14/84	04/11/85	04/24/85	05/01/85	05/01/85	05/09/85	05/14/85	05/23/85	05/30/85	06/13/85
TRACE ELEMENTS										
COPPER (CU) ACID SOL.			0.002			<0.001		<0.001		
IRON (FE) TOTAL REC.	0.070 (D)	0.12		0.074	0.101		0.014		0.018	0.015
LEAD (PB) TOTAL REC.	<0.020 (D)	<0.002		<0.002	<0.001		<0.001		<0.001	<0.002
LEAD (PB) ACID SOL.			0.002			0.015		0.002		
MANGANESE (MN) TOTAL REC.	0.012 (D)	0.008		<0.008	0.007		<0.008		<0.008	<0.008
MERCURY (HG) TOTAL REC.	<0.0005(D)	<0.0005		<0.0005	<0.0002		<0.0005		<0.0005	<0.0005
MOLYBDENUM (MO) TOTAL REC.		<0.020		<0.020	<0.001		<0.020		<0.020	<0.020
SELENIUM (SE) TOTAL REC.		<0.004		<0.004			<0.004		<0.004	<0.004
SILVER (AG) TOTAL REC.	<0.008 (D)	<0.0003		<0.0003	0.0002		<0.0002		<0.0002	<0.0002
SILVER (AG) ACID SOL.			<0.0002			0.0003		0.0001		
ZINC (ZN) TOTAL REC.	0.022 (D)	<0.001		<0.001	0.038		<0.001		<0.001	<0.001

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2
SAMPLE DATE	06/27/85	08/08/85	10/16/85	03/04/86	03/04/86	03/04/86	03/04/86	03/04/86	03/04/86	04/08/86
LAB	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	FORD	EL	FORD	EL	ASARCO
REMARKS					DUPLICATE	SPLIT	SPLIT	DUP./SPLIT	DUP./SPLIT	
SAMPLE NUMBER	8506-101	8508-109	8510-132	8603-148	8603-153	8603-148	8603-148	8603-153	8603-153	8604-167
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	9.5	9	5	7	7					4
SPEC. COND. (UMHOS/CM) LAB	51	71	80	72	70					70
PH LAB	7.9	8.0	8.1	7.6	7.7					7.9
TURBIDITY (NTU) LAB	0.25	0.24	0.33	0.37	0.40					0.31
TOTAL SUSP. SOLIDS	<1.0	1.7	<1.0	1.0	<1.0					<1.0
TDS MEAS. @ 180 DEG. C	53	74	53	48	47					46
FLOW (CFS)	10	1.6	0.25							
STAGE (FT)	0.50	0.30	0.13							
COMMON IONS										
TOTAL HARDNESS AS CACO3	32	36	37	32	32					31
CALCIUM (CA)	7.5	8.1	8.9	7.2	7.4					7.0
MAGNESIUM (MG)	3.3	3.9	3.7	3.3	3.3					3.3
SODIUM (NA)	0.90	1.0	1.0	0.80	0.80					0.80
POTASSIUM (K)	0.30	0.40	0.30	0.20	0.20					0.30
ALKALINITY AS CACO3 (LAB)	36	39	39	32	32					34
BICARBONATE (HCO3) (LAB)	44	48	48	39	39					41
CARBONATE AS CO3 (LAB)	<1.0	<1.0	<1.0	<1.0	<1.0					<1.0
SULFATE (SO4)	<2.0	2.1	<3.0	<2.0	2.0					<1.0
CHLORIDE (CL)	<2.0	<2.0	<1.0	<1.0	<1.0					<1.0
FLUORIDE (F)	<0.13	<0.13	<0.13	<0.13	<0.13					<0.013
NUTRIENTS										
NITRATE + NITRITE AS N	0.50	0.30	<0.010	12	0.48	12.7	13	0.50	0.48	1.4
KJELDAHL NITROGEN AS N	0.50	0.10	0.050	<0.10	1.5					0.46
ORTHO-PHOSPHATE (PO4-P)	<0.010	<0.010	<0.010	<0.010	<0.010					<0.010
PHOSPHORUS (P) TOTAL	<0.010	<0.010	<0.10	<0.020	<0.020					<0.040
AMMONIA (NH3 AS N)	0.40	0.050	<0.040	0.14	1.2	0.51	0.1	1.26	1.2	0.23
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.	0.014	0.007	0.013	0.011	0.012					0.009
ANTIMONY (SB) TOTAL REC.	<0.010	<0.010	<0.010	<0.010	<0.010					0.065
ARSENIC (AS) TOTAL REC.	<0.001	0.001	<0.001	<0.001	<0.001					0.001
BARIUM (BA) TOTAL REC.	<0.060	<0.060	<0.020	<0.020	<0.020					0.020
BORON (B) TOTAL REC.	<0.020	<0.020	<0.010	<0.010	<0.010					<0.010
CADMIUM (CD) TOTAL REC.	0.00020	0.00088	0.0005	0.0003	0.0010					0.0006
CHROMIUM (CR) TOTAL REC.	<0.030	<0.030	<0.033	<0.020	<0.020					<0.020
COBALT (CO) TOTAL REC.	<0.020	<0.020	<0.020	<0.020	<0.020					<0.020
COPPER (CU) TOTAL REC.	<0.002	<0.002	<0.001	0.001	<0.001					<0.001
IRON (FE) TOTAL REC.	0.010	<0.005	0.013	0.039	0.042					0.011

(D) = Dissolved.
Quantities in milligrams per liter unless otherwise noted. [illegible] line indicates parameter not tested.

Output Date: 02-7
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO [illegible] CREEK

SITE NAME	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2	WRC-2
SAMPLE DATE	06/27/85	08/08/85	10/16/85	03/04/86	03/04/86	03/04/86	03/04/86	03/04/86	03/04/86	04/08/86
TRACE ELEMENTS										
LEAD (PB) TOTAL REC.	<0.002	<0.002	<0.001	0.007	0.003					<0.002
MANGANESE (MN) TOTAL REC.	<0.008	<0.008	<0.008	<0.008	<0.008					<0.008
MERCURY (HG) TOTAL REC.	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005					<0.00005
MOLYBDENUM (MO) TOTAL REC.	<0.020	<0.020	<0.020	<0.020	<0.020					<0.020
SELENIUM (SE) TOTAL REC.	<0.004	<0.004	<0.005	<0.004	<0.004					<0.004
SILVER (AG) TOTAL REC.	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002					<0.0002
ZINC (ZN) TOTAL REC.	<0.001	<0.001	0.001	<0.001	0.002					<0.001
OTHER PARAMETERS										
OIL AND GREASE	<1.0									

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	WRC-2	WRC-2	WRC-2
SAMPLE DATE	04/08/86	08/20/86	08/20/86
LAB	EL	ASARCO	EL
REMARKS	SPLIT		SPLIT
SAMPLE NUMBER	8604-167	8608-200	8608-207
PHYSICAL PARAMETERS			
WATER TEMPERATURE (FIELD) (C)		11	
SPEC. COND. (UMHOS/CM) LAB		78	76
PH LAB		8.0	7.5
TURBIDITY (NTU) LAB		0.30	0.13
TOTAL SUSP. SOLIDS		1.2	2
TDS MEAS. @ 180 DEG. C		46	61
FLOW (CFS)		0.3	
STAGE (FT)		0.05	
COMMON IONS			
TOTAL HARDNESS AS CACO3		37	40
CALCIUM (CA)		8.3	9
MAGNESIUM (MG)		3.9	4
SODIUM (NA)		0.90	<1
POTASSIUM (K)		0.30	<1
ALKALINITY AS CACO3 (LAB)		40	41
BICARBONATE (HCO3) (LAB)		49	50
CARBONATE AS CO3 (LAB)		<1.0	0
SULFATE (SO4)		2.5	3
CHLORIDE (CL)		<1.0	1
FLUORIDE (F)		<0.13	0.03
NUTRIENTS			
NITRATE + NITRITE AS N	0.018	0.020	0.013
KJELDAHL NITROGEN AS N	<0.05	0.060	<0.05
ORTHO-PHOSPHATE (PO4-P)		<0.010	0.004
PHOSPHORUS (P) TOTAL		<0.040	0.004
AMMONIA (NH3 AS N)	<0.05	<0.040	0.08
TRACE ELEMENTS			
ALUMINUM (AL) TOTAL REC.		<0.005	<0.005
ANTIMONY (SB) TOTAL REC.		<0.010	
ARSENIC (AS) TOTAL REC.		<0.001	<0.001
BARIUM (BA) TOTAL REC.		<0.040	
BORON (B) TOTAL REC.		<0.010	
CADMIUM (CD) TOTAL REC.		0.0003	0.0007
CHROMIUM (CR) TOTAL REC.		<0.030	<0.01
COBALT (CO) TOTAL REC.		<0.020	
COPPER (CU) TOTAL REC.		<0.001	<0.001
IRON (FE) TOTAL REC.		0.005	0.012

(D) = Dissolved.
Quantities in milligrams per liter unless otherwise noted. [illegible]K line indicates parameter not tested.

Output Date: 02-7[illegible]7
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO [illegible]REEK

SITE NAME	WRC-2	WRC-2	WRC-2
SAMPLE DATE	04/08/86	08/20/86	08/20/86
TRACE ELEMENTS			
LEAD (PB) TOTAL REC.		<0.001	<0.001
MANGANESE (MN) TOTAL REC.		<0.008	<0.001
MERCURY (HG) TOTAL REC.		<0.0005	<0.0002
MOLYBDENUM (MO) TOTAL REC.		<0.020	0.002
SELENIUM (SE) TOTAL REC.		<0.004	
SILVER (AG) TOTAL REC.		<0.0002	0.0065
ZINC (ZN) TOTAL REC.		<0.002	0.010

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

WATER QUALITY ANALYSIS DATA COLLECTED BY HYDROMETRICS
FOR NORTHERN SAMPLING SITE RC-2000

NORTHERN SAMPLING SITE	RC-2000	RC-2000	RC-2000	RC-2000
SAMPLE DATE	06/20/83	9/23/83	2/15/84	06/13/84
HYDROMETRICS SAMPLING SITE	RC-1	RC-1	RC-1	RC-1
PHYSICAL PARAMETERS				
WATER TEMPERATURE (FIELD) (C)	7.8	8.3	2.8	
SPEC. COND. (UMHOS/CM) LAB	15	25	32	15
PH FIELD				
PH LAB	7.8	7.7	8.2	7.3
TURBIDITY (NTU) LAB	<1.0	0.25	0.22	1.0
TOTAL SUSP. SOLIDS	3.0	<1.0	<1.0	2.2
TOTAL DISS. SOLIDS. MEAS.				
OXYGEN (O) DISS				
FLOW (CFS)	145	2		
COMMON IONS				
TOTAL HARDNESS AS CACO3	7.8	11.1	9.4	5.7
CALCIUM (CA)	2.3	2.8	2.3	1.3
MAGNESIUM (MG)	0.50	1.0	0.90	0.60
SODIUM (NA)	0.77	1.0	0.70	0.50
POTASSIUM (K)	0.22	0.20	0.20	0.30
ALKALINITY AS CACO3 (LAB)				
SULFATE (SO4)	<10	<10	<10	<10
CHLORIDE (CL)	0.66	1.3	<0.66	<0.66
FLUORIDE (F)			<0.10	<0.13
NUTRIENTS				
NITRATE (NO3-N)				
NITRATE + NITRITE AS N	<0.05	<0.02	<0.05	<0.05
KJELDAHL NITROGEN AS N	0.13	1.1	0.22	0.55
ORTHO-PHOSPHATE (PO4-P)	<0.02	<0.02	<0.2	<0.02
PHOSPHORUS (P) TOTAL	<0.02	<0.02	<0.02	0.09
AMMONIA (NH3 AS N)	<0.01	0.80	0.10	0.32
TRACE ELEMENTS				
ALUMINUM (AL) TOTAL REC.	0.07	<0.03	<0.03	0.12
ANTIMONY (SB) TOTAL REC.	<0.050	<0.08	<0.08	<0.08
ARSENIC (AS) TOTAL REC.	<0.008	0.011	0.009	<0.010
BARIUM (BA) TOTAL REC.		<0.02	<0.05	<0.03
CADMIUM (CD) TOTAL REC.	<0.003	<0.003	<0.003	<0.003
CHROMIUM (CR) TOTAL REC.	<0.02	<0.02	<0.02	<0.02
COBALT (CO) TOTAL REC.		0.02	<0.02	<0.02
COPPER (CU) TOTAL REC.	<0.008	<0.008	<0.008	0.008
IRON (FE) TOTAL REC.	0.08	0.05	0.07	0.10
LEAD (PB) TOTAL REC.	<0.02	<0.02	<0.02	<0.02
MANGANESE (MN) TOTAL REC.	<0.008	<0.008	<0.008	<0.008
MERCURY (HG) TOTAL REC.	<0.0005	<0.50	<0.50	<0.50
SILVER (AG) TOTAL REC.	<0.008	<0.008	<0.008	<0.008
ZINC (ZN) TOTAL REC.	<0.02	0.30	0.04	<0.02
OTHER PARAMETERS				
OIL AND GREASE	0.77	<1.0	<1.0	<1.0

ALL QUANTITIES IN MILLIGRAMS PER LITER UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1
SAMPLE DATE	09/14/84	10/16/84	11/01/84	11/15/84	12/12/84	04/10/85	04/10/85	04/10/85	04/24/85	05/01/85
LAB	WQB	WQB	WQB	ASARCO	WQB	ASARCO	ASARCO	WQB	WQB/EL	ASARCO
REMARKS							DUPLICATE			
SAMPLE NUMBER						8504-16	8504-27			8505-30
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	8.0	6.5	0.2	2		6		4.0	5.0	
SPEC. COND. (UMHOS/CM) LAB			31	30		15	15	23		20
PH FIELD			6.60							
PH LAB			7.45	7.3		7.0	7.0	7.27		7.4
TURBIDITY (NTU) LAB				0.41		0.43	0.51			0.39
TOTAL SUSP. SOLIDS	0.2	0.5	0.0	1.3		2.3	3.2	9.5		3.0
TDS MEAS. @ 180 DEG. C						24	24			19
OXYGEN (O) DISS			13.50							
SODIUM ADSORPTION RATIO			0.2							
FLOW (CFS)	3.0	1.0	1.0	0.52	-	42	42	80	40	350 (EST)
STAGE (FT)		-	-	-	-	0.95	0.95	-	-	1.96
COMMON IONS										
TOTAL HARDNESS AS CACO3			9	14		8.0	8.7	5	9	8.4
CALCIUM (CA)			3.2	3.3		2.3	2.4	1.7		2.3
MAGNESIUM (MG)			0.3	0.89		0.55	0.66	<0.10		0.66
SODIUM (NA)			1.2	1.3		0.70	0.70			0.50
POTASSIUM (K)				0.20		0.20	0.30			0.20
ALKALINITY AS CACO3 (LAB)			15			8.0	11	6.6		8.5
BICARBONATE (HCO3) (LAB)			18.3	17		9.8	13	8.1		10
CARBONATE AS CO3 (LAB)			0.0			<1.0	<1.0	0.0		<1.0
SULFATE (SO4)			1.2	<10		4.2	4.1			3.5
CHLORIDE (CL)			0.3	2.0		<0.66	<0.66			1.3
FLUORIDE (F)				<0.13		<0.13	<0.13			<0.13
NUTRIENTS										
NITRATE + NITRITE AS N	<0.01	<0.01	0.01		0.03	5.7	4.7	0.09		7.4
KJELDAHL NITROGEN AS N	<0.1	<0.1	<0.1		0.1	5.1	<0.010	<0.1		0.25
ORTHO-PHOSPHATE (PO4-P)						<0.010	<0.010			<0.010
PHOSPHORUS (P) TOTAL	<0.01	<0.01	<0.01		<0.003	<0.010	<0.010	0.011		<0.010
AMMONIA (NH3 AS N)	<0.01	<0.01	0.01		<0.01	3.0	<0.010	<0.01		0.10
TOTAL PHOSPHATE (PO4)	0.001	<0.003	<0.003		<0.003			0.002		
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.				0.090 (D)		0.096	0.096			0.063
ANTIMONY (SB) TOTAL REC.				<0.080 (D)		<0.010	<0.010			<0.010
ARSENIC (AS) TOTAL REC.	<0.001	<0.001	<0.001	<0.008 (D)	<0.001	<0.001	<0.001	<0.001		<0.001
BARIUM (BA) TOTAL REC.				<0.040 (D)		<0.060	<0.060			<0.060
BORON (B) TOTAL REC.						<0.010	<0.010			<0.010
CADMIUM (CD) TOTAL REC.	<0.005	<0.005	<0.005	<0.003 (D)	<0.005	0.0004	0.0002			0.0004

(D[illegible] issolved.
A[illegible] ntities in milligrams per liter unless otherwise noted. B[illegible]ine indicates parameter not tested.

Output Date: 02-24-[illegible]
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1
SAMPLE DATE	09/14/84	10/16/84	11/01/84	11/15/84	12/12/84	04/10/85	04/10/85	04/10/85	04/24/85	05/01/85
TRACE ELEMENTS										
CADMIUM (CD) ACID SOL.								0.0002	0.0024	
CHROMIUM (CR) TOTAL REC.				<0.030 (D)		<0.020	<0.020			<0.020
COBALT (CO) TOTAL REC.				<0.020 (D)		<0.030	<0.030			<0.030
COPPER (CU) TOTAL REC.	<0.01	<0.01	<0.01	<0.008 (D)	<0.01	<0.001	0.002			<0.001
COPPER (CU) ACID SOL.								0.002	0.005	
IRON (FE) TOTAL REC.	<0.01	0.01	<0.01	0.070 (D)	<0.01	0.066	0.084			0.039
LEAD (PB) TOTAL REC.			<0.05	<0.020 (D)		<0.002	<0.002			<0.002
LEAD (PB) ACID SOL.								0.007	0.016	
MANGANESE (MN) TOTAL REC.	<0.005	<0.005	<0.005	<0.008 (D)	<0.005	<0.008	<0.008			<0.008
MERCURY (HG) TOTAL REC.				<0.0005(D)		<0.0005	<0.0005			<0.0005
MOLYBDENUM (MO) TOTAL REC.						<0.020	<0.020			<0.020
SELENIUM (SE) TOTAL REC.						<0.004	<0.004			<0.004
SILVER (AG) TOTAL REC.			0.01	<0.008 (D)		<0.0003	<0.0003			<0.0003
SILVER (AG) ACID SOL.								<0.0002	<0.0002	
ZINC (ZN) TOTAL REC.	<0.005	0.008	<0.005	0.038 (D)	<0.005	<0.001	<0.001			<0.001
BACTERIOLOGICAL PARAMETERS										
5 - DAY BOD			<2.0							

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROC

SITE NAME	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1
SAMPLE DATE	05/09/85	05/15/85	05/23/85	05/31/85	05/31/85	06/13/85	06/13/85	06/27/85	08/08/85	10/16/85
LAB	WQB	ASARCO	WQB/EL	ASARCO	EL	ASARCO	EL	ASARCO	ASARCO	ASARCO
REMARKS					SPLIT		SPLIT			
SAMPLE NUMBER		8505-45		8505-72	8505-75	8506-78	8506-89	8506-96	8508-115	8510-128
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	6.0	7	8.5	10	10	10	10	14	12	7
SPEC. COND. (UMHOS/CM) LAB	28	25		20	22	22	24	22	21	25
PH LAB	7.70	7.5		7.4	6.6	7.5	6.6	7.5	7.1	7.1
TURBIDITY (NTU) LAB		0.29		0.46	5.5	0.27	2.7	0.34	0.27	0.41
TOTAL SUSP. SOLIDS	1.1	<1.0		<1.0	6	<1.0	4	<1.0	<1.0	<1.0
TDS MEAS. @ 180 DEG. C		20		15	20	30	8	22	43	29
FLOW (CFS)	80	191	150	183	183	194	194	44	3.1	15
STAGE (FT)		1.34		1.54	1.54	1.50	1.50	0.9	0.17	0.66
COMMON IONS										
TOTAL HARDNESS AS CACO3	29	11	3	7.7	8	9.6	8	8.9	11	9.9
CALCIUM (CA)	8.8	2.9		2.0	2	2.2	2	2.4	2.9	2.7
MAGNESIUM (MG)	1.7	0.89		0.66	1	1.0	1	0.70	0.90	0.78
SODIUM (NA)		0.60		0.40	<1	0.50	1	0.70	1.2	0.70
POTASSIUM (K)		0.20		0.20	<1	0.20	<1	0.30	0.30	0.20
ALKALINITY AS CACO3 (LAB)	12.8	8.9		8.1	10	12	11	11	13	12
BICARBONATE (HCO3) (LAB)		11		9.9	12	14	13	14	16	15
CARBONATE AS CO3 (LAB)		<1.0		<1.0	0	<1.0	0	<1.0	<1.0	<1.0
SULFATE (SO4)		4.0		3.5	2	3.8	2	5.0	<2.0	<3.0
CHLORIDE (CL)		<1.0		<1.0	1	<2.0	<1	<2.0	<2.0	<1.0
FLUORIDE (F)		<0.13		<0.13	0.02	<0.13	0.03	<0.13	<0.13	<0.13
NUTRIENTS										
NITRATE + NITRITE AS N	0.02	<0.010		0.010	0.018	<0.010	0.002	0.010	<0.010	3.7
KJELDAHL NITROGEN AS N	<0.1	<0.010		0.030	0.10	0.35	<0.05	0.35	0.12	1.3
ORTHO-PHOSPHATE (PO4-P)		<0.010		<0.010	<0.001	<0.010	<0.001	<0.010	<0.010	<0.010
PHOSPHORUS (P) TOTAL	<0.001	<0.010		<0.010	0.002	0.010	0.006	<0.010	<0.010	<0.10
AMMONIA (NH3 AS N)	<0.01	<0.010		<0.010	<0.05	0.20	<0.05	0.20	0.050	0.76
TOTAL PHOSPHATE (PO4)	<0.001									
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.		0.026		0.039	<0.005	0.019	0.034	0.011	<0.005	0.016
ANTIMONY (SB) TOTAL REC.		<0.010		<0.010		<0.010		<0.010	<0.010	<0.010
ARSENIC (AS) TOTAL REC.	<0.001	<0.001		0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
BARIUM (BA) TOTAL REC.		<0.060		<0.060		<0.060		<0.060	<0.060	<0.020
BORON (B) TOTAL REC.		<0.010		<0.010		<0.020		0.030	<0.020	<0.010
CADMIUM (CD) TOTAL REC.	<0.005	0.0004		0.0004	<0.0001	0.00034	<0.0001	0.00020	0.00038	0.0003
CADMIUM (CD) ACID SOL.	0.0027		0.0018							
CHROMIUM (CR) TOTAL REC.		<0.030		<0.030	<0.01		<0.01	<0.030	<0.030	<0.033
COBALT (CO) TOTAL REC.		<0.020		<0.020				<0.020	<0.020	<0.020

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1
SAMPLE DATE	05/09/85	05/15/85	05/23/85	05/31/85	05/31/85	06/13/85	06/13/85	06/27/85	08/08/85	10/16/85
TRACE ELEMENTS										
COPPER (CU) TOTAL REC.	<0.01	0.001		<0.001	<0.01	<0.002	<0.001	<0.002	<0.002	<0.001
COPPER (CU) ACID SOL.	<0.001		0.001							
IRON (FE) TOTAL REC.		0.020		0.036	0.051	0.012	0.049	<0.005	<0.005	0.016
LEAD (PB) TOTAL REC.		0.004		<0.001	<0.001		<0.001	<0.002	<0.002	<0.001
LEAD (PB) ACID SOL.	0.019		0.003							
MANGANESE (MN) TOTAL REC.		<0.008		<0.008	0.002		0.001		<0.008	<0.0008
MERCURY (HG) TOTAL REC.		<0.0005		<0.0005	<0.0002		<0.0002		<0.0005	<0.0005
MOLYBDENUM (MO) TOTAL REC.		<0.020		<0.020	<0.001		0.002	<0.020	<0.020	<0.020
SELENIUM (SE) TOTAL REC.		<0.004		<0.004				<0.004	<0.004	<0.005
SILVER (AG) TOTAL REC.		<0.0002		<0.0002	0.0129		0.0005	<0.0002	<0.0002	<0.0002
SILVER (AG) ACID SOL.	0.001		0.0011							
ZINC (ZN) TOTAL REC.	<0.005	<0.001		<0.001	<0.01	<0.001	0.010	<0.001	0.001	<0.001
OTHER PARAMETERS										
OIL AND GREASE								<1.0		

(" Dissolved.
(ntities in milligrams per liter unless otherwise noted. E ine indicates parameter not tested.

Output Date: 02-24
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO R[illegible]EEK

SITE NAME	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1
SAMPLE DATE	10/16/85	10/16/85	03/05/86	03/05/86	03/05/86	04/09/86	04/09/86	08/20/86	10/17/86	10/17/86
LAB	FORD	EL	ASARCO	EL	EL	ASARCO	EL	ASARCO	ASARCO	EL
REMARKS	SPLIT	SPLIT		SPLIT	SPLIT		SPLIT			SPLIT
SAMPLE NUMBER	8510-128	8510-128	8603-159	8603-147	8603-159	8604-160	8604-160	8608-203	8610-221	8610-221
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)			6	6		5.5		10	6.5	
SPEC. COND. (UMHOS/CM) LAB			26	28		25		27	25	
PH LAB			7.2	6.8		7.0		7.6	7.4	
TURBIDITY (NTU) LAB			0.42	0.39		0.36		0.28	0.31	
TOTAL SUSP. SOLIDS			1.7	1		<1.0		<1.0	<1.0	
TDS MEAS. @ 180 DEG. C			26	13		22		34	33	
FLOW (CFS)								1.1	6	
STAGE (FT)								0.09	0.36	
COMMON IONS										
TOTAL HARDNESS AS CACO3			11	11		10		12	12	
CALCIUM (CA)			2.4	3		2.4		2.8	3.0	
MAGNESIUM (MG)			0.99	1		0.99		1.1	1.0	
SODIUM (NA)			0.60	<1		0.60		1.1	0.81	
POTASSIUM (K)			0.20	<1		0.20		0.30	0.30	
ALKALINITY AS CACO3 (LAB)			10	13		10		14	9.0	
BICARBONATE (HCO3) (LAB)			12	15		12		17	11	
CARBONATE AS CO3 (LAB)			<1.0	0		<1.0		<1.0	<1.0	
SULFATE (SO4)			<2.0	2		<1.0		<2.0	<3.0	
CHLORIDE (CL)			<1.0	<1		<1.0		<1.0	<1.0	
FLUORIDE (F)			<0.13	0.03		<0.013		<0.13	<0.13	
NUTRIENTS										
NITRATE + NITRITE AS N	2.9	4.5	11	0.019	12.6	0.030	0.020	0.010	<0.020	0.007
KJELDAHL NITROGEN AS N			<0.10	<0.05		0.65	0.08	<0.040	0.080	<0.05
ORTHO-PHOSPHATE (PO4-P)			<0.010	<0.001		<0.010		<0.010	<0.020	
PHOSPHORUS (P) TOTAL			<0.020	0.006		<0.040		<0.040	<0.020	
AMMONIA (NH3 AS N)			0.11	<0.05	<0.1	0.29	0.07	<0.040	<0.020	0.1
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.			0.064	0.086		0.013		0.012	0.006	
ANTIMONY (SB) TOTAL REC.			<0.010			<0.010		<0.010	<0.010	
ARSENIC (AS) TOTAL REC.			<0.001	<0.001		<0.001		<0.001	0.005	
BARIUM (BA) TOTAL REC.			<0.020			0.020		<0.040	<0.060	
BORON (B) TOTAL REC.			<0.010			0.015		<0.010	<0.020	
CADMIUM (CD) TOTAL REC.			0.0009	<0.0001		0.0012		0.0006	<0.0001	
CHROMIUM (CR) TOTAL REC.			<0.020	<0.01		<0.020		<0.030	<0.030	
COBALT (CO) TOTAL REC.			<0.020			<0.020		<0.020	<0.020	
COPPER (CU) TOTAL REC.			0.001	0.003		<0.001		<0.001	<0.001	
IRON (FE) TOTAL REC.			0.087	0.082		0.024		0.005	<0.005	

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1	RC-1
SAMPLE DATE	10/16/85	10/16/85	03/05/86	03/05/86	03/05/86	04/09/86	04/09/86	08/20/86	10/17/86	10/17/86
TRACE ELEMENTS										
LEAD (PB) TOTAL REC.			<0.002	0.007		0.006		<0.001	<0.001	
MANGANESE (MN) TOTAL REC.			<0.008	0.009		<0.008		<0.008	<0.008	
MERCURY (HG) TOTAL REC.			<0.0005	<0.0002		<0.00005		<0.0005	<0.0005	
MOLYBDENUM (MO) TOTAL REC.			<0.020	0.001		<0.020		<0.020	<0.020	
SELENIUM (SE) TOTAL REC.			<0.004			<0.004		<0.004	0.006	
SILVER (AG) TOTAL REC.			<0.0002	0.0007		<0.0002		<0.0002	<0.0002	
ZINC (ZN) TOTAL REC.			0.002	0.012		<0.001		<0.002	<0.002	

= Dissolved.
quantities in milligrams per liter unless otherwise noted; [illegible]nk line indicates parameter not tested.

Output Date: 02 [illegible] 87
HWQ-6/86-R1

WATER QUALITY ANALYSIS - COLLECTED BY U.S. FOREST SERVICE

NORTHERN SAMPLING SITE	RC-850	RC-850	RC-850	RC-850	RC-850
SAMPLE DATE	8/17/79	09/19/80	11/04/81	09/24/82	09/15/83
USFS SAMPLING SITE	USFS	USFS	USFS	USFS	USFS
REMARKS	NO. 6	NO. 6	NO. 6	NO. 6	NO. 6
PHYSICAL PARAMETERS					
WATER TEMPERATURE (FIELD) (C)	16.5	11.5			
SPEC. COND. (UMHOS/CM) LAB		18	5	10	13
PH FIELD	7.6		22	40	27
PH LAB			7.6	7.8	7.6
TURBIDITY (NTU) LAB		0.54	0.73	0.47	0.31
TOTAL SUSP. SOLIDS		0.001	0.001	0.004	0.001
TOTAL DISS. SOLIDS MEAS.					
TDS MEAS. @ 180 DEG. C		12	13	27	19
OXYGEN (O) DISS	10	10	11	10	10
FLOW (CFS)	3.97	22.6	12.2	4.34	22
STAGE (FT)	2.9		0.45	0.2	0.5
COMMON IONS					
TOTAL HARDNESS AS CACO3	17	17	17	16.7	17
CALCIUM (CA)		6.5	3.1	4.2	2.8
MAGNESIUM (MG)		0.5	0.4	1.5	0.9
SODIUM (NA)			0.8	0.9	0.8
POTASSIUM (K)		0.6	<0.1	0.2	0.1
ALKALINITY AS CACO3 (LAB)	17	17	34		
SULFATE (SO4)					
CHLORIDE (CL)					
FLUORIDE (F)					
NUTRIENTS					
NITRATE + NITRITE AS N					
KJELDAHL NITROGEN AS N					
ORTHO-PHOSPHATE (PO4-P)					
PHOSPHORUS (P) TOTAL					
AMMONIA (NH3 AS N)					
TRACE ELEMENTS					
ALUMINUM (AL) TOTAL REC.				0.012	0.05
ANTIMONY (SB) TOTAL REC.					
ARSENIC (AS) TOTAL REC.		<0.1	<0.1	<0.1	
BARIUM (BA) TOTAL REC.					
BORON (B) TOTAL REC.				<0.02	<0.02
CADMIUM (CD) TOTAL REC.		<0.01		<0.002	<0.002
CHROMIUM (CR) TOTAL REC.				<0.002	<0.002
COBALT (CO) TOTAL REC.					
COPPER (CU) TOTAL REC.		0.01	0.003	<0.002	0.002
IRON (FE) TOTAL REC.		0.12	0.005	0.011	0.005
LEAD (PB) TOTAL REC.		<0.04	<0.04	<0.04	<0.04
LITHIUM (LI) TOTAL REC.				<0.002	<0.002
MANGANESE (MN) TOTAL REC.			0.001	<0.001	<0.001
MERCURY (HG) TOTAL REC.					

WATER QUALITY ANALYSES - U.S. FOREST SERVICE DATA (CONTINUED)

NORTHERN SAMPLING SITE	RC-850	RC-850	RC-850	RC-850	RC-850
SAMPLE DATE	8/17/79	09/19/80	11/04/81	09/24/82	09/15/83
USFS SAMPLING SITE	USFS	USFS	USFS	USFS	USFS
REMARKS	NO. 6	NO. 6	NO. 6	NO. 6	NO. 6
MOLYBDENUM (MO) TOTAL REC.				<0.02	<0.02
NICKEL (NI) TOTAL REC.				<0.01	<0.01
SILVER (AG) TOTAL REC.		<0.01	<0.002	<0.002	<0.002
STRONTIUM (SR) TOTAL REC.				0.014	0.012
TITANIUM (TI) TOTAL REC.				<0.002	<0.002
VANADIUM (V) TOTAL REC.				<0.001	<0.001
ZINC (ZN) TOTAL REC.		0.09	0.068	<0.004	<0.003
OTHER PARAMETERS					
OIL AND GREASE					
SILICA (S102)					5.5

ALL QUANTITIES IN MILLIGRAMS PER LITER UNLESS OTHERWISE NOTED
BLANK LINE INDICATES PARAMETER NOT TESTED

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3
SAMPLE DATE	02/21/85	02/21/85	04/11/85	04/24/85	05/01/85	05/01/85	05/09/85	05/14/85	05/23/85	05/31/85
LAB	ASARCO	EL	ASARCO	WQB/EL	ASARCO	ASARCO	WQB/EL	ASARCO	WQB/EL	ASARCO
REMARKS		SPLIT				DUPLICATE				
SAMPLE NUMBER	8502-10	8502-11	8504-18		8505-32	8505-40		8505-47		8505-70
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	2	2	5	4.0	6	6	6.0	6.5	7.0	8
SPEC. COND. (UMHOS/CM) LAB	15	22	15		27	28		35		7.0
PH LAB	7.0	6.3	7.1		7.2	7.3		7.5		7.0
TURBIDITY (NTU) LAB	0.20	0.24	0.31		0.38	0.52		0.26		0.26
TOTAL SUSP. SOLIDS	3.4	1	1.0		1.6	1.9		<1.0		<1.0
TDS MEAS. @ 180 DEG. C	29	23	27		18	23		38		12
FLOW (CFS)	0.5	0.5	160	60	300	300	170	150	300	217
STAGE (FT)	-	-	2.1	1.40	2.7	2.7	1.95	1.8	2.70	2.15
COMMON IONS										
TOTAL HARDNESS AS CACO3	6.9	6	8.4	41	12	12	14	17	7	3.6
CALCIUM (CA)	1.9	1.9	2.3		3.0	3.0		4.0		1.1
MAGNESIUM (MG)	0.40	0.4	0.66		1.0	1.1		1.6		0.22
SODIUM (NA)	0.90	1.2	0.60		0.50	0.50		0.60		0.30
POTASSIUM (K)	0.20	<0.01	0.30		0.20	<0.10		0.20		0.10
ALKALINITY AS CACO3 (LAB)	6.1	8	13		11	12		16		3.4
BICARBONATE (HCO3) (LAB)	9	11	16		13	15		20		4.1
CARBONATE AS CO3 (LAB)	<1.0	<1.0	<1.0		<1.0	<1.0		<1.0		<1.0
SULFATE (SO4)	<2.0	2	4.6		4.3	3.5		2.8		3.0
CHLORIDE (CL)	<0.66	<1	<0.66		2.6	1.2		<1.0		<1.0
FLUORIDE (F)	<0.13	0.03	0.14		<0.13	<0.13		<0.13		<0.13
NUTRIENTS										
NITRATE + NITRITE AS N	0.13	0.102	0.12		6.0	6.9		0.47		0.010
KJELDAHL NITROGEN AS N	<0.010	<0.05	0.16		<0.010	0.050		1.1		<0.010
ORTHO-PHOSPHATE (PO4-P)	<0.010	<0.001	<0.010		<0.010	<0.010		<0.010		<0.010
PHOSPHORUS (P) TOTAL	<0.010	<0.001	<0.010		<0.010	<0.010		<0.010		<0.010
AMMONIA (NH3 AS N)	<0.010	<0.05	0.10		<0.010	<0.010		0.60		<0.010
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.	<0.030	0.009	0.067		0.051	0.069		0.021		0.023
ANTIMONY (SB) TOTAL REC.	<0.008	<0.01	<0.010		<0.010	<0.010		<0.010		<0.010
ARSENIC (AS) TOTAL REC.	<0.001	<0.001	<0.001		0.002	<0.001		<0.001		<0.001
BARIUM (BA) TOTAL REC.	<0.040	<0.1	<0.060		<0.060	<0.060		<0.060		<0.060
BORON (B) TOTAL REC.	<0.010	<0.1	<0.010		<0.010	<0.010		<0.010		<0.010
CADMIUM (CD) TOTAL REC.	0.0002	0.0001	0.0003		0.0003	0.0003		<0.0001		0.0014
CADMIUM (CD) ACID SOL.				0.0002			0.0028		0.0014	
CHROMIUM (CR) TOTAL REC.	<0.020	<0.01	<0.020		<0.020	<0.020		<0.030		<0.030
COBALT (CO) TOTAL REC.	<0.020	<0.01	<0.030		<0.030	<0.030		<0.020		<0.020
COPPER (CU) TOTAL REC.	0.004	0.001	0.001		<0.001	0.002		0.003		<0.001

(D[illegible] Dissolved.
[illegible]ntities in milligrams per liter unless otherwise noted. [illegible]line indicates parameter not tested.

Output Date: 02-24
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK

SITE NAME	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3
SAMPLE DATE	02/21/85	02/21/85	04/11/85	04/24/85	05/01/85	05/01/85	05/09/85	05/14/85	05/23/85	05/31/85
TRACE ELEMENTS										
COPPER (CU) ACID SOL.				<0.001			0.001		<0.001	
IRON (FE) TOTAL REC.	<0.005	0.006	0.045		0.023	0.020		0.010		0.009
LEAD (PB) TOTAL REC.	0.007	<0.001	<0.002		<0.002	<0.002		<0.001		<0.001
LEAD (PB) ACID SOL.				0.003			0.023		0.003	
MANGANESE (MN) TOTAL REC.	<0.008	<0.001	<0.008		<0.008	<0.008		<0.008		<0.008
MERCURY (HG) TOTAL REC.	<0.0005	<0.0002	<0.0005		<0.0005	<0.0005		<0.0005		<0.0005
MOLYBDENUM (MO) TOTAL REC.	<0.020	0.002	<0.020		<0.020	<0.020		<0.020		<0.020
SELENIUM (SE) TOTAL REC.	<0.004	0.008	<0.004		<0.004	<0.004		<0.004		<0.004
SILVER (AG) TOTAL REC.	0.0002	<0.0002	<0.0003		<0.0003	<0.0003		<0.0002		<0.0002
SILVER (AG) ACID SOL.				<0.0002			0.0005		0.0002	
ZINC (ZN) TOTAL REC.	<0.001	0.002	<0.001		<0.001	<0.001		<0.001		<0.001

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3
SAMPLE DATE	06/13/85	06/27/85	08/08/85	10/16/85	10/16/85	03/05/86	04/08/86	08/20/86	10/17/86	10/17/86
LAB	ASARCO	ASARCO	ASARCO	ASARCO	FORD	ASARCO	ASARCO	ASARCO	ASARCO	EL
REMARKS					SPLIT					SPLIT
SAMPLE NUMBER	8506-80	8506-98	8508-114	8510-126	8510-126	8603-157	8604-162	8608-205	8610-219	8610-219
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	10	12.5	12	5		6	5.5	10	5	
SPEC. COND. (UMHOS/CM) LAB	19	23	33	15		16	35	46	11	
PH LAB	7.4	7.4	7.0	7.0		6.9	7.4	7.6	7.7	
TURBIDITY (NTU) LAB	0.37	0.27	0.25	0.32		0.27	0.27	0.27	0.25	
TOTAL SUSP. SOLIDS	2.1	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	
TDS MEAS. @ 180 DEG. C	22	97	46	19		20	22	34	16	
FLOW (CFS)	208	57	3.3	56				0.5	8	
STAGE (FT)	2.10	1.40	0.70	1.45				0.38	0.85	
COMMON IONS										
TOTAL HARDNESS AS CACO3	7.1	10	16	4.6		5.0	13	21	4.7	
CALCIUM (CA)	1.7	2.5	3.9	1.3		1.3	3.2	4.7	1.4	
MAGNESIUM (MG)	0.70	1.0	1.6	0.33		0.44	1.3	2.3	0.30	
SODIUM (NA)	0.50	0.50	0.90	0.50		0.50	0.60	0.80	0.92	
POTASSIUM (K)	0.20	0.20	0.30	0.20		0.20	0.20	0.20	0.20	
ALKALINITY AS CACO3 (LAB)	8.5	13	17	6.5		6.0	16	14	2.4	
BICARBONATE (HCO3) (LAB)	10	16	21	7.9		7.3	20	17	2.9	
CARBONATE AS CO3 (LAB)	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	
SULFATE (SO4)	<2.0	2.9	2.2	<3.0		<2.0	<1.0	<2.0	<3.0	
CHLORIDE (CL)	<2.0	<2.0	<2.0	<1.0		<1.0	<1.0	<1.0	<1.0	
FLUORIDE (F)	<0.13	<0.13	<0.13	<0.13		<0.13	<0.013	<0.13	<0.13	
NUTRIENTS										
NITRATE + NITRITE AS N	1.3	<0.010	0.12	<0.010	0.37	12	0.090	0.10	<0.020	0.011
KJELDAHL NITROGEN AS N	0.10	<0.010	0.12	0.050		<0.10	0.65	0.080	0.080	0.07
ORTHO-PHOSPHATE (PO4-P)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.020	
PHOSPHORUS (P) TOTAL	<0.010	<0.010	<0.010	<0.10		<0.020	<0.040	<0.040	<0.020	
AMMONIA (NH3 AS N)	0.050	<0.010	0.050	<0.040		0.13	0.47	<0.040	<0.020	0.1
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.	0.028	0.010	<0.005	0.017		0.011	0.009	0.024	0.012	
ANTIMONY (SB) TOTAL REC.	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
ARSENIC (AS) TOTAL REC.	<0.001	<0.001	0.003	0.003		<0.001	<0.001	<0.001	0.002	
BARIUM (BA) TOTAL REC.	<0.060	<0.060	<0.060	<0.020		<0.020	<0.020	<0.040	<0.060	
BORON (B) TOTAL REC.	<0.020	<0.020	0.020	<0.010		<0.010	<0.010	<0.010	<0.020	
CADMIUM (CD) TOTAL REC.	0.00053	0.0011	0.00026	0.0008		0.0010	0.0014	0.0005	<0.0001	
CHROMIUM (CR) TOTAL REC.	<0.033	<0.030	<0.030	<0.033		<0.020	<0.020	<0.030	<0.030	
COBALT (CO) TOTAL REC.	<0.020	<0.020	<0.020	<0.020		<0.020	<0.020	<0.020	<0.020	
COPPER (CU) TOTAL REC.	<0.002	<0.002	<0.002	<0.001		<0.001	0.002	<0.001	<0.001	
IRON (FE) TOTAL REC.	0.026	0.005	<0.005	0.015		0.010	0.009	<0.005	<0.005	

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. A blank line indicates parameter not tested.

Output Date: 02-24
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO [illegible]EEK

SITE NAME	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3	RC-3
SAMPLE DATE	06/13/85	06/27/85	08/08/85	10/16/85	10/16/85	03/05/86	04/08/86	08/20/86	10/17/86	10/17/86
TRACE ELEMENTS										
LEAD (PB) TOTAL REC.	<0.002	<0.002	<0.002	0.003		<0.002	<0.002	<0.001	<0.001	
MANGANESE (MN) TOTAL REC.	<0.008	<0.008	<0.008	<0.008		<0.008	<0.008	<0.008	<0.008	
MERCURY (HG) TOTAL REC.	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	<0.00005	<0.0005	<0.0005	
MOLYBDENUM (MO) TOTAL REC.	<0.020	<0.020	<0.020	<0.020		<0.020	<0.020	<0.020	<0.020	
SELENIUM (SE) TOTAL REC.	<0.004	<0.004	<0.004	<0.005		<0.004	<0.004	<0.004	0.006	
SILVER (AG) TOTAL REC.	<0.0002	<0.0002	<0.0002	<0.0002		<0.0002	<0.0002	<0.0002	0.0002	
ZINC (ZN) TOTAL REC.	<0.001	<0.001	<0.001	<0.001		0.002	<0.001	<0.002	<0.002	
OTHER PARAMETERS										
OIL AND GREASE		<1.0								

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO CREEK

SITE NAME	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1
SAMPLE DATE	02/21/85	04/11/85	04/24/85	05/01/85	05/09/85	05/14/85	05/23/85	05/31/85	06/13/85	06/27/85
LAB	ASARCO	ASARCO	WQB/EL	ASARCO	WQB/EL	ASARCO	WQB/EL	ASARCO	ASARCO	ASARCO
SAMPLE NUMBER	8502-7	8504-19		8505-31		8505-48		8505-71	8506-81	8506-99
PHYSICAL PARAMETERS										
WATER TEMPERATURE (FIELD) (C)	1	4	3.0	7	6.0	6	7.0	8	-	12.5
SPEC. COND. (UMHOS/CM) LAB	15	10		5.0		10		6.0	10	10
PH LAB	7.0	6.9		6.9		7.0		6.9	6.9	6.8
TURBIDITY (NTU) LAB	0.22	0.30		0.35		0.25		0.25	0.28	0.26
TOTAL SUSP. SOLIDS	<1.0	2.0		1.6		<1.0		<1.0	<1.0	<1.0
TDS MEAS. @ 180 DEG. C	22	5.0		18		18		12	22	19
FLOW (CFS)	3	155	18	275	65	112	120	174	-	42
STAGE (FT)	-	-	-	-	-	-	-	-	-	-
COMMON IONS										
TOTAL HARDNESS AS CACO3	6.3	4.4	1	3.6	2	3.9	1	2.9	2.6	3.3
CALCIUM (CA)	1.9	1.2		1.1		1.2		0.80	0.70	1.0
MAGNESIUM (MG)	0.39	0.33		0.22		0.22		0.22	0.20	0.20
SODIUM (NA)	0.80	0.50		0.40		0.50		0.30	0.30	0.40
POTASSIUM (K)	0.20	0.20		0.10		0.10		0.10	0.20	0.20
ALKALINITY AS CACO3 (LAB)	6.2	4.0		<1.0		3.6		2.8	3.5	4.3
BICARBONATE (HCO3) (LAB)	9	4.9		<1.2		4.4		3.4	4.3	5.2
CARBONATE AS CO3 (LAB)	<1.0	<1.0		<1.0		<1.0		<1.0	<1.0	<1.0
SULFATE (SO4)	<2.0	4.0		3.7		3.3		2.2	<2.0	4.4
CHLORIDE (CL)	<0.66	<0.66		1.0		<1.0		<1.0	<2.0	<2.0
FLUORIDE (F)	<0.13	<0.13		<0.13		<0.13		<0.13	<0.13	<0.13
NUTRIENTS										
NITRATE + NITRITE AS N	3.1	7.0		10		0.59		0.040	<0.010	<0.010
KJELDAHL NITROGEN AS N	0.25	0.88		0.10		<0.010		0.020	0.35	<0.010
ORTHO-PHOSPHATE (PO4-P)	<0.010	<0.010		<0.010		<0.010		<0.010	<0.010	<0.010
PHOSPHORUS (P) TOTAL	<0.010	<0.010		<0.010		<0.010		<0.010	<0.010	<0.010
AMMONIA (NH3 AS N)	0.10	0.50		0.050		<0.010		<0.010	0.20	<0.010
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL REC.	<0.030	0.045		0.040		0.017		0.021	0.021	0.012
ANTIMONY (SB) TOTAL REC.	<0.008	<0.010		<0.010		<0.010		<0.010	<0.010	<0.010
ARSENIC (AS) TOTAL REC.	<0.001	<0.001		<0.001		<0.001		<0.001	<0.001	<0.001
BARIUM (BA) TOTAL REC.	<0.040	<0.060		<0.060		<0.060		<0.060	<0.060	<0.060
BORON (B) TOTAL REC.		<0.010		<0.010		<0.010		<0.010	0.030	<0.020
CADMIUM (CD) TOTAL REC.	0.0002	0.0003		0.0004		0.0003		0.0004	0.00030	0.00046
CADMIUM (CD) ACID SOL.			0.0001		0.001		0.0005			
CHROMIUM (CR) TOTAL REC.	<0.020	<0.020		<0.020		<0.030		<0.030	<0.033	<0.030
COBALT (CO) TOTAL REC.	<0.020	<0.030		<0.030		<0.020		<0.020	<0.020	<0.020
COPPER (CU) TOTAL REC.	<0.001	<0.001		<0.001		0.001		<0.001	<0.002	<0.002
COPPER (CU) ACID SOL.			0.001		<0.001		<0.001			

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1
SAMPLE DATE	02/21/85	04/11/85	04/24/85	05/01/85	05/09/85	05/14/85	05/23/85	05/31/85	06/13/85	06/27/85
TRACE ELEMENTS										
IRON (FE) TOTAL REC.	<0.005	0.020		0.012		<0.005		0.008	0.017	0.006
LEAD (PB) TOTAL REC.	0.002	<0.002		<0.002		0.005		0.002	<0.002	<0.002
LEAD (PB) ACID SOL.			0.002		0.008		0.001			
MANGANESE (MN) TOTAL REC.	0.010	<0.008		<0.008		<0.008		<0.008	<0.008	<0.008
MERCURY (HG) TOTAL REC.	<0.0005	<0.0005		<0.0005		<0.0005		<0.0005	<0.0005	<0.0005
MOLYBDENUM (MO) TOTAL REC.	<0.020	<0.020		<0.020		<0.020		<0.020	<0.020	<0.020
SELENIUM (SE) TOTAL REC.	<0.004	<0.004		<0.004		<0.004		<0.004	<0.004	<0.004
SILVER (AG) TOTAL REC.	0.0002	<0.0003		<0.0003		<0.0002		<0.0002	<0.0002	<0.0002
SILVER (AG) ACID SOL.			<0.0002		0.0006		0.0002			
ZINC (ZN) TOTAL REC.	0.004	<0.001		<0.001		<0.001		<0.001	<0.001	<0.001
OTHER PARAMETERS										
OIL AND GREASE										<1.0

) = Dissolved.
! quantities in milligrams per liter unless otherwise note ank line indicates parameter not tested.

Output Date: (1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO [illegible]REEK

SITE NAME	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1
SAMPLE DATE	08/08/85	10/16/85	03/05/86	04/08/86	08/20/86	10/17/86
LAB	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO	ASARCO
SAMPLE NUMBER	8508-116	8510-136	8603-156	8604-170	8608-195	8610-218
PHYSICAL PARAMETERS						
WATER TEMPERATURE (FIELD) (C)	11	5	5	5.5	11.5	5
SPEC. COND. (UMHOS/CM) LAB	12	15	14	12	18	12
PH LAB	7.0	6.8	6.7	6.7	7.5	7.8
TURBIDITY (NTU) LAB	0.25	0.42	0.27	0.29	0.25	0.36
TOTAL SUSP. SOLIDS	<1.0	<1.0	<1.0	<1.0	<1.0	1.3
TDS MEAS. @ 180 DEG. C	27	16	19	21	7.2	21
FLOW (CFS)	2.8	52			0.7	10
STAGE (FT)	-	-			-	-
COMMON IONS						
TOTAL HARDNESS AS CACO3	5.4	4.9	3.6	2.7	5.8	4.4
CALCIUM (CA)	1.5	1.4	1.1	0.89	1.6	1.3
MAGNESIUM (MG)	0.40	0.33	0.22	0.11	0.44	0.30
SODIUM (NA)	0.80	0.50	0.50	0.50	0.70	0.51
POTASSIUM (K)	0.30	0.20	0.10	0.20	0.20	0.28
ALKALINITY AS CACO3 (LAB)	<1.0	4.5	3.4	3.5	6.0	4.6
BICARBONATE (HCO3) (LAB)	<1.2	5.5	4.1	4.3	7.3	5.6
CARBONATE AS CO3 (LAB)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SULFATE (SO4)	2.3	<3.0	<2.0	<1.0	<2.0	<3.0
CHLORIDE (CL)	<2.0	<1.0	<1.0	<1.0	<1.0	<1.0
FLUORIDE (F)	<0.13	0.17	<0.13	<0.013	<0.13	<0.13
NUTRIENTS						
NITRATE + NITRITE AS N	0.26	1.3	7.2	0.040	0.13	<0.020
KJELDAHL NITROGEN AS N	0.11	<0.010	<0.10	0.41	0.11	0.040
ORTHO-PHOSPHATE (PO4-P)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020
PHOSPHORUS (P) TOTAL	<0.010	<0.10	<0.020	<0.040	0.060	<0.020
AMMONIA (NH3 AS N)	0.050	0.060	0.13	0.35	<0.040	<0.020
TRACE ELEMENTS						
ALUMINUM (AL) TOTAL REC.	0.005	0.029	0.010	0.011	0.007	0.010
ANTIMONY (SB) TOTAL REC.	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ARSENIC (AS) TOTAL REC.	<0.001	0.002	<0.001	<0.001	<0.001	0.001
BARIUM (BA) TOTAL REC.	<0.060	<0.020	<0.020	<0.020	<0.040	<0.060
BORON (B) TOTAL REC.	0.030	<0.010	<0.010	0.015	<0.010	<0.020
CADMIUM (CD) TOTAL REC.	0.00040	<0.0001	0.0009	0.0001	0.0016	<0.0001
CHROMIUM (CR) TOTAL REC.	<0.030	<0.033	<0.020	<0.020	<0.030	<0.030
COBALT (CO) TOTAL REC.	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
COPPER (CU) TOTAL REC.	<0.002	<0.001	<0.001	0.001	<0.001	<0.001
IRON (FE) TOTAL REC.	<0.005	0.021	0.013	0.009	0.004	<0.005
LEAD (PB) TOTAL REC.	<0.002	<0.001	0.003	0.002	<0.001	<0.001

(D) = Dissolved.
All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-24-1987
HWQ-6/86-R1

SUMMARY OF SURFACE WATER QUALITY ANALYSIS - ASARCO ROCK CREEK

SITE NAME	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1	ERC-1
SAMPLE DATE	08/08/85	10/16/85	03/05/86	04/08/86	08/20/86	10/17/86
TRACE ELEMENTS						
MANGANESE (MN) TOTAL REC.	<0.008	0.018	<0.008	<0.008	<0.008	<0.008
MERCURY (HG) TOTAL REC.	<0.0005	<0.0005	<0.0005	<0.00005	<0.0005	<0.0005
MOLYBDENUM (MO) TOTAL REC.	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
SELENIUM (SE) TOTAL REC.	<0.004	<0.005	<0.004	<0.004	<0.004	<0.004
SILVER (AG) TOTAL REC.	<0.0002	0.0003	0.0004	<0.0002	<0.0002	0.0012
ZINC (ZN) TOTAL REC.	<0.001	0.002	0.003	<0.001	<0.002	<0.002

(D) = Dissolved.
l quantities in milligrams per liter unless otherwise note lank line indicates parameter not tested.

Output Date: 0 1987
HWQ-6/86-R1

Chen-Northern, Inc.

APPENDIX E

APPENDIX E

CONTINUOUS DISCHARGE DATA
FOR
LB-3000

APPENDIX E

CONTINUOUS DISCHARGE DATA
FOR
LB-3000

OUTPUT FOR STATION #1b30 STARTING ON 17 / 10 / 88

STARTING TIME 15.5
STARTING STAGE OR ELEVATION-8.37
STARTING RECORDER READING 174

DAY	MONTH	HOUR	SWL	STAGE	FLOW	
17	10	15.5	-8.38	1.41	400.96	
17	10	17.5	-8.43	1.38	338.75	
17	10	20.0	-8.47	1.35	298.51	
17	10	22.5	-8.52	1.31	252.19	
18	10	2.0	-8.54	1.29	231.80	
18	10	5.5	-8.59	1.24	195.84	
18	10	9.5	-8.62	1.22	180.00	
18	10	12.5	-8.65	1.18	158.62	
18	10	15.5	-8.67	1.17	152.07	
19	10	15.5	-8.67	1.17	152.07	
20	10	15.5	-8.67	1.17	152.07	
21	10	15.5	-8.67	1.17	152.07	
22	10	15.5	-8.67	1.17	152.07	
23	10	9.0	-8.67	1.17	152.07	
23	10	10.0	-8.73	1.10	123.17	
23	10	15.5	-8.71	1.11	128.48	
24	10	15.5	-8.73	1.10	123.17	
25	10	15.5	-8.71	1.11	128.48	
26	10	15.5	-8.73	1.10	123.17	
27	10	15.5	-8.73	1.10	123.17	
28	10	15.5	-8.73	1.10	123.17	
29	10	15.5	-8.73	1.10	123.17	
30	10	15.5	-8.73	1.10	123.17	
31	10	15.5	-8.71	1.11	128.48	
1	11	15.5	-8.71	1.11	128.48	
2	11	15.5	-8.71	1.11	128.48	
3	11	15.5	-8.71	1.11	128.48	
4	11	15.5	-8.73	1.10	123.17	
5	11	15.5	-8.73	1.10	123.17	
6	11	15.5	-8.71	1.11	128.48	
7	11	15.5	-8.73	1.10	123.17	
8	11	15.5	-8.73	1.10	123.17	
9	11	15.5	-8.73	1.10	123.17	
10	11	15.5	-8.73	1.10	123.17	
11	11	15.5	-8.73	1.10	123.17	
12	11	15.5	-8.73	1.10	123.17	
13	11	15.5	-8.73	1.10	123.17	
14	11	15.5	-8.73	1.10	123.17	
15	11	15.5	-8.73	1.10	123.17	Probable equipment malfunction
16	11	15.5	-8.73	1.10	123.17	
17	11	15.5	-8.73	1.10	123.17	
18	11	15.5	-8.73	1.10	123.17	
19	11	15.5	-8.73	1.10	123.17	
20	11	15.5	-8.73	1.10	123.17	
21	11	15.5	-8.73	1.10	123.17	
22	11	15.5	-8.73	1.10	123.17	
23	11	15.5	-8.73	1.10	123.17	
24	11	15.5	-8.73	1.10	123.17	
25	11	15.5	-8.73	1.10	123.17	
26	11	15.5	-8.73	1.10	123.17	
27	11	15.5	-8.73	1.10	123.17	
28	11	15.5	-8.73	1.10	123.17	
29	11	15.5	-8.73	1.10	123.17	

OUTPUT FOR STATION #1b30 STARTING ON 29 / 11 / 88

STARTING TIME 16.5
STARTING STAGE OR ELEVATION-8.97
STARTING RECORDER READING 145

DAY	MONTH	HOUR	SWL	STAGE	FLOW
29	11	16.5	-8.96	0.80	55.81
30	11	16.5	-8.96	0.80	55.81
1	12	14.0	-8.93	0.84	60.72
1	12	16.5	-8.93	0.84	60.72
2	12	16.5	-8.95	0.82	58.21
3	12	16.5	-8.96	0.80	55.81
4	12	16.5	-8.97	0.79	53.51
5	12	16.5	-8.96	0.80	55.81
6	12	16.5	-8.97	0.79	53.51
7	12	16.5	-8.97	0.79	53.51
7	12	21.0	-8.95	0.82	58.21
8	12	16.5	-8.93	0.84	60.72
9	12	16.5	-8.93	0.84	60.72
10	12	16.5	-8.95	0.82	58.21
11	12	16.5	-8.93	0.84	60.72
12	12	16.5	-8.93	0.84	60.72
13	12	16.5	-8.95	0.82	58.21
14	12	16.5	-8.96	0.80	55.81

OUTPUT FOR STATION #1b30 STARTING ON 12 / 12 / 88

STARTING TIME 16.5
STARTING STAGE OR ELEVATION-8.979999
STARTING RECORDER READING 145

DAY	MONTH	HOUR	SWL	STAGE	FLOW
12	12	16.5	-8.97	0.79	53.93
13	12	16.5	-8.97	0.79	53.93
14	12	16.5	-8.97	0.79	53.93
15	12	16.5	-8.98	0.77	51.70
16	12	16.5	-8.97	0.79	53.93
17	12	16.5	-8.97	0.79	53.93
18	12	16.5	-8.97	0.79	53.93
19	12	16.5	-8.98	0.77	51.70
20	12	16.5	-8.98	0.77	51.70
21	12	16.5	-8.98	0.77	51.70
22	12	16.5	-8.97	0.79	53.93
23	12	16.5	-8.97	0.79	53.93
24	12	16.5	-8.97	0.79	53.93
25	12	16.5	-8.97	0.79	53.93
26	12	16.5	-8.98	0.77	51.70
27	12	16.5	-8.98	0.77	51.70
28	12	16.5	-8.98	0.77	51.70
29	12	16.5	-8.98	0.77	51.70
30	12	16.5	-8.98	0.77	51.70
31	12	16.5	-8.98	0.77	51.70
1	1	16.5	-8.98	0.77	51.70
2	1	16.5	-8.98	0.77	51.70
3	1	16.5	-8.98	0.77	51.70
4	1	16.5	-8.97	0.79	53.93
5	1	16.5	-8.97	0.79	53.93
6	1	16.5	-8.98	0.77	51.70
7	1	16.5	-8.97	0.79	53.93
8	1	16.5	-8.98	0.77	51.70
9	1	16.5	-8.97	0.79	53.93
10	1	16.5	-8.97	0.79	53.93
11	1	16.5	-8.97	0.79	53.93
12	1	16.5	-8.97	0.79	53.93
13	1	16.5	-8.98	0.77	51.70
14	1	16.5	-8.98	0.77	51.70
15	1	16.5	-8.98	0.77	51.70
16	1	16.5	-8.98	0.77	51.70
17	1	16.5	-8.97	0.79	53.93
18	1	16.5	-8.98	0.77	51.70
19	1	16.5	-8.98	0.77	51.70
20	1	16.5	-8.98	0.77	51.70
21	1	16.5	-8.97	0.79	53.93

OUTPUT FOR STATION #1b30 STARTING ON 24 / 1 / 89

STARTING TIME 17
STARTING STAGE OR ELEVATION-8.310001
STARTING RECORDER READING 146

DAY	MONTH	HOUR	SWL	STAGE	FLOW	
24	1	17.0	-8.32	1.45	492.49	
25	1	17.0	-8.31	1.46	513.69	
26	1	17.0	-8.31	1.46	513.69	
27	1	17.0	-8.31	1.46	513.69	
28	1	17.0	-8.31	1.46	513.69	
29	1	17.0	-8.31	1.46	513.69	
30	1	17.0	-8.31	1.46	513.69	
31	1	17.0	-8.31	1.46	513.69	
1	2	17.0	-8.31	1.46	513.69	
2	2	17.0	-8.31	1.46	513.69	
3	2	17.0	-8.31	1.46	513.69	
4	2	17.0	-8.31	1.46	513.69	Frozen stilling well
5	2	17.0	-8.31	1.46	513.69	
6	2	17.0	-8.31	1.46	513.69	
7	2	17.0	-8.31	1.46	513.69	
8	2	17.0	-8.31	1.46	513.69	
9	2	17.0	-8.31	1.46	513.69	
10	2	17.0	-8.31	1.46	513.69	
11	2	17.0	-8.31	1.46	513.69	
12	2	17.0	-8.31	1.46	513.69	
13	2	17.0	-8.31	1.46	513.69	
14	2	17.0	-8.31	1.46	513.69	
15	2	17.0	-8.31	1.46	513.69	
16	2	17.0	-8.31	1.46	513.69	
17	2	17.0	-8.31	1.46	513.69	
18	2	17.0	-8.31	1.46	513.69	
19	2	17.0	-8.31	1.46	513.69	
20	2	17.0	-8.32	1.45	492.49	
21	2	17.0	-8.31	1.46	513.69	
22	2	17.0	-8.32	1.45	492.49	
22	2	22.0	-8.32	1.45	492.49	
22	2	22.5	-9.29	0.25	17.63	
23	2	4.0	-9.27	0.29	19.18	
23	2	6.5	-9.21	0.40	23.68	

OUTPUT FOR STATION #1b30 STARTING ON 24 / 1 / 89

STARTING TIME 17
STARTING STAGE OR ELEVATION-8.310001
STARTING RECORDER READING 146

DAY	MONTH	HOUR	SWL	STAGE	FLOW	
24	1	17.0	-8.32	1.45	492.49	
25	1	17.0	-8.31	1.46	513.69	
26	1	17.0	-8.31	1.46	513.69	
27	1	17.0	-8.31	1.46	513.69	
28	1	17.0	-8.31	1.46	513.69	
29	1	17.0	-8.31	1.46	513.69	
30	1	17.0	-8.31	1.46	513.69	
31	1	17.0	-8.31	1.46	513.69	
1	2	17.0	-8.31	1.46	513.69	
2	2	17.0	-8.31	1.46	513.69	
3	2	17.0	-8.31	1.46	513.69	
4	2	17.0	-8.31	1.46	513.69	Frozen stilling well
5	2	17.0	-8.31	1.46	513.69	
6	2	17.0	-8.31	1.46	513.69	
7	2	17.0	-8.31	1.46	513.69	
8	2	17.0	-8.31	1.46	513.69	
9	2	17.0	-8.31	1.46	513.69	
10	2	17.0	-8.31	1.46	513.69	
11	2	17.0	-8.31	1.46	513.69	
12	2	17.0	-8.31	1.46	513.69	
13	2	17.0	-8.31	1.46	513.69	
14	2	17.0	-8.31	1.46	513.69	
15	2	17.0	-8.31	1.46	513.69	
16	2	17.0	-8.31	1.46	513.69	
17	2	17.0	-8.31	1.46	513.69	
18	2	17.0	-8.31	1.46	513.69	
19	2	17.0	-8.31	1.46	513.69	
20	2	17.0	-8.32	1.45	492.49	
21	2	17.0	-8.31	1.46	513.69	
22	2	17.0	-8.32	1.45	492.49	
22	2	22.0	-8.32	1.45	492.49	
22	2	22.5	-9.29	0.25	17.63	
23	2	4.0	-9.27	0.29	19.18	
23	2	6.5	-9.21	0.40	23.68	

OUTPUT FOR STATION #LB30 STARTING ON 23 / 2 / 89

STARTING TIME 11.5
STARTING STAGE OR ELEVATION-8.28
STARTING RECORDER READING 73

DAY	MONTH	HOUR	SWL	STAGE	FLOW	
23	2	11.5	-8.32	1.46	501.69	
23	2	15.5	-8.32	1.46	501.69	
23	2	16.0	-8.24	1.50	646.06	
23	2	22.0	-8.22	1.51	702.89	
24	2	11.5	-8.21	1.52	733.15	
25	2	11.5	-8.19	1.52	764.72	
26	2	11.5	-8.19	1.52	764.72	
27	2	11.5	-8.19	1.52	764.72	
28	2	11.5	-8.19	1.52	764.72	
1	3	11.5	-8.19	1.52	764.72	
2	3	11.5	-8.19	1.52	764.72	
3	3	11.5	-8.19	1.52	764.72	
4	3	11.5	-8.19	1.52	764.72	
5	3	11.5	-8.19	1.52	764.72	
6	3	11.5	-8.19	1.52	764.72	
7	3	11.5	-8.19	1.52	764.72	
8	3	11.5	-8.19	1.52	764.72	
9	3	11.5	-8.19	1.52	764.72	
10	3	11.5	-8.19	1.52	764.72	
11	3	11.5	-8.19	1.52	764.72	
12	3	11.5	-8.19	1.52	764.72	Frozen stilling well and DSM
13	3	11.5	-8.19	1.52	764.72	
14	3	11.5	-8.19	1.52	764.72	
15	3	11.5	-8.19	1.52	764.72	
16	3	11.5	-8.19	1.52	764.72	
17	3	11.5	-8.19	1.52	764.72	
18	3	11.5	-8.19	1.52	764.72	
19	3	11.5	-8.19	1.52	764.72	
20	3	11.5	-8.19	1.52	764.72	
21	3	11.5	-8.19	1.52	764.72	
22	3	11.5	-8.19	1.52	764.72	
23	3	11.5	-8.19	1.52	764.72	
24	3	11.5	-8.19	1.52	764.72	
25	3	11.5	-8.19	1.52	764.72	
26	3	11.5	-8.19	1.52	764.72	
27	3	11.5	-8.19	1.52	764.72	
28	3	11.5	-8.19	1.52	764.72	
29	3	11.5	-8.19	1.52	764.72	

OUTPUT FOR STATION #LB30 STARTING ON 30 / 3 / 89

STARTING TIME 16.5
STARTING STAGE OR ELEVATION-8.75
STARTING RECORDER READING 146

DAY	MONTH	HOUR	SWL	STAGE	FLOW
30	3	16.5	-8.75	1.07	113.72
31	3	16.5	-8.75	1.07	113.72
1	4	16.5	-8.77	1.04	104.53
2	4	16.5	-8.79	1.03	100.21
3	4	16.5	-8.79	1.03	100.21
4	4	16.5	-8.80	1.01	96.08
5	4	8.5	-8.77	1.04	104.53
5	4	10.5	-8.71	1.12	129.05
5	4	13.0	-8.60	1.23	188.59
5	4	14.5	-8.52	1.31	253.32
5	4	16.0	-8.42	1.39	354.91
5	4	16.5	-8.39	1.41	386.13
5	4	18.0	-8.28	1.48	564.27
5	4	19.0	-8.23	1.50	667.90
6	4	16.0	-8.25	1.50	640.33
6	4	16.5	-8.21	1.51	726.65
6	4	18.5	-8.14	1.54	935.76
7	4	1.5	-8.16	1.54	860.10
7	4	5.0	-8.17	1.53	824.60
7	4	13.0	-8.20	1.52	757.93
7	4	14.0	-8.23	1.50	667.90
7	4	15.0	-8.22	1.51	696.66
7	4	16.5	-8.21	1.51	726.65
7	4	20.5	-8.23	1.50	667.90
7	4	22.0	-8.27	1.48	588.56
7	4	23.0	-8.32	1.45	497.24
8	4	6.0	-8.31	1.46	518.65
8	4	7.5	-8.23	1.50	667.90
8	4	10.5	-8.26	1.49	613.90
8	4	16.5	-8.27	1.48	588.56
9	4	16.5	-8.27	1.48	588.56
10	4	16.5	-8.27	1.48	588.56

OUTPUT FOR STATION #LB30 STARTING ON 11 / 4 / 39

STARTING TIME 10.7
STARTING STAGE OR ELEVATION-8.35
STARTING RECORDER READING 184

DAY	MONTH	HOUR	SWL	STAGE	FLOW
11	4	10.7	-8.35	1.44	447.89
12	4	10.7	-8.36	1.43	429.41
13	4	10.7	-8.36	1.43	429.41
14	4	10.7	-8.36	1.43	429.41
15	4	10.7	-8.34	1.44	467.17
15	4	16.7	-8.31	1.46	508.27
15	4	18.2	-8.25	1.49	627.51
15	4	19.2	-8.23	1.51	682.71
15	4	20.2	-8.29	1.47	552.97
15	4	22.2	-8.33	1.45	487.29
16	4	10.7	-8.33	1.45	487.29
17	4	10.7	-8.33	1.45	487.29
17	4	14.7	-8.30	1.47	530.15
17	4	18.7	-8.24	1.50	654.53
18	4	10.7	-8.25	1.49	627.52
18	4	15.7	-8.28	1.48	576.78
19	4	3.2	-8.25	1.49	627.52
19	4	10.7	-8.25	1.49	627.52
20	4	10.7	-8.25	1.49	627.52
20	4	18.7	-8.26	1.49	601.62
21	4	10.7	-8.28	1.48	576.78
22	4	10.7	-8.25	1.49	627.52
23	4	10.7	-8.26	1.49	601.62
24	4	10.7	-8.26	1.49	601.62
25	4	10.7	-8.25	1.49	627.52
26	4	9.7	-8.26	1.49	601.62
26	4	10.7	-8.30	1.47	530.15
27	4	10.7	-8.30	1.47	530.15
28	4	10.7	-8.30	1.47	530.15
29	4	10.7	-8.30	1.47	530.15
30	4	10.7	-8.30	1.47	530.15
30	4	15.7	-8.33	1.45	487.29
1	5	1.7	-8.35	1.44	447.89
1	5	10.7	-8.35	1.44	447.89
2	5	10.7	-8.34	1.44	467.17
2	5	18.7	-8.31	1.46	508.27
3	5	10.7	-8.34	1.44	467.17
4	5	10.7	-8.34	1.44	467.17
5	5	10.7	-8.31	1.46	508.27
6	5	1.7	-8.34	1.44	467.18
6	5	10.7	-8.31	1.46	508.27
6	5	14.2	-8.28	1.48	576.78
6	5	18.2	-8.28	1.48	576.78
6	5	19.2	-8.33	1.45	487.29
7	5	0.2	-8.35	1.44	447.89
7	5	5.7	-8.39	1.41	394.69
7	5	10.7	-8.39	1.41	394.69
8	5	9.7	-8.41	1.39	362.78
8	5	10.7	-8.41	1.39	362.78
8	5	11.7	-8.37	1.42	411.68
9	5	10.7	-8.39	1.41	394.69
9	5	16.2	-8.36	1.43	429.41

STARTING TIME 20.1
STARTING STAGE OR ELEVATION-8.42
STARTING RECORDER READING 152

DAY	MONTH	HOUR	SWL	STAGE	FLOW
24	5	20.1	-8.41	1.40	365.26
25	5	3.6	-8.39	1.41	392.49
25	5	18.1	-8.37	1.42	421.75
25	5	20.1	-8.32	1.46	504.80
25	5	22.1	-8.28	1.48	562.28
26	5	9.1	-8.29	1.47	542.43
26	5	9.6	-8.35	1.44	453.19
26	5	10.1	-8.33	1.45	486.97
26	5	11.1	-8.38	1.42	406.36
26	5	20.1	-8.39	1.41	392.49
27	5	5.1	-8.41	1.40	365.26
27	5	11.1	-8.44	1.37	327.92
27	5	20.1	-8.46	1.36	305.17
27	5	22.1	-8.44	1.37	327.92
28	5	20.1	-8.46	1.36	305.17
29	5	9.1	-8.48	1.34	284.00
29	5	13.6	-8.51	1.31	254.96
29	5	19.1	-8.55	1.28	228.90
29	5	20.1	-8.56	1.28	220.81
30	5	7.6	-8.58	1.26	205.50
30	5	12.1	-8.60	1.24	191.24
30	5	20.1	-8.63	1.20	171.69
31	5	20.1	-8.64	1.19	165.62
31	5	23.6	-8.62	1.22	177.97
1	6	16.6	-8.64	1.19	165.62
1	6	20.1	-8.65	1.18	159.78
2	6	17.1	-8.63	1.20	171.69
2	6	20.1	-8.58	1.26	205.50
2	6	22.6	-8.50	1.32	264.30
3	6	11.1	-8.52	1.30	245.96
3	6	13.6	-8.56	1.28	220.81
3	6	16.6	-8.55	1.28	228.90
3	6	19.1	-8.45	1.36	316.34
3	6	20.1	-8.42	1.39	352.36
3	6	22.1	-8.38	1.42	406.86
4	6	7.6	-8.40	1.40	378.63
4	6	11.1	-8.44	1.37	327.92
4	6	15.1	-8.48	1.34	284.00
4	6	19.1	-8.46	1.36	305.17
4	6	20.1	-8.43	1.38	339.92
4	6	21.1	-8.40	1.40	378.63
5	6	9.1	-8.42	1.39	352.36
5	6	12.1	-8.46	1.36	305.17
5	6	16.6	-8.49	1.33	273.97
5	6	20.1	-8.49	1.33	273.97
5	6	22.6	-8.45	1.36	316.34
6	6	11.6	-8.47	1.35	294.39
6	6	20.1	-8.46	1.36	305.17
7	6	7.6	-8.48	1.34	284.00
7	6	9.6	-8.51	1.31	254.96

STARTING TIME 15.5
STARTING STAGE OR ELEVATION-8.37
STARTING RECORDER READING 174

DAY	MONTH	HOUR	SWL	STAGE	FLOW	
17	10	15.5	-8.38	1.41	400.96	
17	10	17.5	-8.43	1.38	338.75	
17	10	20.0	-8.47	1.35	298.51	
17	10	22.5	-8.52	1.31	252.19	
18	10	2.0	-8.54	1.29	231.80	
18	10	5.5	-8.59	1.24	195.84	
18	10	9.5	-8.62	1.22	180.00	
18	10	12.5	-8.65	1.18	158.62	
18	10	15.5	-8.67	1.17	152.07	
19	10	15.5	-8.67	1.17	152.07	
20	10	15.5	-8.67	1.17	152.07	
21	10	15.5	-8.67	1.17	152.07	
22	10	15.5	-8.67	1.17	152.07	
23	10	9.0	-8.67	1.17	152.07	
23	10	10.0	-8.73	1.10	123.17	
23	10	15.5	-8.71	1.11	128.48	
24	10	15.5	-8.73	1.10	123.17	
25	10	15.5	-8.71	1.11	128.48	
26	10	15.5	-8.73	1.10	123.17	
27	10	15.5	-8.73	1.10	123.17	
28	10	15.5	-8.73	1.10	123.17	
29	10	15.5	-8.73	1.10	123.17	
30	10	15.5	-8.73	1.10	123.17	
31	10	15.5	-8.71	1.11	128.48	
1	11	15.5	-8.71	1.11	128.48	
2	11	15.5	-8.71	1.11	128.48	
3	11	15.5	-8.71	1.11	128.48	
4	11	15.5	-8.73	1.10	123.17	
5	11	15.5	-8.73	1.10	123.17	
6	11	15.5	-8.71	1.11	128.48	
7	11	15.5	-8.73	1.10	123.17	Probable Equipment Malfunction
8	11	15.5	-8.73	1.10	123.17	
9	11	15.5	-8.73	1.10	123.17	
10	11	15.5	-8.73	1.10	123.17	
11	11	15.5	-8.73	1.10	123.17	
12	11	15.5	-8.73	1.10	123.17	
13	11	15.5	-8.73	1.10	123.17	
14	11	15.5	-8.73	1.10	123.17	
15	11	15.5	-8.73	1.10	123.17	
16	11	15.5	-8.73	1.10	123.17	
17	11	15.5	-8.73	1.10	123.17	
18	11	15.5	-8.73	1.10	123.17	
19	11	15.5	-8.73	1.10	123.17	
20	11	15.5	-8.73	1.10	123.17	
21	11	15.5	-8.73	1.10	123.17	
22	11	15.5	-8.73	1.10	123.17	
23	11	15.5	-8.73	1.10	123.17	
24	11	15.5	-8.73	1.10	123.17	
25	11	15.5	-8.73	1.10	123.17	
26	11	15.5	-8.73	1.10	123.17	
27	11	15.5	-8.73	1.10	123.17	
28	11	15.5	-8.73	1.10	123.17	
29	11	15.5	-8.73	1.10	123.17	New Staff Gage Installed

STARTING TIME 10.4
STARTING STAGE OR ELEVATION-8.479999
STARTING RECORDER READING 161

DAY	MONTH	HOUR	SWL	STAGE	FLOW
8	6	10.4	-8.48	1.34	286.87
8	6	13.9	-8.53	1.30	242.36
9	6	4.9	-8.55	1.28	222.77
9	6	8.4	-8.59	1.24	196.31
9	6	10.4	-8.60	1.23	188.20
9	6	17.9	-8.62	1.22	180.44
10	6	1.9	-8.59	1.24	196.31
10	6	10.4	-8.59	1.24	196.31
11	6	10.4	-8.62	1.22	180.44
11	6	18.9	-8.64	1.19	165.85
12	6	1.9	-8.62	1.22	180.44
12	6	10.4	-8.63	1.21	172.99
12	6	18.4	-8.65	1.18	159.00
13	6	10.4	-8.65	1.18	159.00
13	6	23.4	-8.63	1.21	172.99
14	6	10.4	-8.64	1.19	165.85
14	6	17.9	-8.65	1.18	159.00
14	6	21.4	-8.63	1.21	172.99
15	6	0.4	-8.59	1.24	196.31
15	6	9.4	-8.62	1.22	180.44
15	6	10.4	-8.62	1.22	180.44
15	6	17.9	-8.64	1.19	165.85
15	6	20.4	-8.62	1.22	180.44
15	6	23.9	-8.58	1.25	204.76
16	6	10.4	-8.60	1.23	188.20
16	6	18.9	-8.58	1.25	204.76
16	6	20.9	-8.52	1.31	252.80
17	6	1.9	-8.49	1.33	275.03
17	6	9.9	-8.50	1.32	263.68
17	6	10.4	-8.53	1.30	242.36
17	6	18.4	-8.52	1.31	252.80
17	6	20.9	-8.46	1.36	312.11
18	6	4.9	-8.47	1.35	299.23
18	6	6.9	-8.52	1.31	252.80
18	6	9.9	-8.54	1.29	232.36
18	6	10.4	-8.55	1.28	222.77
18	6	14.9	-8.59	1.24	196.31
19	6	7.4	-8.62	1.22	180.44
19	6	10.4	-8.64	1.19	165.85
19	6	17.4	-8.66	1.17	152.44
19	6	19.4	-8.70	1.13	134.33
19	6	21.4	-8.68	1.16	146.15
19	6	23.4	-8.64	1.19	165.85
20	6	10.4	-8.66	1.17	152.44
20	6	17.9	-8.68	1.16	146.15
20	6	20.9	-8.65	1.18	159.00
20	6	23.4	-8.60	1.23	188.20
21	6	7.4	-8.63	1.21	172.99
21	6	10.4	-8.65	1.18	159.00
21	6	14.9	-8.69	1.14	140.11
21	6	23.9	-8.66	1.17	152.44
22	6	10.4	-8.69	1.14	140.11
22	6	17.9	-8.70	1.13	134.33
22	6	21.9	-8.68	1.16	146.15
23	6	2.9	-8.64	1.19	165.85
23	6	7.9	-8.66	1.17	152.44
23	6	10.4	-8.66	1.17	152.44
23	6	14.4	-8.69	1.14	140.11

STARTING TIME 16.6
STARTING STAGE OR ELEVATION-8.729999
STARTING RECORDER READING 143

DAY	MONTH	HOUR	SWL	STAGE	FLOW
23	6	16.6	-8.73	1.10	121.79
24	6	7.1	-8.75	1.07	111.94
24	6	15.1	-8.79	1.02	98.65
24	6	16.6	-8.82	0.99	90.67
25	6	16.6	-8.84	0.96	83.34
26	6	16.6	-8.83	0.98	86.93
27	6	16.6	-8.84	0.96	83.34
28	6	16.6	-8.82	0.99	90.67
28	6	23.6	-8.84	0.96	83.34
29	6	8.1	-8.88	0.91	73.44
29	6	16.6	-8.89	0.90	70.41
30	6	14.6	-8.91	0.86	64.72
30	6	16.1	-8.91	0.86	64.72
30	6	16.6	-8.95	0.81	57.03
1	7	16.1	-8.96	0.80	54.68
1	7	16.6	-8.99	0.76	50.25
2	7	16.6	-8.98	0.78	52.42
3	7	16.6	-8.96	0.80	54.68
4	7	16.6	-8.99	0.76	50.25
5	7	7.6	-8.96	0.80	54.68
5	7	10.6	-8.85	0.95	79.90
5	7	11.1	-8.82	0.99	90.67
5	7	11.6	-8.73	1.10	121.79
5	7	12.6	-8.66	1.18	156.84
5	7	16.1	-8.63	1.20	170.63
5	7	16.6	-8.62	1.22	177.98
5	7	19.6	-8.57	1.26	210.67
5	7	22.6	-8.68	1.15	144.16
6	7	1.1	-8.72	1.11	127.03
6	7	3.6	-8.78	1.04	102.89
6	7	6.1	-8.80	1.01	94.57
6	7	9.1	-8.84	0.96	83.34
6	7	13.1	-8.87	0.93	76.60
6	7	16.6	-8.89	0.90	70.41
6	7	23.6	-8.93	0.85	62.05
7	7	6.6	-8.95	0.81	57.03
7	7	16.1	-8.95	0.81	57.03
7	7	16.6	-8.99	0.76	50.25
8	7	16.6	-9.00	0.74	48.18
9	7	16.6	-9.00	0.74	48.18
10	7	16.6	-9.00	0.74	48.18
11	7	16.6	-9.01	0.72	46.19
12	7	16.6	-9.03	0.70	44.28
13	7	16.6	-9.04	0.69	42.46
14	7	10.6	-9.01	0.72	46.19
14	7	12.6	-8.98	0.78	52.42
14	7	15.6	-8.95	0.81	57.03
14	7	16.6	-8.95	0.81	57.03
14	7	18.6	-8.89	0.90	70.41
14	7	22.6	-8.91	0.86	64.72
15	7	3.6	-8.95	0.81	57.03
15	7	11.6	-8.99	0.76	50.25
15	7	16.6	-9.01	0.72	46.19
15	7	22.6	-9.04	0.69	42.46
16	7	16.6	-9.06	0.65	39.02
17	7	16.6	-9.07	0.63	37.41

STARTING TIME 16.7
STARTING STAGE OR ELEVATION-9.100001
STARTING RECORDER READING 112

DAY	MONTH	HOUR	SWL	STAGE	FLOW
18	7	16.7	-9.10	0.59	34.27
19	7	16.2	-9.08	0.63	37.29
19	7	16.7	-9.11	0.57	32.86
20	7	14.2	-9.09	0.61	35.75
20	7	16.7	-9.10	0.59	34.27
21	7	16.2	-9.08	0.63	37.29
21	7	16.7	-9.11	0.57	32.86
22	7	16.7	-9.10	0.59	34.27
23	7	16.2	-9.08	0.63	37.29
23	7	16.7	-9.11	0.57	32.86
24	7	16.7	-9.11	0.57	32.86
24	7	21.2	-9.14	0.53	30.20
25	7	14.7	-9.11	0.57	32.86
25	7	16.2	-9.10	0.59	34.27
25	7	16.7	-9.14	0.53	30.20
26	7	16.2	-9.11	0.57	32.86
26	7	16.7	-9.15	0.51	28.95
27	7	16.7	-9.15	0.51	28.95
28	7	16.7	-9.16	0.48	27.76
28	7	23.2	-9.19	0.44	25.51
29	7	14.7	-9.16	0.48	27.76
29	7	16.7	-9.17	0.46	26.61
30	7	16.7	-9.17	0.46	26.61
30	7	21.7	-9.20	0.42	24.46
31	7	15.7	-9.17	0.46	26.61
31	7	16.2	-9.16	0.48	27.76
31	7	16.7	-9.20	0.42	24.46
1	8	16.7	-9.20	0.42	24.46
2	8	16.7	-9.20	0.42	24.46
3	8	16.7	-9.21	0.40	23.45
4	8	16.7	-9.21	0.40	23.45
5	8	16.7	-9.21	0.40	23.45
6	8	16.7	-9.22	0.38	22.48
7	8	16.7	-9.21	0.40	23.45
8	8	16.7	-9.21	0.40	23.45
9	8	16.2	-9.19	0.44	25.51
9	8	16.7	-9.22	0.38	22.48
10	8	16.7	-9.21	0.40	23.45
11	8	16.7	-9.21	0.40	23.45
12	8	16.7	-9.21	0.40	23.45
13	8	16.7	-9.22	0.38	22.48
14	8	16.7	-9.21	0.40	23.45

STARTING TIME 15.1
STARTING STAGE ØR ELEVATIØN-9.26
STARTING RECØRDER READING 100

DAY	MØNTH	HØUR	SWL	STAGE	FLØW
15	8	15.1	-9.26	0.31	19.81
16	8	15.1	-9.26	0.31	19.81
17	8	15.1	-9.26	0.31	19.81
18	8	15.1	-9.26	0.31	19.81
19	8	15.1	-9.26	0.31	19.81
20	8	15.1	-9.26	0.31	19.81
21	8	15.1	-9.26	0.31	19.81
22	8	15.1	-9.26	0.31	19.81
23	8	15.1	-9.26	0.31	19.81
24	8	15.1	-9.26	0.31	19.81
25	8	15.1	-9.26	0.31	19.81
26	8	15.1	-9.26	0.31	19.81
27	8	15.1	-9.26	0.31	19.81
28	8	15.1	-9.26	0.31	19.81
29	8	15.1	-9.26	0.31	19.81
30	8	15.1	-9.26	0.31	19.81
31	8	15.1	-9.26	0.31	19.81
1	9	15.1	-9.26	0.31	19.81
2	9	15.1	-9.26	0.31	19.81
3	9	15.1	-9.26	0.31	19.81
4	9	15.1	-9.26	0.31	19.81
5	9	15.1	-9.26	0.31	19.81
6	9	15.1	-9.26	0.31	19.81
7	9	15.1	-9.26	0.31	19.81
8	9	15.1	-9.26	0.31	19.81
9	9	15.1	-9.26	0.31	19.81
10	9	15.1	-9.26	0.31	19.81
11	9	15.1	-9.26	0.31	19.81
12	9	15.1	-9.26	0.31	19.81

STARTING TIME 17.3
STARTING STAGE OR ELEVATION-9.26
STARTING RECORDER READING 101

DAY	MONTH	HOUR	SWL	STAGE	FLOW
12	9	17.3	-9.27	0.29	18.99
13	9	17.3	-9.27	0.29	18.99
14	9	17.3	-9.27	0.29	18.99
15	9	17.3	-9.27	0.29	18.99
16	9	17.3	-9.27	0.29	18.99
17	9	17.3	-9.27	0.29	18.99
18	9	17.3	-9.27	0.29	18.99
19	9	17.3	-9.26	0.31	19.81
20	9	17.3	-9.27	0.29	18.99
21	9	17.3	-9.27	0.29	18.99
22	9	17.3	-9.27	0.29	18.99
23	9	17.3	-9.27	0.29	18.99
24	9	17.3	-9.27	0.29	18.99
25	9	17.3	-9.27	0.29	18.99
26	9	17.3	-9.27	0.29	18.99
27	9	17.3	-9.27	0.29	18.99
27	9	17.8	-9.21	0.40	23.44
27	9	18.3	-9.12	0.55	31.49
27	9	18.8	-9.05	0.66	40.55
27	9	19.8	-9.01	0.72	46.02
28	9	4.8	-9.04	0.68	42.30
28	9	7.8	-9.08	0.63	37.27
28	9	12.8	-9.11	0.57	32.85
28	9	16.8	-9.14	0.53	30.19
28	9	17.3	-9.15	0.51	28.94
28	9	22.8	-9.17	0.46	26.60
29	9	16.8	-9.20	0.42	24.45
29	9	17.3	-9.22	0.38	22.48
30	9	17.3	-9.25	0.33	20.66
1	10	17.3	-9.25	0.33	20.66
2	10	17.3	-9.25	0.33	20.66
3	10	17.3	-9.25	0.33	20.66
4	10	17.3	-9.25	0.33	20.66
5	10	17.3	-9.25	0.33	20.66
6	10	17.3	-9.25	0.33	20.66
7	10	17.3	-9.25	0.33	20.66
8	10	17.3	-9.25	0.33	20.66
9	10	17.3	-9.25	0.33	20.66
10	10	17.3	-9.25	0.33	20.66
11	10	17.3	-9.25	0.33	20.66
12	10	17.3	-9.25	0.33	20.66
13	10	17.3	-9.25	0.33	20.66
14	10	17.3	-9.25	0.33	20.66
14	10	23.8	-9.24	0.36	21.55

STARTING TIME 17.3
STARTING STAGE OR ELEVATION-9.26
STARTING RECORDER READING 101

DAY	MONTH	HOUR	SWL	STAGE	FLOW
15	10	1.8	-9.14	0.53	30.19
15	10	3.3	-9.03	0.70	44.12
15	10	3.8	-8.95	0.81	56.81
15	10	4.3	-8.89	0.90	70.14
15	10	4.8	-8.82	0.99	90.33
15	10	5.3	-8.72	1.11	126.56
15	10	5.8	-8.63	1.20	169.99
15	10	6.3	-8.55	1.28	228.33
15	10	6.8	-8.46	1.36	306.70
15	10	8.8	-8.35		
15	10	9.8	-8.24		
15	10	10.8	-8.13		
15	10	11.8	-8.04		
15	10	12.8	-7.93		
15	10	13.3	-7.80		
15	10	14.3	-7.70		
15	10	15.8	-7.81		
15	10	16.3	-7.83		
15	10	16.8	-7.91		
15	10	17.3	-7.98		
15	10	17.8	-8.07		
15	10	18.8	-8.18		
15	10	19.8	-8.24		
15	10	20.8	-8.25		
15	10	21.3	-8.21		
15	10	21.8	-8.12		
15	10	22.3	-8.02		
15	10	23.3	-7.92		
16	10	0.8	-7.87		
16	10	1.8	-7.94		
16	10	2.8	-8.04		
16	10	3.8	-8.09		
16	10	4.3	-8.05		
16	10	4.8	-7.93		
16	10	5.3	-7.80		
16	10	5.8	-7.67		
16	10	6.3	-7.55		
16	10	6.8	-7.48		
16	10	7.8	-7.45		
16	10	8.3	-7.43		
16	10	8.8	-7.35		
16	10	9.3	-7.27		
16	10	10.3	-7.23		
16	10	11.3	-7.12		
16	10	12.3	-7.06		
16	10	13.3	-7.00		
16	10	13.8	-6.90		

STARTING TIME 17.3
STARTING STAGE OR ELEVATION-9.26
STARTING RECORDER READING 101

DAY	MONTH	HOUR	SWL	STAGE	FLOW
16	10	14.8	-6.95		
16	10	15.3	-7.02		
16	10	15.8	-7.11		
16	10	16.3	-7.21		
16	10	16.8	-7.32		
16	10	17.3	-7.39		
16	10	17.8	-7.46		
16	10	18.3	-7.51		
16	10	18.8	-7.60		
16	10	19.8	-7.69		
16	10	21.8	-7.71		
17	10	0.3	-7.81		
17	10	1.3	-7.83		
17	10	2.8	-7.93		
17	10	4.8	-8.03		
17	10	7.3	-8.14		
17	10	9.3	-8.21		
17	10	11.3	-8.26		
17	10	13.8	-8.30		

STARTING TIME 15.5
STARTING STAGE OR ELEVATION-8.37
STARTING RECORDER READING 174

DAY	MONTH	HOUR	SWL	STAGE	FLOW	
17	10	15.5	-8.38	1.41	400.96	
17	10	17.5	-8.43	1.38	338.75	
17	10	20.0	-8.47	1.35	298.51	
17	10	22.5	-8.52	1.31	252.19	
18	10	2.0	-8.54	1.29	231.80	
18	10	5.5	-8.59	1.24	195.84	
18	10	9.5	-8.62	1.22	180.00	
18	10	12.5	-8.65	1.18	158.62	
18	10	15.5	-8.67	1.17	152.07	
19	10	15.5	-8.67	1.17	152.07	
20	10	15.5	-8.67	1.17	152.07	
21	10	15.5	-8.67	1.17	152.07	
22	10	15.5	-8.67	1.17	152.07	
23	10	9.0	-8.67	1.17	152.07	
23	10	10.0	-8.73	1.10	123.17	
23	10	15.5	-8.71	1.11	128.48	
24	10	15.5	-8.73	1.10	123.17	
25	10	15.5	-8.71	1.11	128.48	
26	10	15.5	-8.73	1.10	123.17	
27	10	15.5	-8.73	1.10	123.17	
28	10	15.5	-8.73	1.10	123.17	
29	10	15.5	-8.73	1.10	123.17	
30	10	15.5	-8.73	1.10	123.17	
31	10	15.5	-8.71	1.11	128.48	
1	11	15.5	-8.71	1.11	128.48	
2	11	15.5	-8.71	1.11	128.48	
3	11	15.5	-8.71	1.11	128.48	
4	11	15.5	-8.73	1.10	123.17	
5	11	15.5	-8.73	1.10	123.17	
6	11	15.5	-8.71	1.11	128.48	
7	11	15.5	-8.73	1.10	123.17	
8	11	15.5	-8.73	1.10	123.17	
9	11	15.5	-8.73	1.10	123.17	
10	11	15.5	-8.73	1.10	123.17	
11	11	15.5	-8.73	1.10	123.17	
12	11	15.5	-8.73	1.10	123.17	
13	11	15.5	-8.73	1.10	123.17	
14	11	15.5	-8.73	1.10	123.17	
15	11	15.5	-8.73	1.10	123.17	
16	11	15.5	-8.73	1.10	123.17	
17	11	15.5	-8.73	1.10	123.17	
18	11	15.5	-8.73	1.10	123.17	Probable Equipment Malfunction
19	11	15.5	-8.73	1.10	123.17	
20	11	15.5	-8.73	1.10	123.17	
21	11	15.5	-8.73	1.10	123.17	
22	11	15.5	-8.73	1.10	123.17	
23	11	15.5	-8.73	1.10	123.17	
24	11	15.5	-8.73	1.10	123.17	
25	11	15.5	-8.73	1.10	123.17	
26	11	15.5	-8.73	1.10	123.17	
27	11	15.5	-8.73	1.10	123.17	
28	11	15.5	-8.73	1.10	123.17	
29	11	15.5	-8.73	1.10	123.17	New Staff Gage Installed

APPENDIX F

Chen-Northern, Inc.

APPENDIX F

RATING CURVES

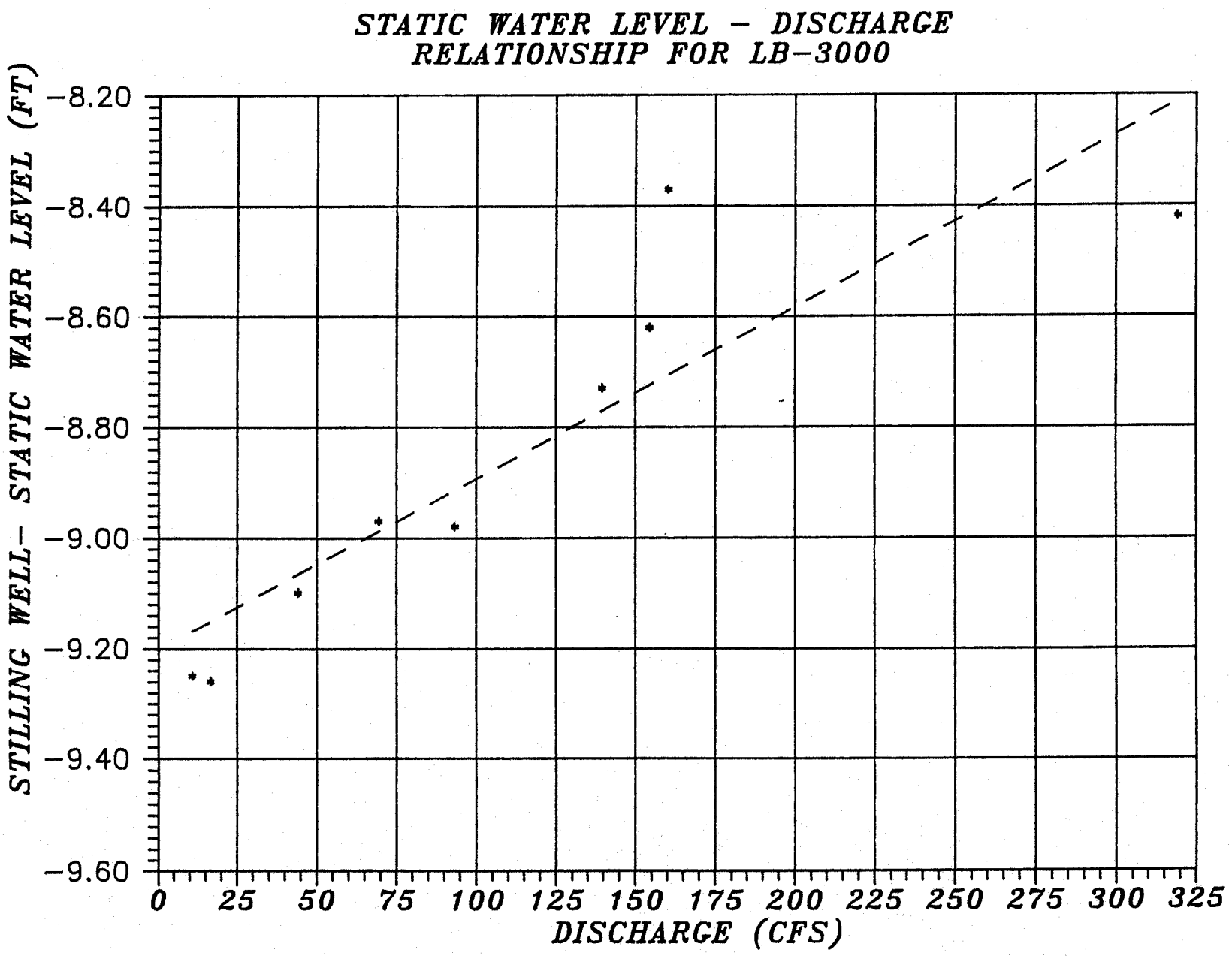
APPENDIX F

RATING CURVES

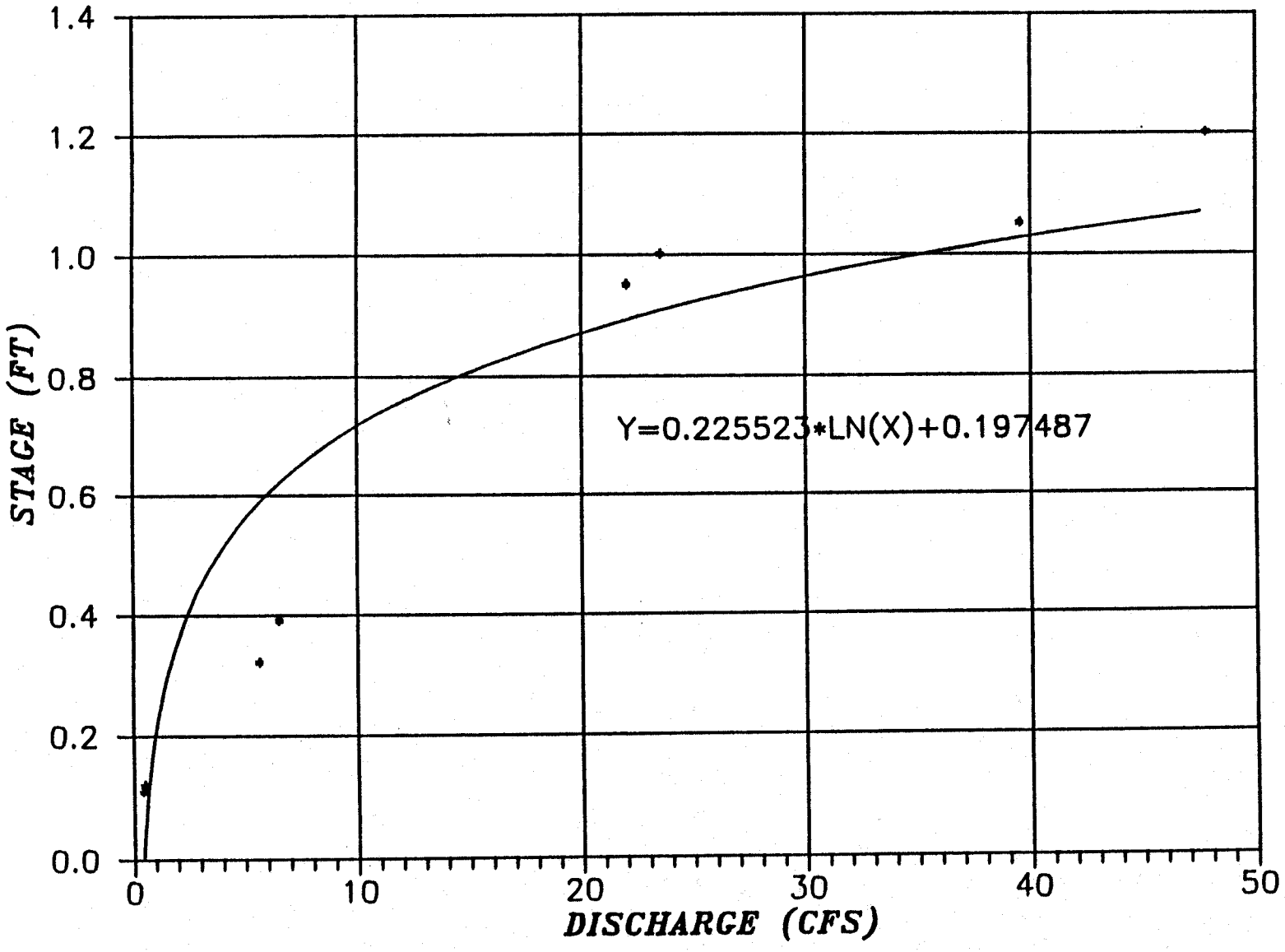
TABLE F-1

RATING CURVE LOCATIONS

Site Code	Location
LB-3000	Libby Creek at Gage (Stilling Well Static Water Level vs. Discharge)
EF-300	East Fork Rock Creek at Third Bridge
EF-400	East Fork Rock Creek at Second Bridge
EF-800	East Fork Rock Creek above Confluence
RC-850	Rock Creek at Bridge below Confluence
BC-100	Bear Creek above Libby Creek
LB-200	Libby Creek at Fourth Bridge
LB-500	Libby Creek at Howard Lake Bridge
LB-800	Libby Creek at Second Bridge
LB-2000	Libby Creek above Bear Creek Confluence
LB-3000	Libby Creek at Gage (stage vs. discharge)
LC-600	Lower Little Cherry Creek
PM-1000	Poorman Creek at USFS Road #6212
RA-200	Ramsey Creek at Upper Bridge
RA-600	Ramsey Creek at Libby Creek Road

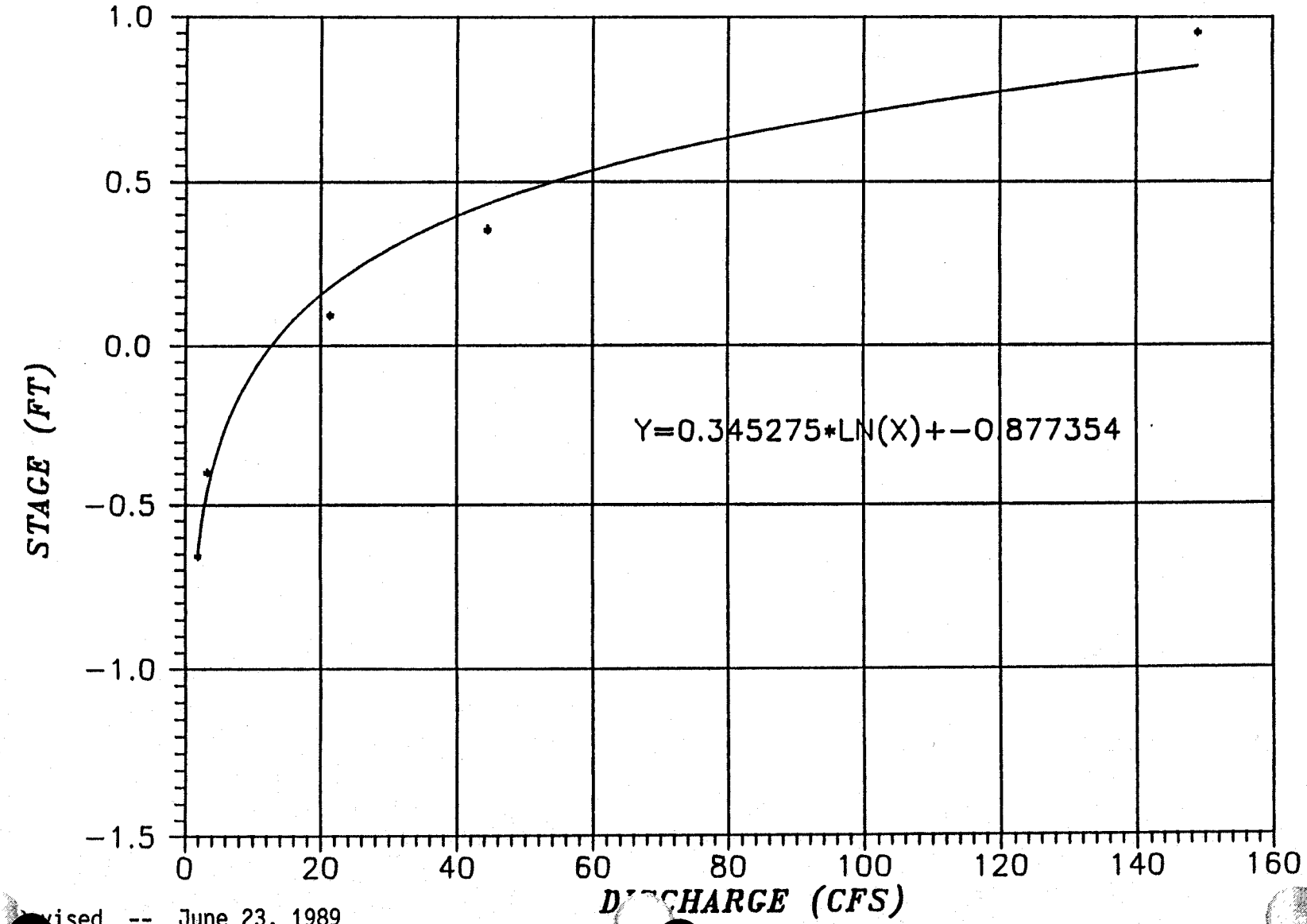

STATIC WATER LEVEL - DISCHARGE
RELATIONSHIP FOR LB-3000
STILLING WELL- STATIC WATER LEVEL (FT)
-8.20
-8.40
-8.60
-8.80
-9.00
-9.20
-9.40
-9.60
0
25
50
75
100
125
150
175
200
225
250
275
300
325
DISCHARGE (CFS)

STAGE-DISCHARGE RELATIONSHIP FOR EF-300



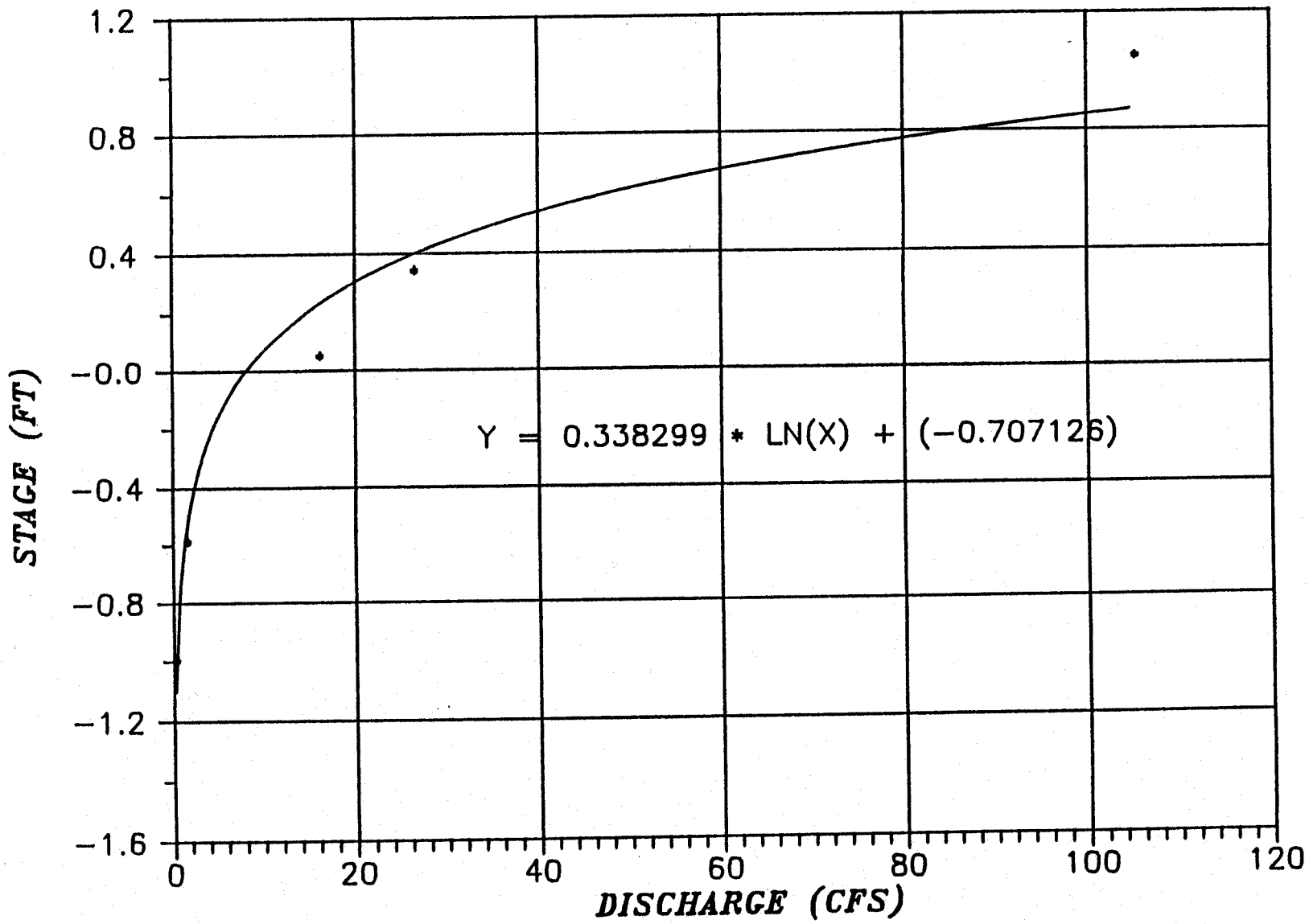
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR EF-400

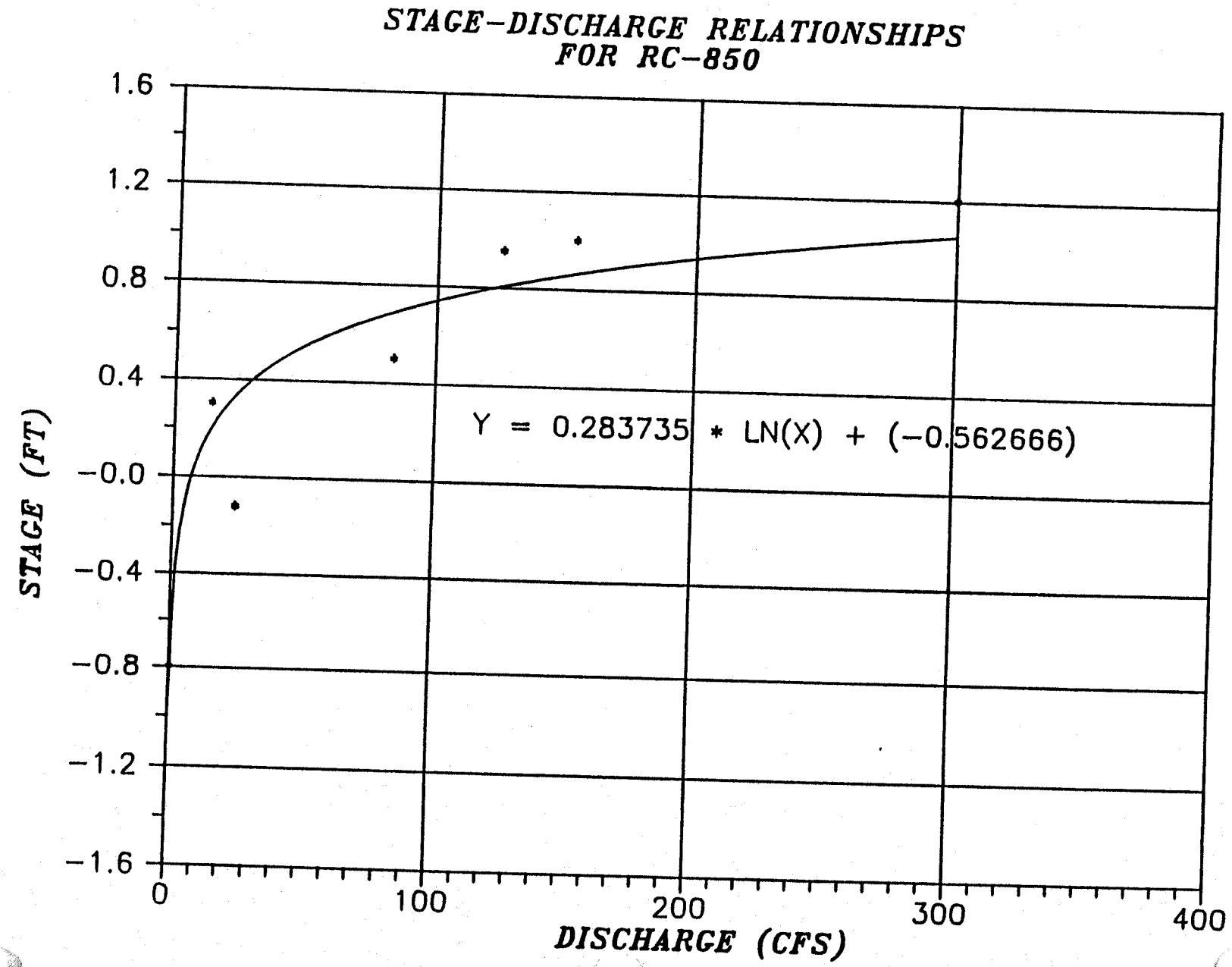


Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP
EF-800

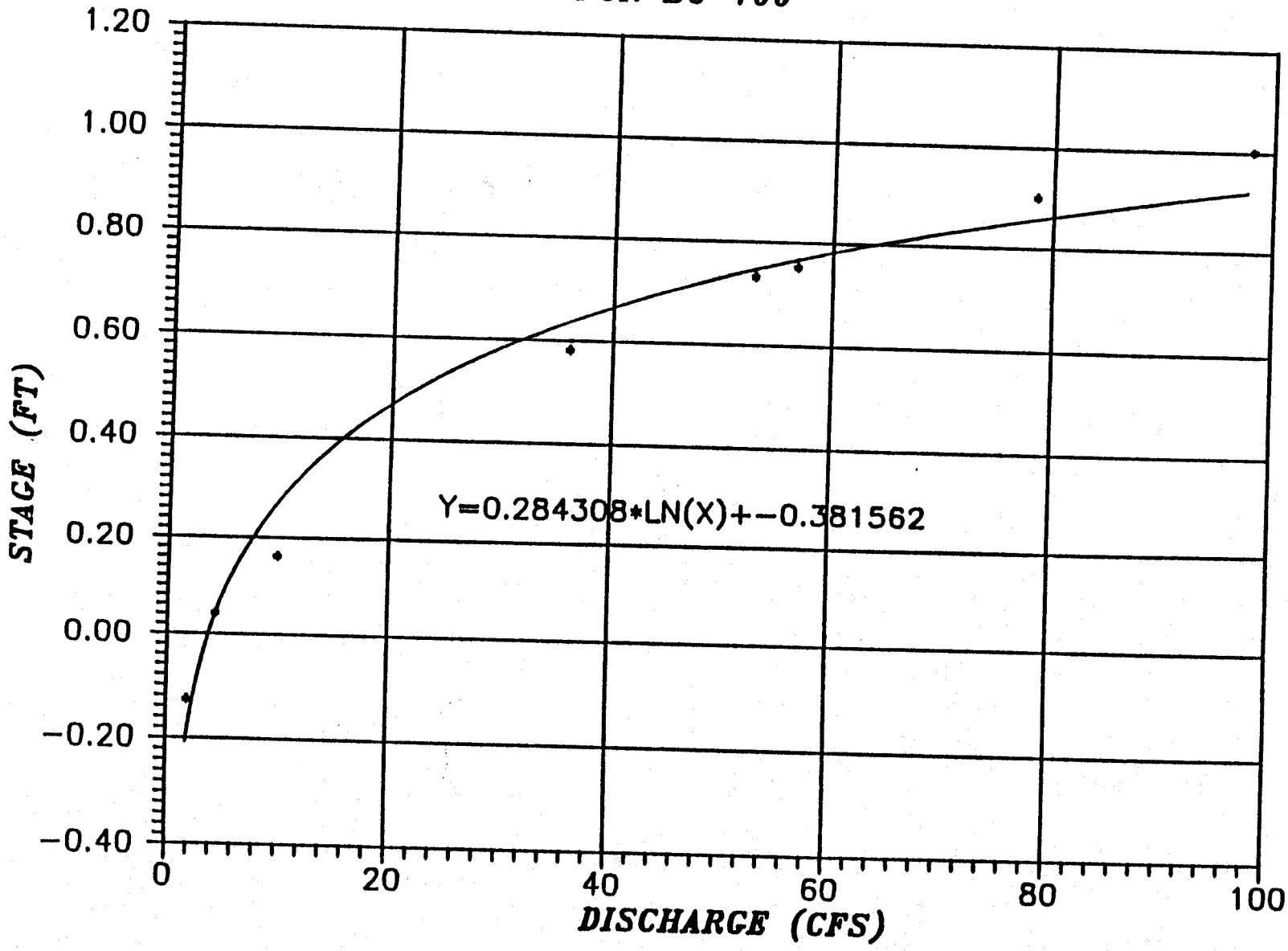


Revised -- June 23, 1989



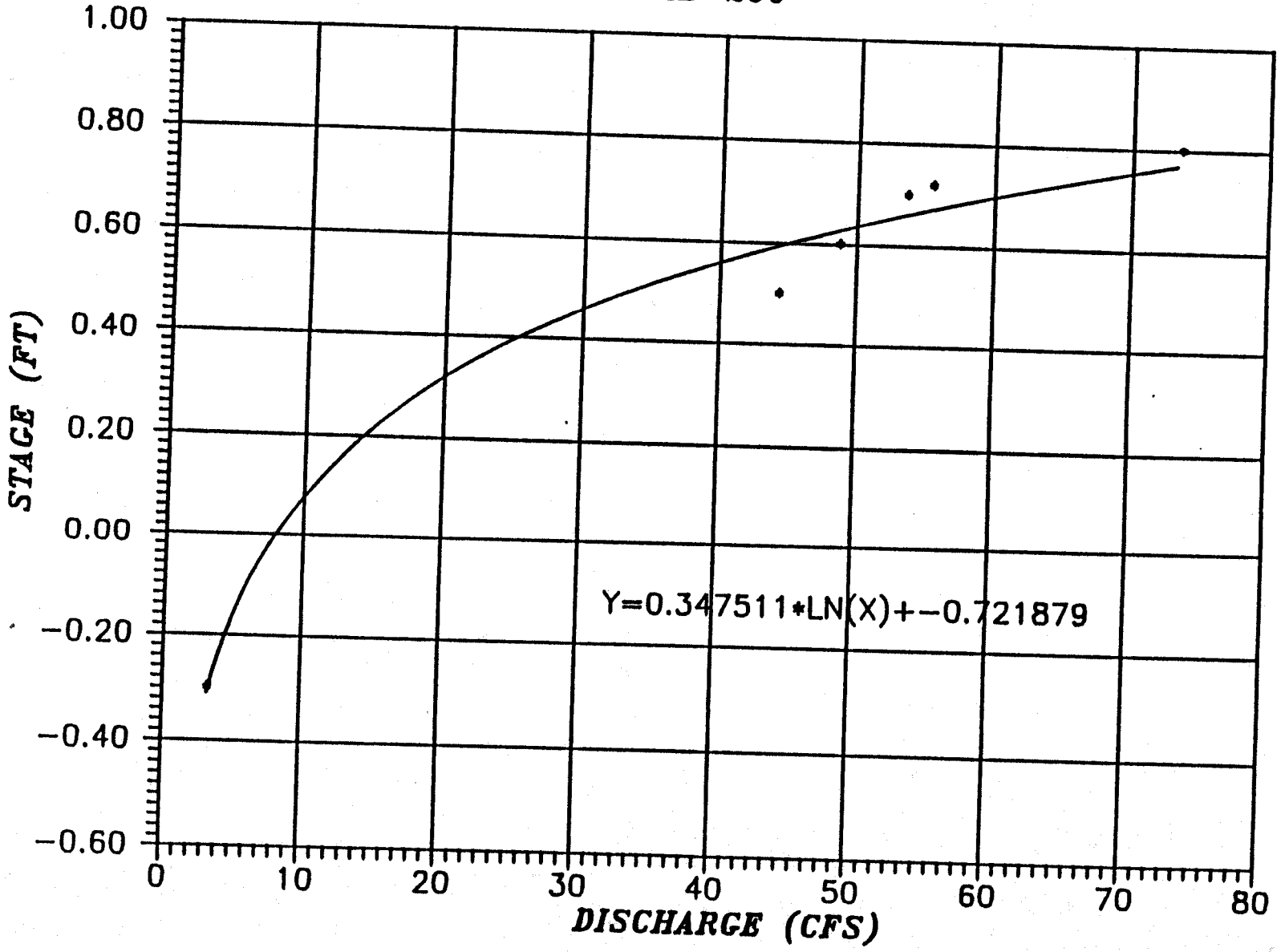
vised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR BC-100



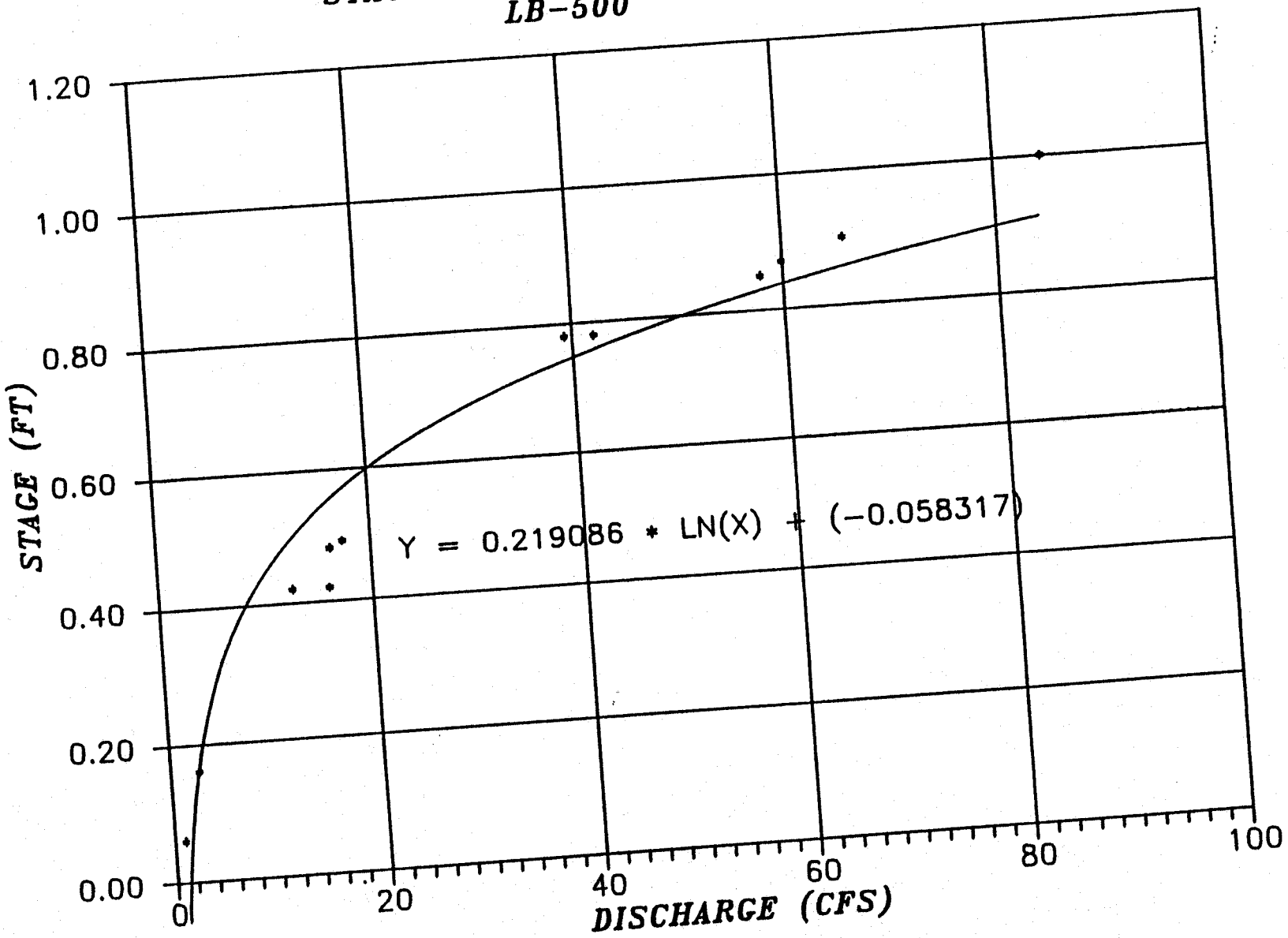
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR LB-200



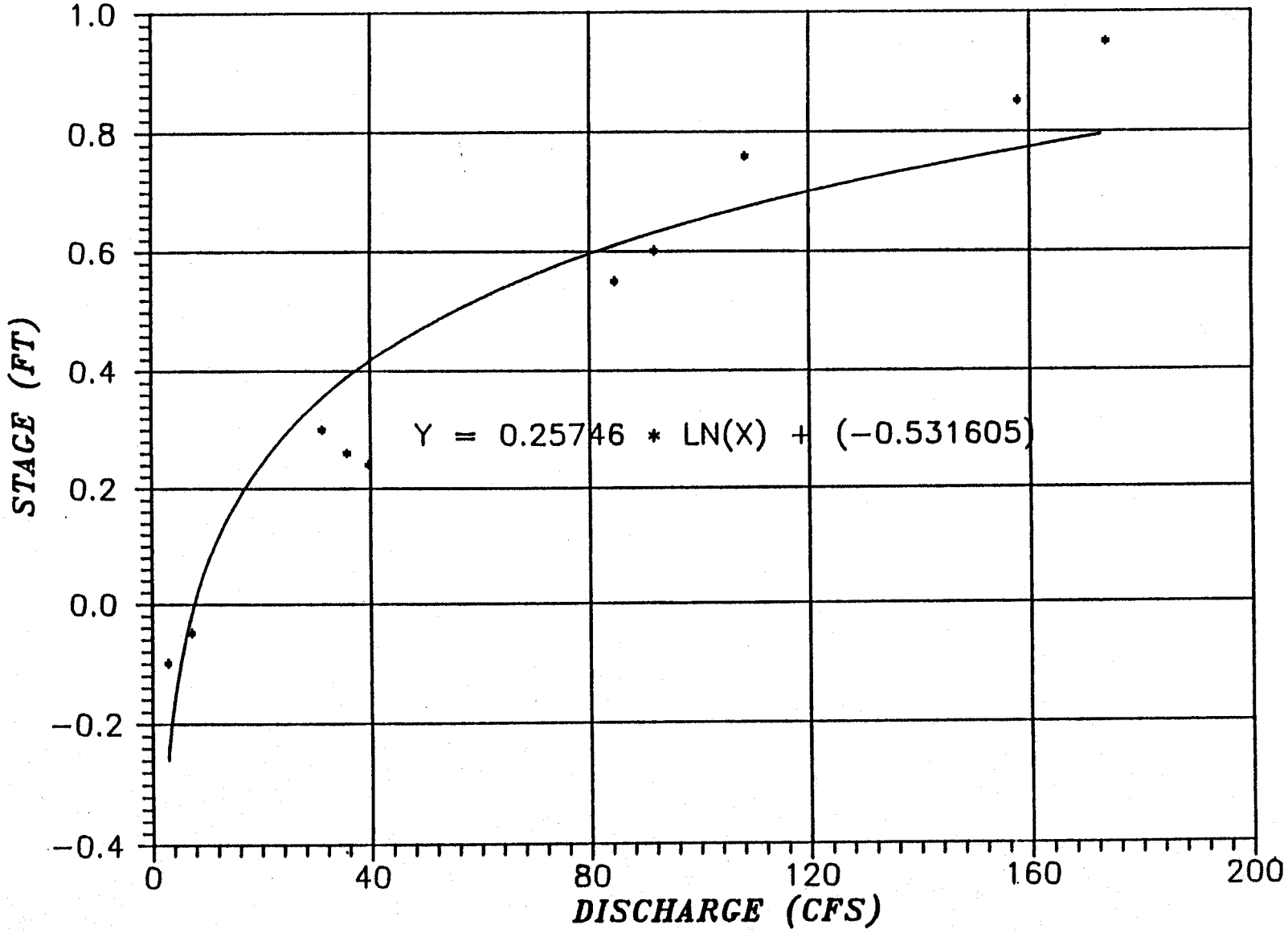
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP
LB-500



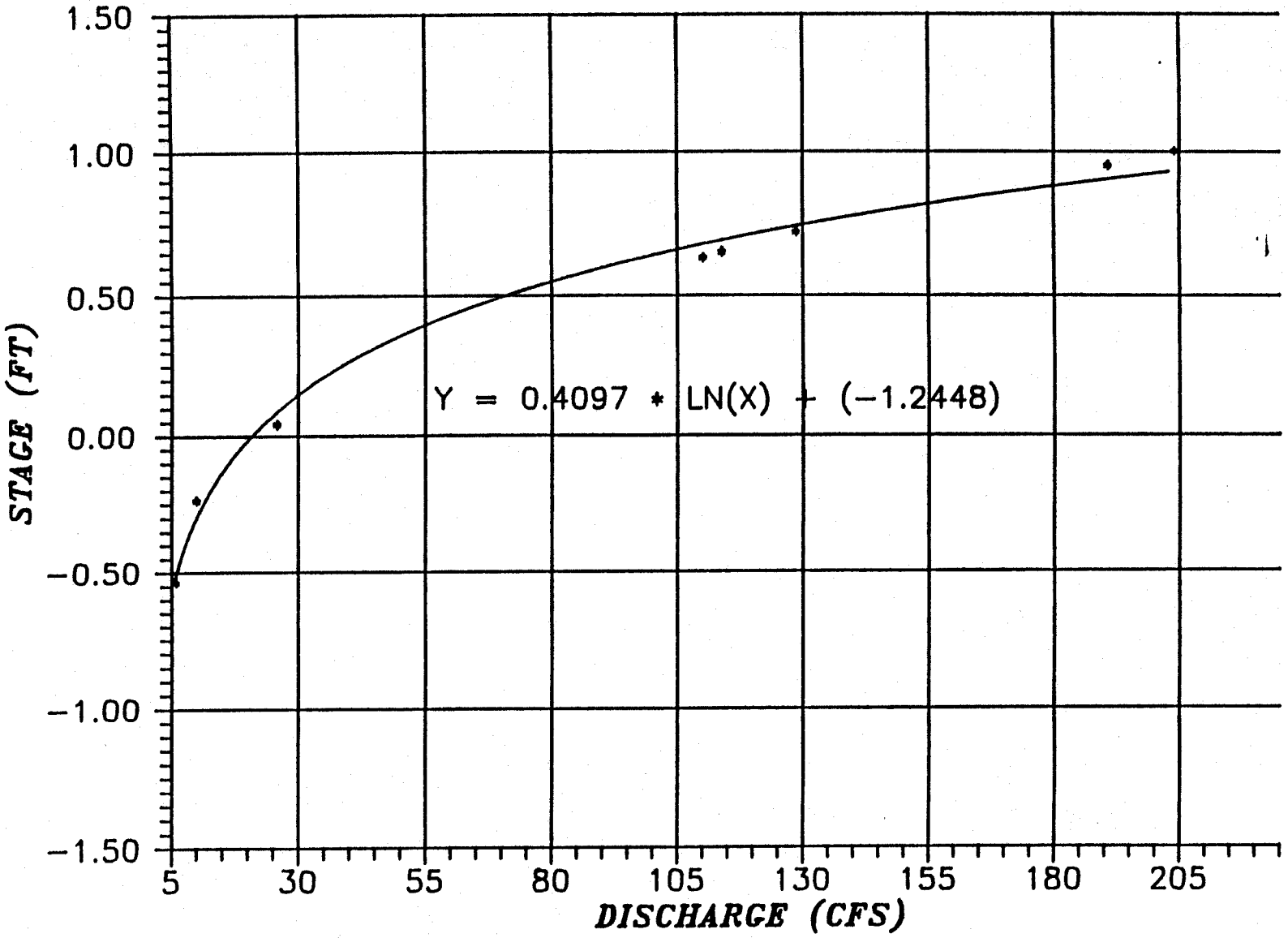
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR LB-800



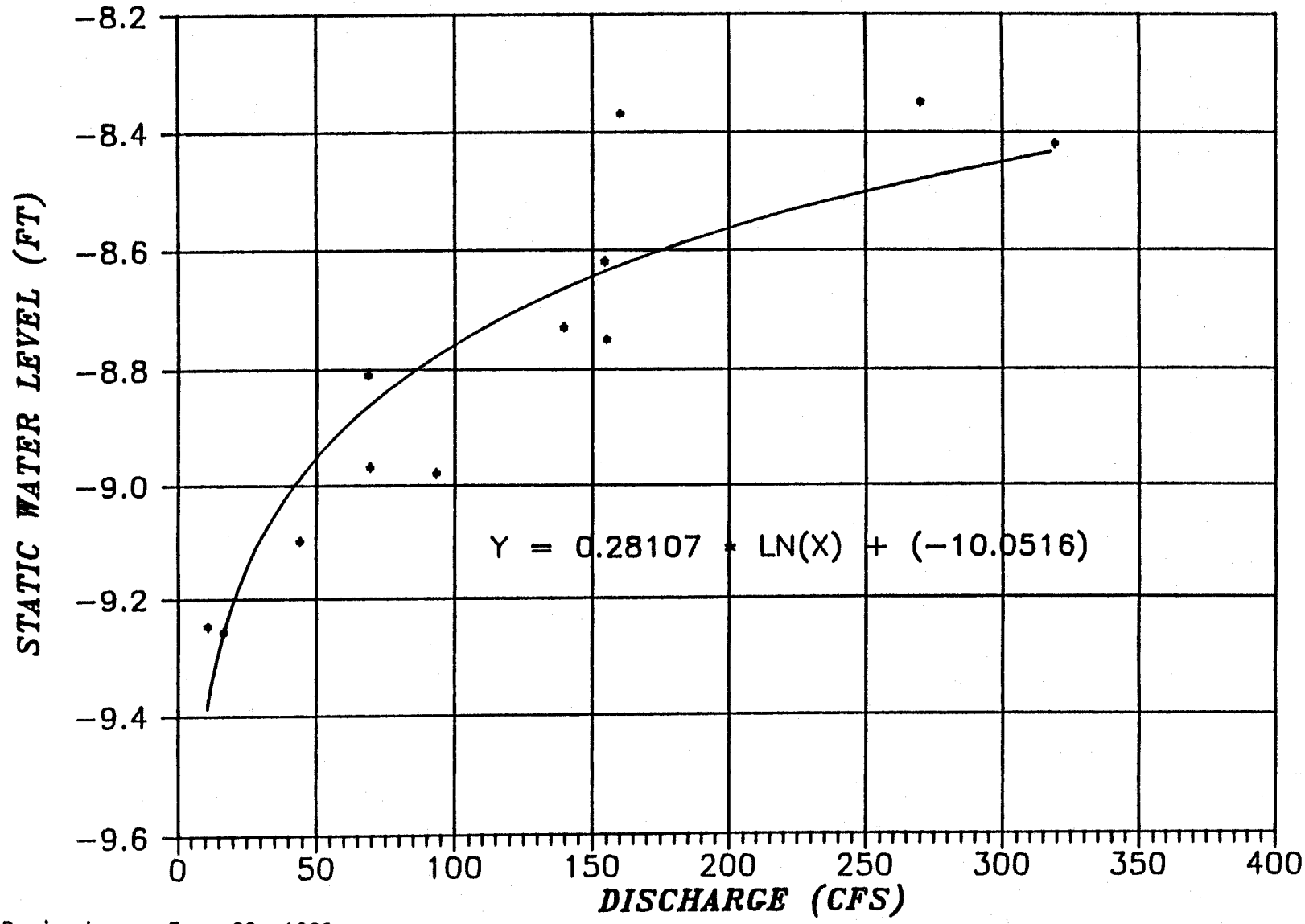
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR LB-2000



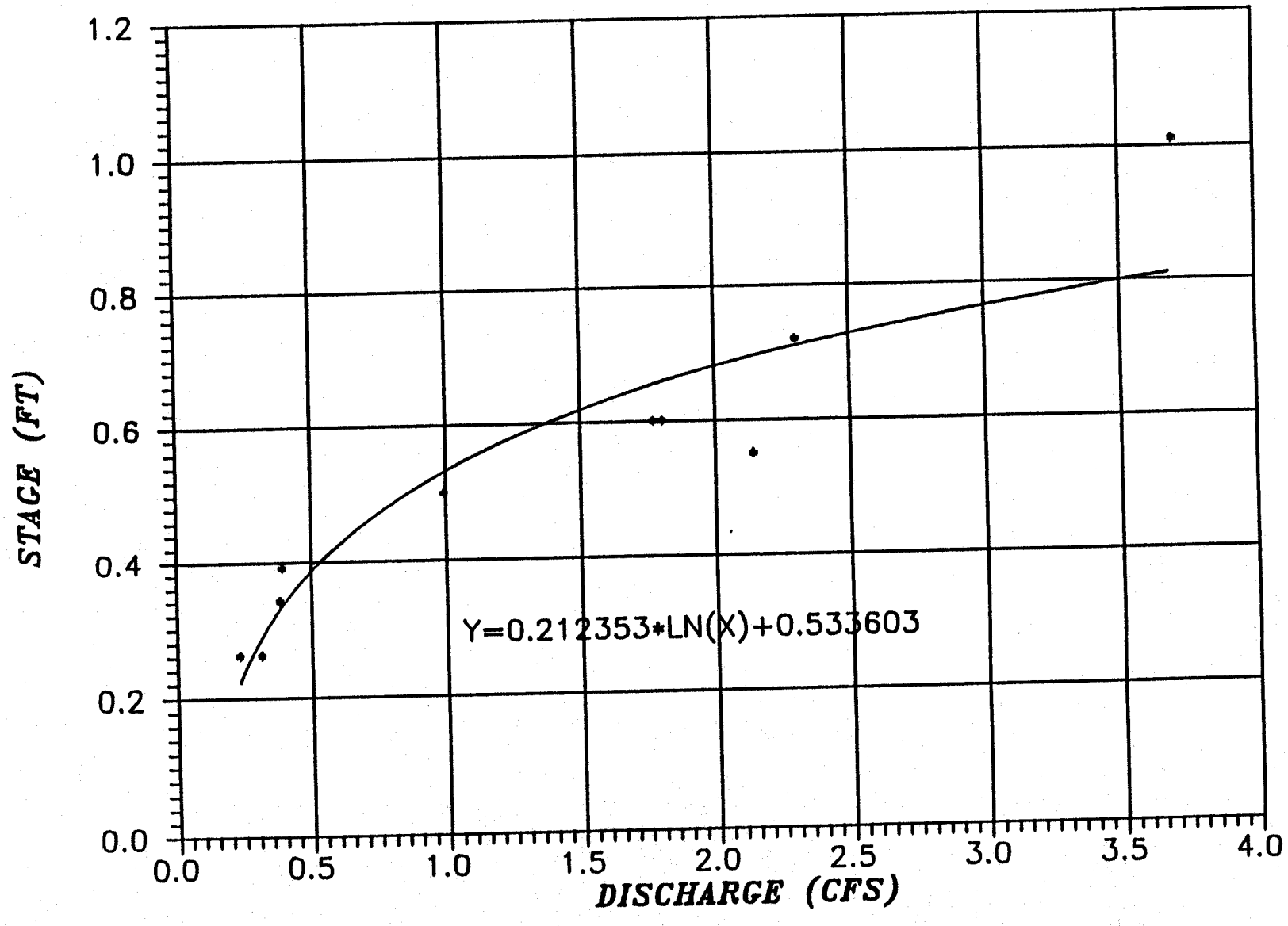
Revised -- June 23, 1989

STATIC WATER LEVEL – DISCHARGE RELATIONSHIP FOR LB-3000



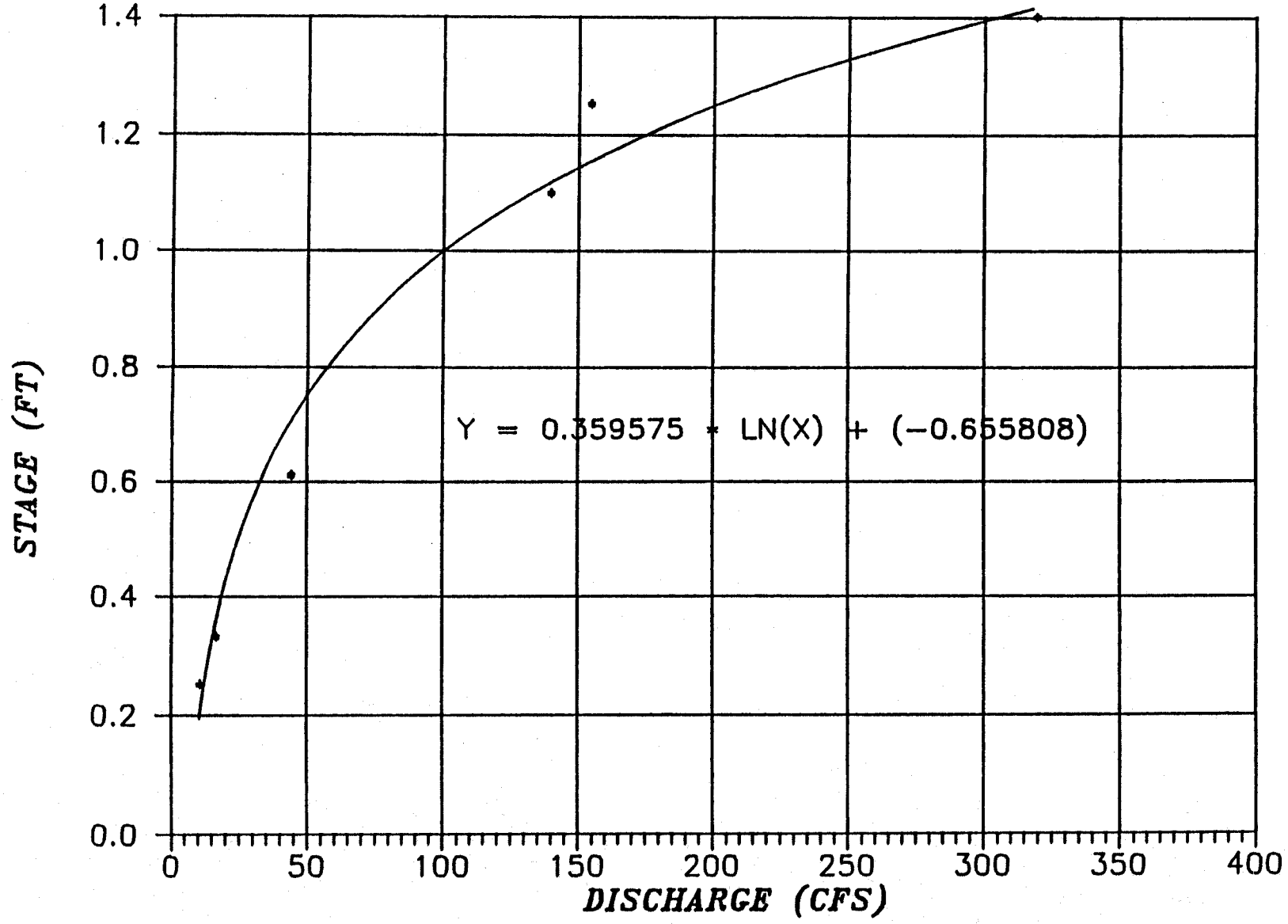
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR LC-600



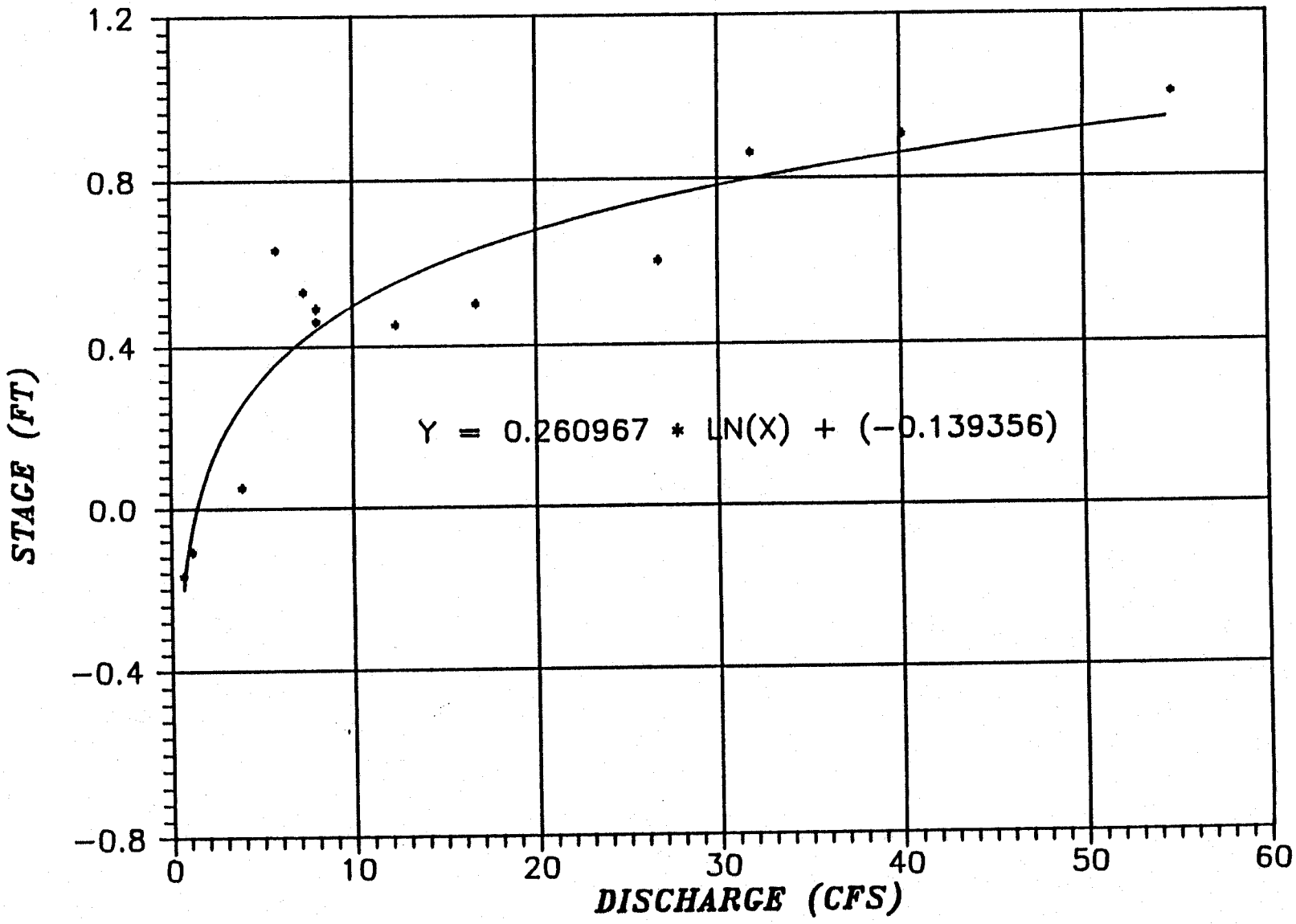
REvised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR LB-3000



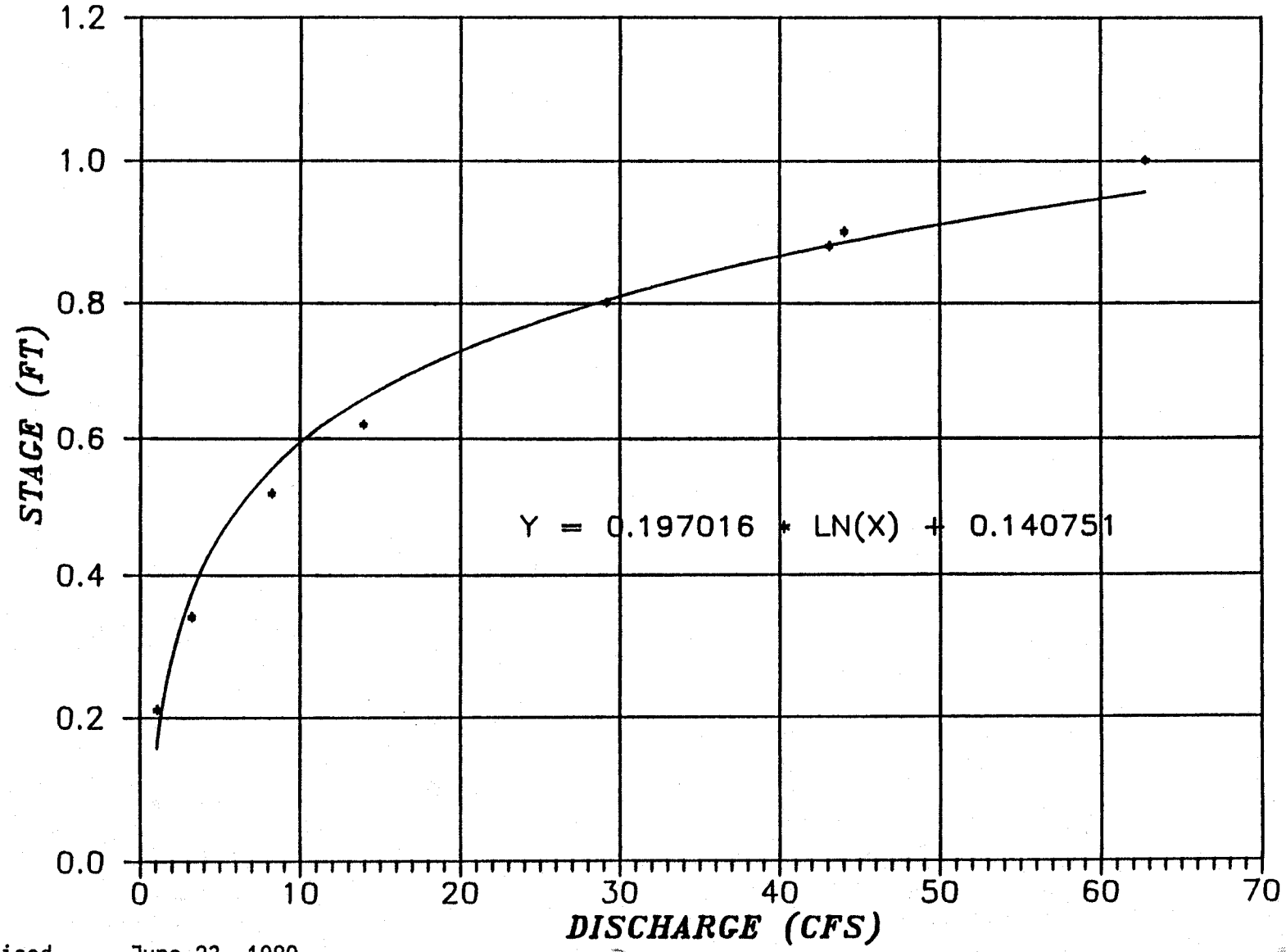
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR PM-1000



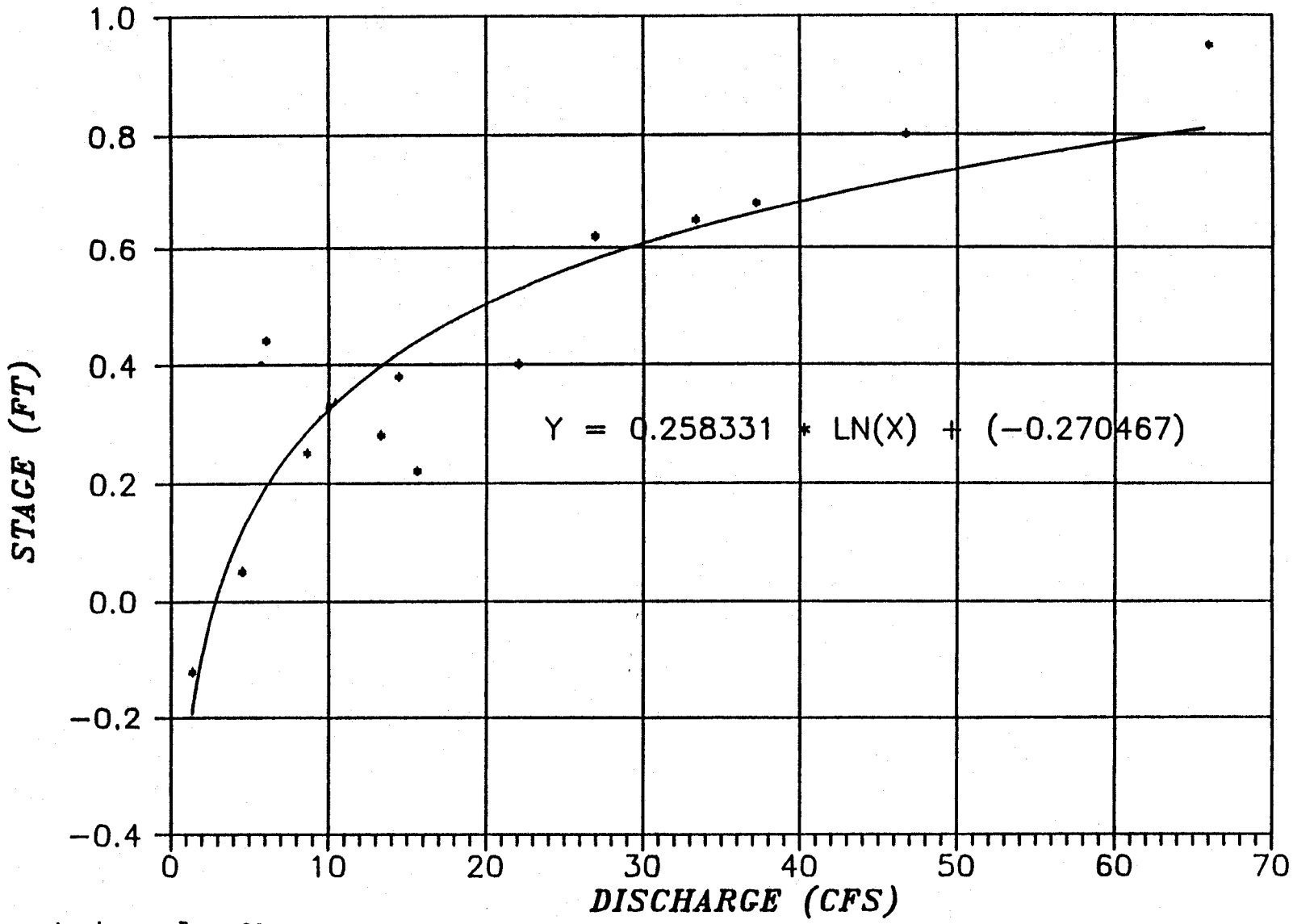
Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR RA-200



Revised -- June 23, 1989

STAGE-DISCHARGE RELATIONSHIP FOR RA-600



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APPENDIX G

Chen-Northern, Inc.

APPENDICES
G-1 AND G-2

APPENDIX G1

SURFACE WATER QUALITY DATABASE

COMPARABILITY

The objective of a comparability assessment is to insure that data developed during the investigation are directly comparable, or comparable within defined limitations, to existing data. Comparability was assessed for Chen-Northern water quality data by comparing these results with data collected by U.S. Borax during the 1986 and 1987 field samplings.

Samples collected by U.S. Borax were analyzed by ABC Laboratories, Inc. in Spokane, Washington. ABC Laboratories holds U.S. Department of Social and Health Services certification and administers the EPA drinking water program. Laboratory methods used by ABC in their analyses follow EPA procedures and are similar to those used for this project by the Chen-Northern laboratory in Billings, Montana.

Analytical detection limit goals for U.S. Borax and Chen-Northern analyses varied considerably. Table G-1 presents detection limit goals used by each laboratory in their analyses of surface water quality samples. Detection limits used by ABC Labs for U.S. Borax Samples for many of the common ions are up to two orders of magnitude lower than those used by the Chen-Northern Lab, although this is not true for all parameters.

Sample preparation methods also varied for samples collected by U.S. Borax during 1986 and 1987 and for Chen-Northern in 1988. U.S. Borax surface water metals samples were filtered through a 0.45 micron filter and preserved with nitric acid. This method of sample preparation prepares samples for analysis of dissolved metals. Chen-Northern's surface water quality metals samples were acidified, but were not filtered, and were analyzed for total recoverable metals. Because metals samples were prepared by different methods, data were not directly comparable. However, they are still of value.

TABLE G-1

COMPARISON OF SURFACE WATER LABORATORY DETECTION LIMITS

	CHEN-NORTHERN LABORATORY (mg/L)	ABC LABORATORIES (mg/L)
Total Hardness	1.0	0.1
Calcium	1	0.01
Magnesium	1	0.01
Sodium	1	0.1
Potassium	1	0.01
Total Alkalinity	1	1
Carbonate as $CaCO_3$	1	1
Bicarbonate as $H2O_3$	1	1
Chloride	1	1
Fluoride	0.05	0.2
Sulfate	1	1
TSS	1	1
TDS	1	1
Turbidity (NTU)	0.1	0.1
Ortho-phosphate	0.005	0.01
Total phosphorus	0.005	0.01
Nitrate/nitrate as N	0.01	--
Nitrite NO_2-N	--	0.01
Nitrate NO_3-N	--	0.2
Total Kjeldahl Nitrogen	0.2	0.1
Ammonia	0.05	
Aluminum	0.1	0.05
Arsenic	0.005	0.010
Cadmium	0.0001	0.002
Chromium	0.02	0.010
Copper	0.001	0.010
Iron	0.05	0.05
Lead	0.001	0.010
Manganese	0.02	0.010
Mercury	0.0002	0.0010
Molybdenum	0.05	0.05
Silver	0.0002	0.010
Zinc	0.02	0.010

Preservation of nutrient samples also varied. U.S. Borax placed nutrient samples on ice to preserve sample quality. Chen-Northern's method included the addition of 2 milliliters. sulfuric acid to all nutrient samples and packing samples on ice until they were analyzed. Without the addition of sulfuric acid, holding times for some parameters may have been exceeded for some U.S. Borax samples.

Data from both U.S. Borax and Chen-Northern indicate water of good quality, with low concentrations of metals, nutrients, and common ions. A more detailed discussion of water quality is presented in Section 3.5 of this report.

COMPLETENESS

Completeness for surface water sampling was assessed by comparing the number of valid natural samples to the number of samples collected and to the number of samples planned. Valid samples are those which have not exceeded holding times and were collected by approved methods.

Completeness was calculated for samples collected from April, 1988 through April, 1989. In April, 1988, Chen-Northern proposed a completeness of 80% for surface water data. Table G-2 presents completeness data for surface water sampling. Because greater than 80% of the samples were collected as proposed, the sampling program meets the proposed completeness criterion.

TABLE G-2

SURFACE WATER COMPLETENESS SUMMARY FOR SAMPLES COLLECTED APRIL, 1988 - APRIL, 1989[a]

	NATURAL SAMPLES	FIELD DUPLICATES	CROSS-CONTAMINATION BLANKS	BOTTLE BLANKS	BLIND FIELD STANDARDS	TOTAL
Number of samples proposed	237	15	15	15	13	295
Number of samples collected	231	15	14	13	12	285
Percent valid samples	100	100	100	100	100	
Percent completeness	98	115	93	87	92	

(a) April - October, 1988 sampling episodes included 21 sampling locations. The winter sampling program was completed from November through April, 1989. Eight sampling sites were proposed and sampled. Six stream sites were dry during late summer months and could not be sampled as proposed.

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REPRESENTATIVENESS

Representativeness was addressed to assess whether actual site conditions are accurately represented. Representativeness is the detection of bias due to contamination of bottle blanks and/or cross-contamination blanks which have been analyzed with natural samples. To detect contamination and identify its source, analytical results from field blanks are compared with instrument detection limits.

Results from cross-contamination and bottle blank analyses indicate contamination of cadmium in all blanks and random contamination of other assorted parameters. (A discussion of cadmium occurrence is presented in Section 3.5, Water Quality Analysis.) Natural sample data associated with contaminated blanks were evaluated to determine if contamination was present in most samples, or if it was an isolated occurrence that did not affect other samples. If contaminant analytes were detected in natural samples at concentrations less than 1.5 times the level found in the highest associated blank, results were considered suspect and values for natural samples were flagged in the database with a "Z". This method is approved by the Environmental Protection Agency (EPA, no date), and is frequently applied for EPA Superfund sites at 5 times the level found in the highest associated blank. The 1.5 times concentration limit is applicable to this study because of low detection limits and low concentrations of analytes in blanks and natural samples. Interference caused by low instrument detection limits can also be misinterpreted as blank contamination.

EPA methods usually avoid misinterpretation of blank levels near instrument detection limits by applying the 5 times criterion <u>only</u> when the contaminant level in the blank exceeds twice the instrument detection limit. Because parameter detection limits used during this study are exceedingly low, no such rule was applied, and any contamination was treated with the 1.5 times rule. Therefore, a significant amount of reported concentrations is most likely due to interference (or "noise") in laboratory instrumentation at these low detection limits.

Natural samples flagged with the "Z" code were not used in statistical analysis of the data. This statistical summary of the data are presented in Appendix G3.

ACCURACY

A laboratory accuracy statement was prepared using blind field standards as quality control samples to assess laboratory accuracy. Blind field standards used in this investigation are certified standards prepared by the U.S. Environmental Protection Agency (EPA). Blind field standard samples were inserted into the sample train at specified frequencies and submitted for analysis along with natural samples. Although the laboratory can usually recognize the blind field standard, its concentration and exact contents are unknown. Blind field standards submitted during the Montana Project contained concentrations similar to those expected in natural samples.

Accuracy statements were generated by comparing laboratory results to the certified expected result provided by the manufacturer. A statistical analysis is applied using the following expression.

"The accuracy of parameter is (mean)% ± (1.96 X SD)%"

where:

mean = average of reported analytical values
SD = standard deviation.

The surface water accuracy statement, presented in Table G-3, contains the total number of standards submitted for analysis, average percent recovery, maximum uncertainty, and completeness for each parameter. Target accuracy levels were set in the project Quality Assurance/Quality Control Program (Appendix C) to achieve an 80% confidence level with ± 20% deviation. All parameters fell inside this range.

TABLE [illegible]ANDA MONTANA PROJECT SURFACE WATER DATA VALIDATION STATEMENTS

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	Parameter	ACCURACY # Samples	Accuracy (Average % Recovered)	Maximum Uncertainty (+/- %)	Completeness (%)	PRECISION Precision (Mean Relative % Difference)	# Samples	Maximum Uncertainty (+/- %)	Completeness (%)
1	Alkalinity, total	12	98.20	1.8	92.3	5.43	15	28.0019	100
2	Aluminum	9	88.62	5.1	69.2	0.00	15	0.0000	100
3	Ammonia	5	105.57	41.4	38.5	-1.59	15	33.4788	100
4	Arsenic	11	99.75	6.1	84.6	0.00	15	0.0000	100
5	Cadmium	11	110.20	9.5	84.6	-3.42	15	110.6921	100
6	Calcium	11	97.84	6.7	84.6	0.70	15	5.3271	100
7	Chloride	11	93.21	16.7	84.6	0.00	15	0.0000	100
8	Chromium	9	94.65	6.5	69.2	0.00	15	0.0000	100
9	Copper	9	93.24	4.9	69.2	3.02	15	80.8474	100
10	Fluoride	12	87.71	4.9	92.3	0.43	15	10.9595	100
11	Iron	9	95.37	8.0	69.2	-4.34	15	31.7725	100
12	Lead	11	102.12	5.5	84.6	0.00	15	47.7127	100
13	Magnesium	11	80.99	11.5	84.6	0.00	15	0.0000	100
14	Manganese	9	94.06	4.4	69.2	0.00	15	0.0000	100
15	Mercury	11	101.14	24.4	84.6	-1.90	15	32.0719	100
16	Molybdenum	0	(1)	(1)	---	0.00	15	0.0000	100
17	Nitrate	6	99.18	4.5	46.2	3.91	15	108.8638	100
18	Ortho-phosphate	6	95.67	3.1	46.2	9.23	15	61.3801	100
19	Phosphate, total	9	93.64	10.4	69.2	-10.46	15	92.6868	100
20	Potassium	11	110.52	21.0	84.6	0.00	15	47.7127	100
21	Silver	2	107.66	3.3	15.4	-5.71	15	43.3774	100
22	Sodium	11	106.58	5.9	84.6	1.46	15	65.7127	100
23	Sulfate	11	105.18	6.8	84.6	-12.89	15	86.7401	100
24	Total Dissolved Solids	12	89.92	8.2	92.3	-6.04	15	58.7603	100
25	Total Kjeldahl Nitrogen	8	100.61	10.6	61.5	4.02	15	21.5781	100
26	Total Suspended Solids	1	102.60	0.0	7.7	-8.00	15	60.7284	100
27	Turbidity	1	85.42	0.0	7.7	5.41	15	65.9147	100
28	Zinc	9	93.28	6.2	69.2	0.00	15	0.0000	100
29	Oil and Grease	0	(1)	(1)	---	0.00	15	0.0000	100

NOTES: 1) The blind field standard was not formulated for this parameter.
2) All values were below the detection level of the instrument.

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magnesium, typical analyte concentrations ranged from approximately 1.0-3.0 mg/L, with a true value near 2.00 mg/L. Natural samples with concentrations analyzed slightly outside this range yielded an extraordinary deviation percentage when averaged with samples that fell within the range.

Laboratory instrumentation and analytical methods are also a plausible source for high and low values. Laboratory instruments and methods used in many of the commercial labs, such as the Chen-Northern lab, analyze common ions accurately to 1.0 mg/L. Blind field standard values provided by the manufacturer are reported to 1.0 mg/L, which is beyond the level of accuracy our instrumentation can achieve. All parameters with detection limits of 1.0 mg/L are subject to this accuracy difference; values presented in the accuracy statement (Table G-3) reflect this difference.

PRECISION

A precision statement was developed using field duplicates collected for each parameter during groundwater sampling episodes. As discussed in the QA/QC program (Appendix C p.12) ranges of duplicate values are determined using laboratory acceptance criteria. Quantitative methods used to calculate precisions are presented in Appendix G-4.

Precision values for cadmium, mercury, nitrite + nitrate as N, sodium and sulfate were greater than 10% of the normal distribution.

As discussed in Appendix G-4, field duplicate samples are more a measure of the natural variation within the system, and are not a test of laboratory precision. Review of the data in Table J-2 indicates little variation within the natural system.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
EF-0200	04-29-88	1250	N	92522	GRAB		27.1	METER	1.0	6.4	6.6	14	11
EF-0300	04-29-88	1405	N	92521	EDI		38.0	METER	3.0	6.8	6.8	13	12
EF-0400	04-29-88	1540	N	92519	GRAB		128.0	EST	5.5	6.6	6.5	14	9
EF-0800	04-29-88	1930	N	92518	GRAB		--	--	5.5	6.7	6.7	14	14
RC-0850	04-29-88	1900	N	92516	GRAB		--	--	5.5	6.9	6.6	17	23
RC-2000	04-29-88	2030	N	92517	GRAB		--	--	6.0	7.0	6.9	31	20
WF-0020	04-29-88	1820	N	92520	EDI		17.4	METER	5.5	7.6	7.5	64	63
BC-0100	04-27-88	1925	N	92536	EDI		55.6	METER	6.0	7.3	7.2	47	47
LB-0100	04-27-88	1320	N	92533	EDI		15.4	METER	5.5	6.7	6.6	10	11
LB-0200	04-27-88	1140	N	92532	EDI		19.9	METER	3.5	6.9	6.5	20	10
LB-0500	04-28-88	1730	N	92538	EDI		42.4	METER	6.0	6.9	6.9	16	15
LB-0800	04-28-88	1845	N	92526	GRAB		157.8	METER	6.5	7.2	7.0	22	24
LB-2000	04-27-88	2020	N	92537	EDI		95.3	METER	6.5	7.0	7.2	16	26
LB-3000	04-28-88	2005	N	92539	EDI		155.5	METER	7.5	7.2	6.9	43	36
LC-0100	04-28-88	1000	N	92528	EDI		2.8	METER	4.5	7.0	7.0	16	12
LC-0600	04-28-88	1115	N	92530	EDI		2.6	METER	5.0	7.2	6.9	25	21
PM-0500	04-28-88	1430	N	92525	EDI		19.6	METER	7.0	7.3	6.8	17	20
PM-1000	04-28-88	1230	N	92527	EDI		20.4	METER	5.5	7.1	7.0	17	17
RA-0100	04-27-88	1550	N	92534	EDI		5.4	METER	7.5	6.3	6.3	12	12
RA-0200	04-27-88	1735	N	92535	GRAB		9.0	METER	7.0	6.4	6.6	15	11
RA-0600	04-28-88	1610	D	92524	EDI		--	--	6.0	7.1	6.4	--	14
RA-0600	04-28-88	1550	N	92529	EDI		22.3	METER	6.0	7.0	6.8	15	14
CC-0100	04-28-88	2030	CCB	92531	GRAB		--	--	--	--	3.8	--	77

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 1

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	04-29-88	N	0.33 C	5U	8 CZ	0.011 CZ	0.015 CZ	1.05 CRZ	0.10U	0.24	0.24	0.20	0.04
EF-0300	04-29-88	N	0.32 C	5U	20 C	0.009 CZ	0.013 CZ	1.88 CRZ	0.10U	0.20U	0.32	0.20	0.12
EF-0400	04-29-88	N	0.50 C	5U	5 CZ	0.005UCZ	0.013 CZ	0.26 CRZ	0.10U	0.20U	0.21	0.23	0.02
EF-0800	04-29-88	N	0.42 C	5U	3 CZ	0.007 CZ	0.012 CZ	0.87 CRZ	0.10U	0.20U	0.21	0.27	0.06
RC-0850	04-29-88	N	0.48 C	5U	2UCZ	0.007 CZ	0.013 CZ	0.50 CRZ	0.10U	0.20U	0.30	0.20	0.10
RC-2000	04-29-88	N	2.4 C	5U	15 CZ	0.008 CZ	0.014 CZ	0.31 CRZ	0.10U	0.20U	0.29	0.27	0.02
WF-0020	04-29-88	N	0.83 C	5U	45 C	0.009 CZ	0.013 CZ	0.53 CRZ	0.10U	0.20U	0.85	0.65	0.20
BC-0100	04-27-88	N	0.43 C	5U	13 CZ	0.008 CZ	0.015 CZ	0.49 CRZ	0.10U	0.20U	0.58	0.48	0.10
LB-0100	04-27-88	N	0.26 CZ	5U	8 CZ	0.007 CZ	0.015 CZ	0.20 CRZ	0.10U	0.20U	0.22	0.20	0.02
LB-0200	04-27-88	N	0.31 C	5U	3 CZ	0.016 C	0.015 CZ	0.16 CRZ	0.10U	0.22	0.18	0.20	0.02
LB-0500	04-28-88	N	0.32 C	5U	25 C	0.008 CZ	0.015 CZ	0.20 CRZ	0.10U	0.20U	0.24	0.27	0.03
LB-0800	04-28-88	N	0.55 C	5U	25 C	0.008 CZ	0.014 CZ	0.27 CRZ	0.10U	0.20U	0.31	0.27	0.04
LB-2000	04-27-88	N	0.50 C	5U	18 CZ	0.011 CZ	0.015 CZ	0.14 CRZ	0.10U	0.20U	0.34	0.32	0.02
LB-3000	04-28-88	N	0.52 C	5U	20 C	0.012 CZ	0.017 CZ	1.08 CRZ	0.10U	0.20U	0.55	0.42	0.13
LC-0100	04-28-88	N	0.41 C	5U	18 CZ	0.010 CZ	0.015 CZ	0.17 CRZ	0.10U	0.20U	0.22	0.27	0.05
LC-0600	04-28-88	N	2.2 C	5U	2UCZ	0.011 CZ	0.017 CZ	0.05 CRZ	0.10U	0.20U	0.40	0.27	0.13
PM-0500	04-28-88	N	0.38 C	5U	20 C	0.008 CZ	0.014 CZ	0.13 CRZ	0.24	0.20U	0.24	0.20	0.04
PM-1000	04-28-88	N	0.27 CZ	5U	13 CZ	0.007 CZ	0.014 CZ	0.09 CRZ	0.10U	0.20U	0.26	0.27	0.01
RA-0100	04-27-88	N	0.25 CZ	5U	15 CZ	0.008 CZ	0.015 CZ	0.18 CRZ	0.10U	0.30	0.20	0.25	0.05
RA-0200	04-27-88	N	0.32 C	5U	18 CZ	0.010 CZ	0.017 CZ	0.18 CRZ	0.10U	0.22	0.22	0.27	0.05
RA-0500	04-28-88	D	0.38 C	5U	18 CZ	0.007 CZ	0.014 CZ	0.59 CRZ	0.10U	0.20U	0.19	0.20	0.01
RA-0600	04-28-88	N	0.36 C	5U	15 CZ	0.012 CZ	0.015 CZ	0.17 CRZ	0.10U	0.27	0.22	0.20	0.02
CC-0100	04-28-88	CCB	0.20	5U	13	0.010	0.012	3.60	0.10U	0.20U			

NOTE:
A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not used for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	04-29-88	N	6U	1U	1U	1	1	6	7	0	1 CZ	1U	0.11 C	1UCZ
EF-0300	04-29-88	N	6U	1U	1U	1U	1	6	7	0	2 CZ	1U	0.07 CZ	1UCZ
EF-0400	04-29-88	N	6U	1U	1U	1	2	6	7	0	2 CZ	1U	0.06 CZ	1UCZ
EF-0800	04-29-88	N	6U	1U	1U	2	2	5	6	0	1UCZ	1U	0.06 CZ	1UCZ
RC-0850	04-29-88	N	3U	1	1U	1	1	11	13	0	1UCZ	1U	0.06 CZ	1UCZ
RC-2000	04-29-88	N	3U	1	1U	2	2	11	13	0	1UCZ	1	0.02 CZ	1UCZ
WF-0020	04-29-88	N	26	7	2	2	2	36	44	0	3 C	1U	0.08 CZ	1UCZ
BC-0100	04-27-88	N	15	6	1U	1	2	24	29	0	2 CZ	1U	0.11 C	2Z
LB-0100	04-27-88	N	6U	1U	1U	1U	1U	6	7	0	3 C	1U	0.07 CZ	1UCZ
LB-0200	04-27-88	N	6U	1U	1U	1U	1U	6	7	0	1UCZ	1U	0.07 CZ	2Z
LB-0500	04-28-88	N	6U	1U	1U	2	2	7	9	0	3 C	1U	0.08 CZ	2 Z
LB-0800	04-28-88	N	3U	1	1U	2	2	11	13	0	2 CZ	1U	0.11 C	1UCZ
LB-2000	04-27-88	N	5U	2	1U	2	2	14	17	0	1 CZ	1U	0.08 CZ	1Z
LB-3000	04-28-88	N	10	4	1U	2	2	20	24	0	2 CZ	1U	0.07 CZ	1Z
LC-0100	04-28-88	N	6U	1U	1U	2	2	8	10	0	1 CZ	1U	0.09 CZ	1UCZ
LC-0600	04-28-88	N	3U	1	1U	2	2	13	16	0	5 C	1U	0.09 CZ	1UCZ
PM-0500	04-28-88	N	3U	1	1U	1	1	9	11	0	1 CZ	1U	0.09 CZ	1UCZ
PM-1000	04-28-88	N	3U	1	1U	2	2	10	12	0	1 CZ	1U	0.10 CZ	2Z
RA-0100	04-27-88	N	6U	1U	1U	2	1	6	7	0	2 CZ	1U	0.07 CZ	3Z
RA-0200	04-27-88	N	6U	1U	1U	2	2	6	7	0	3 C	1U	0.06 CZ	2Z
RA-0600	04-28-88	D	6U	1U	1U	1	1	5	6	0	1 CZ	1U	0.09 CZ	1UCZ
RA-0600	04-28-88	N	6U	1U	1U	1	1	8	10	0	1UCZ	1U	0.08 CZ	1UCZ
CC-0100	04-28-88	CCB	6U	1U	1U	1U	1U	1U	2U	0	2	1U	0.07	1

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 1

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	04-29-88	N	0.1U	0.005U	0.0035 CR	0.02U	0.006 C	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
EF-0300	04-29-88	N	0.1U	0.005U	0.0012 CRZ	0.02U	0.006 C	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
EF-0400	04-29-88	N	0.1U	0.005U	0.0012 CRZ	0.02U	0.003 C	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
EF-0800	04-29-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.022 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
RC-0850	04-29-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.007 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
RC-2000	04-29-88	N	0.1U	0.005U	0.0028 CRZ	0.02U	0.004 C	0.09	0.001U	0.02U	0.0002UCZ	0.05U	0.0002	0.02U
WF-0020	04-29-88	N	0.1U	0.005U	0.0020 CRZ	0.02U	0.003 C	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
BC-0100	04-27-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.002 CZ	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
LB-0100	04-27-88	N	0.1U	0.005U	0.0028 CRZ	0.02U	0.002 CZ	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
LB-0200	04-27-88	N	0.1U	0.005U	0.0017 CRZ	0.02U	0.004 C	0.02U	0.001U	0.02U	0.0004 CZ	0.05U	0.0002U	0.02U
LB-0500	04-28-88	N	0.1U	0.005U	0.0027 CRZ	0.02U	0.003 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0022	0.02U
LB-0800	04-28-88	N	0.1U	0.005U	0.0030 CRZ	0.02U	0.005 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
LB-2000	04-27-88	N	0.1U	0.005U	0.0026 CRZ	0.02U	0.002 CZ	0.05U	0.001U	0.02U	0.0002 CZ	0.05U	0.0002U	0.02U
LB-3000	04-28-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.008 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0005	0.02U
LC-0100	04-28-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.008 C	0.05	0.001U	0.02U	0.0002 CZ	0.05U	0.0010	0.02U
LC-0600	04-28-88	N	0.1	0.005U	0.0045 CR	0.02U	0.006 C	0.11	0.004	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
PM-0500	04-28-88	N	0.1U	0.005U	0.0019 CRZ	0.02U	0.006 C	0.05U	0.001	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
PM-1000	04-28-88	N	0.1U	0.005U	0.0024 CRZ	0.02U	0.005 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
RA-0100	04-27-88	N	0.1U	0.005U	0.0020 CRZ	0.02U	0.003 C	0.05U	0.002	0.02U	0.0002 CZ	0.05U	0.0002	0.02U
RA-0200	04-27-88	N	0.1U	0.005U	0.0019 CRZ	0.02U	0.002 C	0.05U	0.001U	0.02U	0.0002 CZ	0.05U	0.0002U	0.02U
RA-0600	04-28-88	D	0.1U	0.005U	0.0018 CRZ	0.02U	0.002 CZ	0.05U	0.001U	0.02U	0.0004 CZ	0.05U	0.0002U	0.02U
RA-0600	04-28-88	N	0.1U	0.005U	0.0030 CRZ	0.02U	0.004 C	0.05U	0.001U	0.02U	0.0003 CZ	0.05U	0.0002U	0.02U
CC-0100	04-28-88	CCB	0.1U	0.005U	0.0022	0.02U	0.002	0.05U	0.001U	0.02U	0.0004	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 2

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conduc-tance (umhos/cm) Field	Lab
EF-0200	05-12-88	1520	N	92709	EDI	N/G	37.8	METER	2.0	--	6.1	12	8
EF-0300	05-12-88	1730	N	92707	EDI	1.20	47.8	METER	6.0	--	5.9	12	10
EF-0400	05-12-88	1845	N	92708	GRAB	0.95	149.0	METER	6.5	--	4.6	12	19
EF-0800	05-11-88	1700	N	92695	GRAB	N/G	100.0	EST	--	--	6.5	12	8
RC-0850	05-11-88	1520	N	92697	GRAB	0.95	125.3	METER	8.5	--	6.3	13	9
RC-2000	05-11-88	1820	N	92696	GRAB	0.95	--	--	9.0	--	6.6	23	17
WF-0020	05-11-88	1430	D	92694	EDI	1.00	21.7	--	8.0	--	7.3	70	57
WF-0020	05-11-88	1400	N	92693	EDI	1.00	21.7	METER	8.0	--	7.5	70	58
BC-0100	05-09-88	0945	N	92691	EDI	1.00	98.1	METER	7.0	7.8	7.1	46	42
LB-0100	05-10-88	1145	N	92700	GRAB	N/G	48.9	METER	4.5	6.9	6.2	6	10
LB-0200	05-10-88	0950	N	92702	EDI	0.80	73.6	METER	5.5	6.3	5.8	14	10
LB-0500	05-10-88	1355	N	92703	GRAB	1.00	84.4	METER	6.5	7.0	6.1	13	10
LB-0800	05-11-88	0950	N	92698	GRAB	0.95	173.8	METER	6.0	--	6.2	15	14
LB-2000	05-09-88	1145	N	92692	EDI	1.00	204.0	METER	14	7.4	6.6	24	19
LB-3000	05-11-88	1030	N	92699	GRAB	N/G	--	--	7.0	--	6.7	30	27
LC-0100	05-09-88	1730	N	92689	EDI	N/G	2.4	METER	9.0	6.8	6.3	15	13
LC-0600	05-09-88	1815	N	92690	EDI	0.60	1.8	METER	10	7.2	6.8	29	24
PM-0500	05-09-88	1500	N	92688	GRAB	N/G	53.0	METER	7.0	7.4	6.6	18	16
PM-1000	05-09-88	1615	N	92687	EDI	1.00	54.8	METER	8.0	6.8	6.5	19	16
RA-0100	05-10-88	1550	N	92704	GRAB	N/G	51.5	METER	--	6.4	5.9	12	7
RA-0200	05-10-88	1720	N	92705	GRAB	1.00	62.8	METER	--	6.8	6.0	13	7
RA-0600	05-10-88	1905	N	92706	EDI	0.95	66.0	METER	7.0	--	6.1	14	11
BB-100	05-10-88	1020	BB	92701	GRAB	N/G	--	--	--	--	5.9	--	3

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 2
Page 2

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	05-12-88	N	0.39B	1	7	0.009B	0.013BZ	0.04B	0.1U	0.2U	0.15	0.20	0.05
EF-0300	05-12-88	N	0.30B	1U	4	0.008BZ	0.010BZ	0.10B	0.1U	0.2U	0.16	0.20	0.04
EF-0400	05-12-88	N	0.36B	1U	8	0.009B	0.011BZ	0.09B	0.1U	0.2U	0.16	0.23	0.07
EF-0800	05-11-88	N	0.24B	1	1U	0.006BZ	0.012BZ	0.02B	0.1U	0.2U	0.17	0.20	0.03
RC-0850	05-11-88	N	0.26B	1U	9	0.005UBZ	0.009BZ	0.02B	0.1U	0.2U	0.13	0.27	0.14
RC-2000	05-11-88	N	0.75B	7	2	0.006BZ	0.009BZ	0.02B	0.1U	0.2U	0.25	0.27	0.02
WF-0020	05-11-88	D	0.26B	1	29	0.006BZ	0.011BZ	0.01BZ	0.1U	0.2U	0.77	0.65	0.12
WF-0020	05-11-88	N	0.28B	1	29	0.017B	0.017B	0.03B	0.1U	0.2U	0.77	0.65	0.12
BC-0100	05-09-88	N	1.22B	1U	19	0.005UBZ	0.010BZ	0.49B	0.1U	0.2U	0.54	0.45	0.09
LB-0100	05-10-88	N	0.24B	1	10	0.008BZ	0.010BZ	0.20B	0.1U	0.2U	0.12	0.27	0.15
LB-0200	05-10-88	N	0.26B	1U	8	0.005BZ	0.011BZ	0.28B	0.1U	0.2U	0.13	0.23	0.10
LB-0500	05-10-88	N	0.35B	1	7	0.008BZ	0.011BZ	0.16B	0.1U	0.2U	0.14	0.27	0.13
LB-0800	05-11-88	N	0.50B	3	9	0.007BZ	0.009BZ	0.19B	0.1U	0.2U	0.18	0.23	0.05
LB-2000	05-09-88	N	1.13B	1	1U	0.008BZ	0.012BZ	0.12B	0.1U	0.2U	0.26	0.27	0.01
LB-3000	05-11-88	N	0.48B	4	16	0.013B	0.013BZ	0.22B	0.1U	0.2U	0.32	0.37	0.05
LC-0100	05-09-88	N	0.28B	1U	20	0.011B	0.011BZ	0.01BZ	0.1U	0.2U	0.21	0.27	0.06
LC-0600	05-09-88	N	1.22B	2	18	0.016B	0.016B	0.01BZ	0.1U	0.2U	0.29	0.32	0.03
PM-0500	05-09-88	N	0.35B	1U	3	0.005UBZ	0.007BZ	0.08B	0.1U	0.2U	0.23	0.20	0.03
PM-1000	05-09-88	N	0.26B	1U	16	0.005UBZ	0.007BZ	0.05B	0.1U	0.2U	0.23	0.20	0.03
RA-0100	05-10-88	N	0.45B	8	3	0.008BZ	0.013BZ	0.11B	0.1U	0.2U	0.10	0.23	0.13
RA-0200	05-10-88	N	0.35B	7	1	0.010B	0.015B	0.10B	0.1U	0.2U	0.12	0.20	0.08
RA-0600	05-10-88	N	0.55B	3	7	0.094B	0.265B	0.09B	0.1U	1.43	0.16	0.23	0.07
BB-100	05-10-88	BB	0.17	1U	1U	0.006	0.010	0.01	0.1U	0.2U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	05-12-88	N	6U	1U	1U	1	1BZ	5	6	0	1U	1U	0.05U	1U
EF-0300	05-12-88	N	6U	1U	1U	1U	1BZ	5	6	0	1U	1U	0.05	1U
EF-0400	05-12-88	N	6U	1U	1U	1	2B	1U	2U	0	5	1U	0.05	1U
EF-0800	05-11-88	N	6U	1U	1*	1	1BZ	6	7	0	1U	1U	0.05U	1U
RC-0850	05-11-88	N	6U	1U	1U	2	2B	4	5	0	1U	1U	0.05U	1U
RC-2000	05-11-88	N	3U	1	1U	2	2B	9	11	0	2	1U	0.05U	1U
WF-0020	05-11-88	D	26	7	2	2	2B	35	43	0	2	1U	0.05U	1U
WF-0020	05-11-88	N	26	7	2	2	2B	35	43	0	2	1U	0.05U	1U
BC-0100	05-09-88	N	15	6	1U	1	1BZ	23	28	0	1	1U	0.05U	1U
LB-0100	05-10-88	N	6U	1U	1U	2	2B	3	4	0	1U	1U	0.05	1U
LB-0200	05-10-88	N	6U	1U	1U	1	2B	3	4	0	1U	1U	0.05U	1U
LB-0500	05-10-88	N	6U	1U	1U	2	2B	4	5	0	1U	1U	0.05U	1U
LB-0800	05-11-88	N	6U	1U	1U	1	2B	6	7	0	1U	1U	0.05U	1U
LB-2000	05-09-88	N	3U	1	1U	2	2B	10	12	0	1	1U	0.05U	1U
LB-3000	05-11-88	N	8	3	1U	2	2B	13	16	0	1U	1U	0.05U	1
LC-0100	05-09-88	N	6U	1U	1U	2	2B	8	10	0	1	1U	0.05U	1U
LC-0600	05-09-88	N	5U	2	1U	2	2B	12	15	0	1U	1U	0.05U	1U
PM-0500	05-09-88	N	3U	1	1U	1	1BZ	9	11	0	1U	1U	0.05U	1U
PM-1000	05-09-88	N	3U	1	1U	1	1BZ	9	11	0	1U	1U	0.05U	1U
RA-0100	05-10-88	N	6U	1U	1U	1	2B	2	2	0	1	1U	0.05U	1U
RA-0200	05-10-88	N	6U	1U	1U	1	1BZ	3	4	0	1U	1U	0.05U	1U
RA-0600	05-10-88	N	6U	1U	1U	1	2B	5	6	0	1U	1U	0.05U	1U
BB-100	05-10-88	BB	6U	1U	1U	1U	1	2	2	0	1U	1U	0.05U	1U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	05-12-88	N	0.1U	0.005U	0.0040BR	0.02U	0.008B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	05-12-88	N	0.1U	0.005U	0.0017BR	0.02U	0.003B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	05-12-88	N	0.1U	0.005U	0.0026BR	0.02U	0.003B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	05-11-88	N	0.1U	0.005U	0.0007BR	0.02U	0.001BZ	0.05U	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	05-11-88	N	0.1U	0.005U	0.0004BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-2000	05-11-88	N	0.1U	0.005U	0.0013 BR	0.02U	0.004B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
WF-0020	05-11-88	D	0.1U	0.005U	0.0005BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0005	0.02U
WF-0020	05-11-88	N	0.1U	0.005U	0.0013BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BC-0100	05-09-88	N	0.1U	0.005U	0.0009BR	0.02U	0.003B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0100	05-10-88	N	0.1U	0.005U	0.0008BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0200	05-10-88	N	0.1U	0.005U	0.0018BR	0.02U	0.004B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0008U	0.02U
LB-0500	05-10-88	N	0.1U	0.005U	0.0015BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	05-11-88	N	0.1U	0.005U	0.0007BR	0.02U	0.002BZ	0.06	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	05-09-88	N	0.1U	0.005U	0.0004BR	0.02U	0.003B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	05-11-88	N	0.1U	0.005U	0.0009BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	05-09-88	N	0.1U	0.005U	0.0009BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	05-09-88	N	0.1U	0.005U	0.0004BR	0.02U	0.003B	0.09	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	05-09-88	N	0.1U	0.005U	0.0017BR	0.02U	0.003B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	05-09-88	N	0.1U	0.005U	0.0009BR	0.02U	0.002BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0100	05-10-88	N	0.1U	0.005U	0.0006BR	0.02U	0.001UBZ	0.07	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	05-10-88	N	0.1U	0.005U	0.0003BR	0.02U	0.002BZ	0.08	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	05-10-88	N	0.1U	0.005U	0.0003BR	0.02U	0.007B	0.06	0.002	0.02U	0.0002U	0.05U	0.0008	0.02U
BB-100	05-10-88	BB	0.1U	0.005U	0.0002	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Temperature (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
EF-0200	05-24-88	1230	N	92796	EDI	N/G	35.6	METER	1.5	6.3	6.6	13	9
EF-0300	05-24-88	1430	N	92797	EDI	1.05	39.5	METER	--	6.8	6.7	13	10
EF-0400	05-24-88	1620	N	92798	GRAB	0.75	96.1	METER	--	6.5	6.6	12	10
EF-0800	05-23-88	1525	N	92793	GRAB	N/G	--	--	8.5	6.6	6.9	8	8
RC-0850	05-23-88	1810	N	92794	GRAB	1.20	299.6	METER	9.0	6.0	6.7	11	8
RC-2000	05-23-88	1900	N	92795	GRAB	1.20	--	--	10.0	7.0	6.8	14	15
WF-0020	05-23-88	1425	N	92792	EDI	1.00	14.0	METER	8.0	7.7	7.3	60	51
BC-0100	05-26-88	1025	N	92815	EDI	0.90	78.4	METER	6.0	7.4	7.3	63	58
LB-0100	05-25-88	1220	N	92804	GRAB	N/G	40.6	METER	5.5	6.6	6.6	8	9
LB-0200	05-25-88	1045	N	92805	EDI	0.70	53.6	METER	4.5	6.8	6.5	7	11
LB-0500	05-25-88	--	N	92807	GRAB	0.90	65.6	METER	7.0	6.7	6.9	14	10
LB-0800	05-26-88	1825	N	92821	EDI	0.85	157.8	METER	9.0	7.0	7.1	27	12
LB-2000	05-26-88	1150	N	92814	EDI	0.95	190.6	METER	8.0	7.0	7.0	30	18
LB-3000	05-27-88	1000	N	92816	GRAB	1.40	319.2	METER	7.0	7.6	7.4	32	30
LC-0100	05-26-88	1420	N	92811	EDI	N/G	1.6	METER	9.0	6.8	6.9	27	14
LC-0600	05-26-88	1325	N	92813	GRAB	0.55	2.1	METER	11.0	6.6	7.2	47	26
PM-0500	05-26-88	1555	N	92818	GRAB	N/G	37.1	METER	7.0	7.1	7.1	27	19
PM-1000	05-26-88	1700	N	92817	EDI	0.90	40.1	METER	8.0	7.2	7.0	29	20
PM-1000	05-26-88	1730	D	92819	EDI	N/G	0.9	--	8.0	7.2	7.0	27	20
RA-0100	05-25-88	1620	N	92808	GRAB	N/G	60.8	METER	7.5	5.8	6.6	13	7
RA-0200	05-25-88	1830	N	92809	GRAB	0.90	44.0	METER	7.0	6.4	6.8	17	8
RA-0600	05-25-88	2000	N	92820	EDI	0.80	46.7	METER	8.0	6.5	6.9	26	10
BB-100	05-25-88	1250	BB	92806	GRAB	--	--	--	--	--	--	--	--
BFS-100	05-25-88	--	BFS	92810	GRAB	--	--	--	--	--	7.4	--	91
CC-100	05-26-88	1515	CCB	92812	GRAB	--	--	--	--	5.6	6.4	2	1

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 3

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	05-24-88	N	1.45 C	1U	3 C	0.005U	0.005U	0.07 C	0.1U	0.2U	0.17	0.23	0.06
EF-0300	05-24-88	N	1.55 C	1U	1 CZ	0.005	0.005U	0.07 C	0.1U	0.2U	0.19	0.27	0.08
EF-0400	05-24-88	N	1.00 C	1U	8 C	0.005U	0.005U	0.03 C	0.1U	0.2U	0.17	0.20	0.03
EF-0800	05-23-88	N	0.85 C	1U	14 C	0.005U	0.005U	0.02 CZ	0.1U	0.2U	0.15	0.20	0.05
RC-0850	05-23-88	N	0.95 C	1	12 C	0.005U	0.005	0.05 C	0.1U	0.2U	0.15	0.20	0.05
RC-2000	05-23-88	N	1.05 C	2	19 C	0.005U	0.005U	0.02 CZ	0.1U	0.2U	0.23	0.20	0.03
WF-0020	05-23-88	N	0.85 C	1U	37 C	0.005U	0.005U	0.02 CZ	0.1U	0.2U	0.59	0.45	0.14
BC-0100	05-26-88	N	0.28 C	1U	28 C	0.005U	0.005U	0.26 C	0.1U	0.2U	0.67	0.71	0.04
LB-0100	05-25-88	N	1.30 C	1	14 C	0.005U	0.005U	0.13 C	0.1	0.2U	0.16	0.20	0.04
LB-0200	05-25-88	N	0.80 C	1U	11 C	0.005U	0.005U	0.12 C	0.1U	0.2U	0.18	0.25	0.07
LB-0500	05-25-88	N	0.40 C	1U	13 C	0.005U	0.005U	0.09 C	0.1U	0.2U	0.20	0.29	0.09
LB-0800	05-26-88	N	0.35 C	1	8 C	0.005	0.020	0.07 C	0.1U	0.2U	0.19	0.36	0.17
LB-2000	05-26-88	N	1.10 C	1U	10 C	0.005U	0.005U	0.05 C	0.1U	0.2U	0.25	0.31	0.06
LB-3000	05-27-88	N	0.65 C	1U	18 C	0.005U	0.005U	0.25 C	0.1U	0.2U	0.39	0.46	0.07
LC-0100	05-26-88	N	1.10 C	1U	17 C	0.005U	0.005U	0.02 CZ	0.1U	0.2U	0.21	0.36	0.15
LC-0600	05-26-88	N	1.35 C	1U	24 C	0.005U	0.005U	0.01 CZ	0.1U	0.2U	0.33	0.41	0.08
PM-0500	05-26-88	N	0.28 CZ	1U	6 C	0.005U	0.005U	0.05 C	0.1U	0.2U	0.27	0.30	0.03
PM-1000	05-26-88	N	0.22 CZ	1U	8 C	0.005U	0.005U	0.03 C	0.1U	0.2U	0.29	0.30	0.01
PM-1000	05-26-88	D	0.20 CZ	1U	12 C	0.005	0.005U	0.06 C	0.1U	0.2U	0.27	0.36	0.09
RA-0100	05-25-88	N	0.28 CZ	1U	14 C	0.005U	0.005U	0.10 C	0.1U	0.2U	0.16	0.29	0.13
RA-0200	05-25-88	N	0.75 C	1U	7 C	0.005U	0.005U	0.08 C	0.1U	0.2U	0.15	0.25	0.10
RA-0600	05-25-88	N	0.30 C	1U	9 C	0.005U	0.005U	0.08 C	0.1U	0.2U	0.17	0.36	0.19
BB-100	05-25-88	BB				0.005U	0.005U		0.1U	0.2U			
BFS-100	05-25-88	BFS			50	0.047		0.14					
CC-100	05-26-88	CCB	0.20	1U	1	0.005U	0.005U	0.02	0.1U	0.2U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	05-24-88	N	6U	1U	1U	1 ACZ	2 ACZ	6	7	0	1	1U	0.05U	
EF-0300	05-24-88	N	6U	1U	1U	2 ACZ	2 ACZ	7	9	0	1U	1U	0.05U	
EF-0400	05-24-88	N	6U	1U	1U	1 ACZ	1 ACZ	6	7	0	1U	1U	0.05U	
EF-0800	05-23-88	N	6U	1U	1U	1 ACZ	1 ACZ	5	6	0	1U	1U	0.05U	
RC-0850	05-23-88	N	6U	1U	1U	1 ACZ	1 ACZ	5	6	0	1U	1U	0.05U	
RC-2000	05-23-88	N	6U	1U	1U	1 ACZ	1 ACZ	9	11	0	1	1U	0.05U	
WF-0020	05-23-88	N	17	5	1	2 ACZ	1UACZ	27	33	0	1	1U	0.05U	
BC-0100	05-26-88	N	23	9	1U	3 ACZ	2 ACZ	30	37	0	1	1U	0.05U	
LB-0100	05-25-88	N	6U	1U	1U	1 ACZ	1UACZ	5	6	0	1	1U	0.05U	
LB-0200	05-25-88	N	6U	1U	1U	2 ACZ	1UACZ	6	7	0	1U	1U	0.05U	
LB-0500	05-25-88	N	6U	1U	1U	3 ACZ	1 ACZ	6	7	0	2	1U	0.05U	
LB-0800	05-26-88	N	6U	1U	1U	4 ACZ	2 ACZ	7	9	0	1U	1U	0.05U	
LB-2000	05-26-88	N	3U	1	1U	3 ACZ	2 ACZ	10	12	0	1	1U	0.05U	
LB-3000	05-27-88	N	10	4	1U	3 ACZ	2 ACZ	16	20	0	1U	1U	0.05U	
LC-0100	05-26-88	N	6U	1U	1U	4 ACZ	2 ACZ	8	10	0	1U	1U	0.05U	
LC-0600	05-26-88	N	5U	2	1U	4 ACZ	2 ACZ	14	17	0	1U	1U	0.05U	
PM-0500	05-26-88	N	5U	2	1U	2 ACZ	1 ACZ	11	13	0	1U	1U	0.05U	
PM-1000	05-26-88	N	5U	2	1U	2 ACZ	1 ACZ	12	15	0	1U	1U	0.05U	
PM-1000	05-26-88	D	5U	2	1U	3 ACZ	2 ACZ	11	13	0	1U	1U	0.05U	
RA-0100	05-25-88	N	6U	1U	1U	3 ACZ	1 ACZ	5	6	0	1	1U	0.05U	
RA-0200	05-25-88	N	6U	1U	1U	2 ACZ	1 ACZ	5	6	0	1	1U	0.05U	
RA-0600	05-25-88	N	6U	1U	1U	4 ACZ	2 ACZ	6	7	0	1U	1U	0.05U	
BB-100	05-25-88	BB												
BFS-100	05-25-88	BFS	17	5	1	11	4	18	22	0	8	10	0.40	
CC-100	05-26-88	CCB	6U	1U	1U	2	2	2	2	0	1U	1U	0.05U	

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
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U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	05-24-88	N	0.1U	0.005U	0.0021 BCZ	0.02U	0.003 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	05-24-88	N	0.1U	0.005U	0.0018 BCZ	0.02U	0.004 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	05-24-88	N	0.1U	0.005U	0.0022 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	05-23-88	N	0.1U	0.005U	0.0034 BC	0.02U	0.003 B	0.05U	0.024	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	05-23-88	N	0.1U	0.005U	0.0026 BCZ	0.02U	0.001 BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-2000	05-23-88	N	0.1U	0.005U	0.0026 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
WF-0020	05-23-88	N	0.1U	0.005U	0.0028 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BC-0100	05-26-88	N	0.1U	0.005U	0.0030 BC	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0100	05-25-88	N	0.1U	0.005U	0.0026 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0200	05-25-88	N	0.1U	0.005U	0.0016 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0500	05-25-88	N	0.1U	0.005U	0.0028 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	05-26-88	N	0.1U	0.005U	0.0028 BCZ	0.02U	0.004 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	05-26-88	N	0.1U	0.005U	0.0015 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	05-27-88	N	0.1U	0.005U	0.0019 BCZ	0.02U	0.001 BZ	0.05U	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	05-26-88	N	0.1U	0.005U	0.0018 BCZ	0.02U	0.003 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	05-26-88	N	0.1U	0.005U	0.0022 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	05-26-88	N	0.1U	0.005U	0.0023 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	05-26-88	N	0.1U	0.005U	0.0021 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	05-26-88	D	0.1U	0.005U	0.0019 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0100	05-25-88	N	0.1U	0.005U	0.0015 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	05-25-88	N	0.1U	0.005U	0.0018 BCZ	0.02U	0.005 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	05-25-88	N	0.1U	0.005U	0.0019 BCZ	0.02U	0.002 B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-100	05-25-88	BB	0.1U	0.005U	0.0001	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-100	05-25-88	BFS	0.5	0.099	0.0220	0.09	0.11	0.1	0.11	0.1	0.0043	0.05U	0.0002U	0.09
CC-100	05-26-88	CCB	0.1U	0.005U	0.0020	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Temperature (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
EF-0200	06/07/88	1140	N	92945	EDI	N/G	29.7	METER	10.0	6.7	7.0	12	9
EF-0300	06/07/88	1330	N	92958	EDI	1.00	12.4	METER	10.0	6.8	7.1	11	10
EF-0400	06/07/88	1415	N	92946	GRAB	0.60	--	--	10.0	6.8	7.0	11	10
EF-0800	06/06/88	1545	N	92940	GRAB	N/G	--	--	10.0	6.6	6.9	13	9
RC-0850	06/06/88	1720	N	92941	GRAB	0.80	153.3	METER	10.0	7.0	7.0	11	8
RC-2000	06/06/88	1810	N	92942	GRAB	0.70	--	--	11.0	6.8	7.3	18	16
WF-0020	06/06/88	1450	N	92939	EDI	0.78	13.0	METER	9.0	7.6	7.8	55	51
BC-0100	06/10/88	0900	D	92960	EDI	0.75	--	--	8.0	7.5	7.7	70	69
BC-0100	06/10/88	0845	N	92961	EDI	0.75	56.7	METER	8.0	7.6	7.9	65	67
LB-0100	06/08/88	1400	N	92948	EDI	N/G	50.7	METER	5.0	6.6	6.8	12	9
LB-0200	06/08/88	1230	N	92947	EDI	0.60	48.7	METER	5.5	6.8	6.8	4	10
LB-0500	06/08/88	1600	N	92949	GRAB	0.85	57.8	METER	5.0	6.5	6.7	15	11
LB-0800	06/09/88	1800	N	92957	GRAB	0.60	91.7	METER	10.5	7.0	7.2	19	15
LB-2000	06/10/88	1015	N	92959	EDI	0.72	128.5	METER	9.0	6.9	7.1	21	20
LB-3000	06/08/88	1045	N	92938	GRAB	1.25	154.2	METER	8.0	6.8	7.5	30	34
LC-0100	06/09/88	1605	N	92956	EDI	N/G	1.8	METER	9.0	7.1	7.3	14	17
LC-0600	06/09/88	1650	N	92955	EDI	0.50	1.0	METER	13.0	7.9	7.5	31	34
PM-0500	06/09/88	1515	N	92954	GRAB	N/G	22.3	METER	8.0	7.3	7.5	26	24
PM-1000	06/09/88	1100	N	92951	EDI	0.60	26.7	METER	5.0	7.2	7.4	25	24
RA-0100	06/09/88	1230	N	92952	GRAB	N/G	19.3	METER	7.0	6.4	6.4	7	7
RA-0200	06/09/88	1400	N	92953	GRAB	0.80	29.1	METER	8.0	6.9	6.8	14	7
RA-0600	06/09/88	1000	N	92950	EDI	0.65	33.3	METER	5.0	6.4	6.8	12	15
BB-100	06/06/88	1805	BB	92944	GRAB	--	--	--	--	--	5.9	--	3
BFS-100	06/03/88	--	BFS	92962	--	--	--	--	--	--	7.8	--	89
CC-100	06/06/88	1815	CCB	92943	--	--	--	--	20.5	5.9	5.8	2	2

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	06/07/88	N	0.38 BCZ	1U	10 BR	0.005	0.005U	0.01UBZ	0.05UBCZ	0.20U	0.17	0.20	0.03
EF-0300	06/07/88	N	0.32 BCZ	1U	2 BRZ	0.005U	0.005U	0.03 BZ	0.05UBCZ	0.20U	0.17	0.23	0.06
EF-0400	06/07/88	N	0.31 BCZ	1U	10 BR	0.005U	0.005U	0.01UBZ	0.05 BCZ	0.20U	0.15	0.23	0.08
EF-0800	06/06/88	N	0.36 BCZ	1U	4 BRZ	0.005U	0.005U	0.01UBZ	0.07 BCZ	0.20U	0.15	0.20	0.05
RC-0850	06/06/88	N	0.34 BCZ	1U	13 BR	0.005U	0.005U	0.01UBZ	0.05UBCZ	0.20U	0.15	0.20	0.05
RC-2000	06/06/88	N	0.58 BC	2	13 BR	0.005U	0.005U	0.01UBZ	0.06 BCZ	0.20U	0.23	0.20	0.03
WF-0020	06/06/88	N	0.38 BCZ	1U	34 BR	0.005U	0.005U	0.01UBZ	0.05UBCZ	0.20U	0.61	0.48	0.13
BC-0100	06/10/88	D	0.31 BCZ	1U	28 BR	0.005U	0.005U	0.13 B	0.05 BCZ	0.20U	0.76	0.60	0.16
BC-0100	06/10/88	N	0.32 BCZ	1U	39 BR	0.005U	0.005U	0.13 B	0.05 BCZ	0.20U	0.78	0.68	0.10
LB-0100	06/08/88	N	0.31 BCZ	1U	9 BR	0.005U	0.005U	0.07 B	0.05UBCZ	0.20U	0.13	0.23	0.10
LB-0200	06/08/88	N	0.32 BCZ	1U	9 BR	0.005U	0.005U	0.05 B	0.09 BCZ	0.20U	0.15	0.20	0.05
LB-0500	06/08/88	N	0.38 BCZ	1U	6 BR	0.005U	0.005U	0.04 BZ	0.05 BCZ	0.20U	0.15	0.23	0.08
LB-0800	06/09/88	N	0.31 BCZ	1U	9 BR	0.005U	0.005U	0.02 BZ	0.11 BC	0.20U	0.19	0.25	0.06
LB-2000	06/10/88	N	0.34 BCZ	1U	14 BR	0.005U	0.005	0.02 BZ	0.05UBCZ	0.20U	0.23	0.20	0.03
LB-3000	06/08/88	N	0.48 BC	1	19 BR	0.005U	0.005U	0.05 B	0.06 BCZ	0.20U	0.39	0.30	0.09
LC-0100	06/09/88	N	0.52 BC	1U	14 BR	0.005U	0.005U	0.01UBZ	0.05UBCZ	0.20U	0.25	0.25	0.00
LC-0600	06/09/88	N	0.71 BC	1	20 BR	0.005U	0.013	0.01UBZ	0.05UBCZ	0.20U	0.41	0.35	0.06
PM-0500	06/09/88	N	0.26 BCZ	1U	8 BR	0.005U	0.005U	0.01 BZ	0.05UBCZ	0.20U	0.33	0.33	0.00
PM-1000	06/09/88	N	0.22 BCZ	1U	7 BR	0.005U	0.005U	0.02 BZ	0.05UBCZ	0.20U	0.29	0.28	0.01
RA-0100	06/09/88	N	0.30 BCZ	1U	1 BRZ	0.005U	0.005U	0.04 BZ	0.07 BCZ	0.20U	0.11	0.23	0.12
RA-0200	06/09/88	N	0.43 BC	1	3 BRZ	0.005U	0.005U	0.03 BZ	0.06 BCZ	0.20U	0.13	0.23	0.10
RA-0600	06/09/88	N	0.25 BCZ	1U	11 BR	0.005U	0.005U	0.03 BZ	0.08 BCZ	0.20U	0.15	0.23	0.08
BB-100	06/06/88	BB	0.22	--	3	0.005U	0.005U	0.03	0.06	0.20U			
BFS-100	06/03/88	BFS	0.30		34		0.085	0.01		0.38			
CC-100	06/06/88	CCB	0.26	1U	1U	0.005U	0.005U	0.01U	0.07	0.20U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
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U - value less than detection limit.
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NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	06/07/88	N	0.1U	0.005U	0.0027 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	06/07/88	N	0.1U	0.005U	0.0035 BCZ	0.02U	0.007 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	06/07/88	N	0.1U	0.005U	0.0043 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	06/06/88	N	0.1U	0.005U	0.0027 BCZ	0.02U	0.001 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	06/06/88	N	0.1U	0.005U	0.0040 BCZ	0.02U	0.002 AZ	0.05U	0.001 CZ	0.02U	0.0002	0.05U	0.0002U	0.02U
RC-2000	06/06/88	N	0.1U	0.005U	0.0037 BCZ	0.02U	0.002 AZ	0.05U	0.002 C	0.02U	0.0002	0.05U	0.0002U	0.02U
WF-0020	06/06/88	N	0.1U	0.005U	0.0022 BCZ	0.02U	0.001UAZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
BC-0100	06/10/88	D	0.1U	0.005U	0.0037 BCZ	0.02U	0.001UAZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
BC-0100	06/10/88	N	0.1U	0.005U	0.0032 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0100	06/08/88	N	0.1U	0.005U	0.0032 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0200	06/08/88	N	0.1U	0.005U	0.0042 BCZ	0.02U	0.003 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02
LB-0500	06/08/88	N	0.1U	0.005U	0.0037 BCZ	0.02U	0.006 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	06/09/88	N	0.1U	0.005U	0.0023 BCZ	0.02U	0.002 AZ	0.02U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	06/10/88	N	0.1U	0.005U	0.0032 BCZ	0.02U	0.002 AZ	0.05U	0.001 CZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	06/08/88	N	0.1U	0.005U	0.0030 BCZ	0.02U	0.001 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	06/09/88	N	0.1U	0.005U	0.0034 BCZ	0.02U	0.002 AZ	0.05	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0200	06/09/88	N	0.1U	0.005U	0.0040 BCZ	0.02U	0.002 AZ	0.05	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0000	06/09/88	N	0.1U	0.005U	0.0035 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	06/09/88	N	0.1U	0.005U	0.0034 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02
RA-0100	06/09/88	N	0.1U	0.005U	0.0033 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	06/09/88	N	0.1U	0.005U	0.0040 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	06/09/88	N	0.1U	0.005U	0.0051 BCZ	0.02U	0.002 AZ	0.05U	0.001UCZ	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-100	06/06/88	BB	0.1U	0.005U	0.0046	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-100	06/03/88	BFS	0.4	0.092	0.025	0.10	0.087	0.10	0.11	0.10	0.0043	0.05U	0.0002U	0.10
CC-100	06/06/88	CCB	0.1U	0.005U	0.0028	0.02U	0.001U	0.05U	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U

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NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
EF-0200	06/21/88	1115	N	93101	EDI	N/G	23.0	METER	14.0	7.0	6.8	12	8
EF-0300	06/21/88	1300	N	93102	EDI	0.95	22.0	METER	14.0	7.1	6.8	14	9
EF-0400	06/21/88	1420	N	93103	EDI	0.35	44.4	METER	13.0	6.9	6.7	11	10
EF-0800	06/20/88	1815	N	93104	EDI	1.05	105.3	METER	13.0	7.1	6.8	12	12
RC-0850	06/20/88	1530	N	93106	GRAB	0.50	83.4	METER	13.0	7.2	6.9	12	12
RC-2000	06/20/88	1940	N	93107	EDI	0.35	69.2	METER	13.0	7.1	7.0	--	17
WF-0020	06/20/88	1450	N	93105	EDI	0.60	6.2	METER	10.0	7.7	7.9	63	62
BC-0100	06/23/88	0850	N	93118	EDI	0.58	36.0	METER	11.5	7.8	7.4	73	73
LB-0100	06/22/88	1040	N	93110	EDI	N/G	41.1	METER	7.5	6.9	6.5	7	11
LB-0200	06/22/88	0855	N	93111	EDI	0.50	44.3	METER	7.0	6.7	6.5	14	9
LB-0500	06/22/88	1200	N	93112	GRAB	0.78	39.2	METER	9.0	7.0	6.5	13	13
LB-0800	06/23/88	1350	D	93124	GRAB	0.60	--	--	11.5	7.1	6.7	13	12
LB-0800	06/23/88	1345	N	93122	GRAB	0.60	39.5	METER	11.5	7.1	6.8	14	15
LB-2000	06/23/88	1000	N	93119	EDI	0.65	113.7	METER	11.0	7.2	6.7	17	20
LB-3000	06/23/88	1515	N	93123	EDI	1.10	139.4	METER	12.0	7.5	7.0	93	38
LC-0100	06/23/88	1220	N	93120	GRAB	N/G	0.45	BUCKT	13.0	7.2	6.8	93	21
LC-0600	06/23/88	1115	N	93121	GRAB	0.39	0.39	METER	14.0	7.4	7.1	156	48
PM-0500	06/22/88	1720	N	93116	GRAB	N/G	14.1	METER	11.0	7.4	6.6	37	30
PM-1000	06/22/88	1815	N	93117	EDI	0.45	16.7	METER	11.0	7.4	6.7	28	28
RA-0100	06/22/88	1445	N	93113	GRAB	N/G.	33.5	METER	11.0	--	6.1	8	6
RA-0200	06/22/88	1620	N	93114	GRAB	0.88	43.1	METER	14.0	6.7	6.1	22	11
RA-0600	06/22/88	1320	N	93115	EDI	0.62	26.9	METER	10.5	6.9	6.3	12	10
BB-0100	06/24/88	1955	BB	93108-9	GRAB	--	--	--	--	--		--	--
CC-0100	06/24/88	0950	CCB	93125	GRAB	--	--	--	22	5.6	5.3	2	7

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	06/07/88	N	6U	1U	1U	1U	1 BCZ	6	7	0	1UCZ	1U	0.06 BCZ	
EF-0300	06/07/88	N	6U	1U	1U	1	2 BCZ	6	7	0	1UCZ	1U	0.08 BCZ	
EF-0400	06/07/88	N	6U	1U	1U	1U	2 BCZ	5	6	0	1UCZ	1U	0.11 BC	
EF-0800	06/06/88	N	6U	1U	1U	1U	1 BCZ	5	6	0	1UCZ	1U	0.09 BC	
RC-0850	06/06/88	N	6U	1U	1U	1U	1 BCZ	5	6	0	1UCZ	1U	0.08 BCZ	
RC-2000	06/06/88	N	6U	1U	1U	1U	1 BCZ	9	11	0	1UCZ	1U	0.08 BCZ	
WF-0020	06/06/88	N	21	5	2	1U	1 BCZ	28	34	0	1 CZ	1	0.12 BC	
BC-0100	06/10/88	D	27	9	1	1U	1 BCZ	35	43	0	1 CZ	1U	0.08 BCZ	
BC-0100	06/10/88	N	29	10	1	1	2 BCZ	35	43	0	2 C	1U	0.08 BCZ	
LB-0100	06/08/88	N	6U	1U	1U	1U	2 BCZ	4	5	0	1 CZ	1U	0.09 BC	
LB-0200	06/08/88	N	6U	1U	1U	1U	1UBCZ	5	6	0	1UCZ	1U	0.09 BC	
LB-0500	06/08/88	N	6U	1U	1U	1U	2 BCZ	5	6	0	1 CZ	1U	0.09 BC	
LB-0800	06/09/88	N	6U	1U	1U	2	1 BCZ	7	9	0	1UCZ	1U	0.10 BC	
LB-2000	06/10/88	N	3U	1	1U	1U	1 BCZ	9	11	0	1UCZ	1U	0.08 BCZ	
LB-3000	06/08/88	N	8	3	1U	1U	1UBCZ	17	21	0	1UCZ	1U	0.14 BC	
LC-0100	06/09/88	N	6U	1U	1U	2	1 BCZ	9	11	0	2 C	1U	0.13 BC	
LC-0600	06/09/88	N	8	3	1U	2	1 BCZ	18	22	0	1UCZ	1U	0.13 BC	
PM-0500	06/09/88	N	8	3	1U	1	2 BCZ	13	16	0	2 C	1U	0.14 BC	
PM-1000	06/09/88	N	5U	2	1U	1U	2 BCZ	12	15	0	1UCZ	1U	0.10 BC	
RA-0100	06/09/88	N	6U	1U	1U	1U	2 BCZ	3	4	0	1UCZ	1U	0.14 BC	
RA-0200	06/09/88	N	6U	1U	1U	1	2 BCZ	4	5	0	1 CZ	1U	0.12 BC	
RA-0600	06/09/88	N	6U	1U	1U	1U	2 BCZ	5	6	0	1UCZ	1U	0.10 BC	
BB-100	06/06/88	BB	6U	1U	1U	1U	2	2	2	0	1U	1U	0.05	
BFS-100	06/03/88	BFS	10	4	1U	8	3	18	22	0	7	11	0.43	
CC-100	06/06/88	CCB	6U	1U	1U	1U	1	2	2	0	1	1U	0.06	

NOTE: A - blind field standard outside advisory range.
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SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	06/21/88	N	0.35C	1U	17	0.005UCZ	0.005UCZ	0.03CZ	0.05U	0.20U	0.15	0.20	0.05
EF-0300	06/21/88	N	0.25C	1U	10	0.005UCZ	0.005UCZ	0.04CZ	0.05U	0.20U	0.17	0.20	0.03
EF-0400	06/21/88	N	0.37C	1U	11	0.005CZ	0.005UCZ	0.07CZ	0.05U	0.20U	0.17	0.20	0.03
EF-0800	06/20/88	N	0.30C	1U	16	0.005CZ	0.005UCZ	0.01CZ	0.05U	0.20U	0.17	0.20	0.03
RC-0850	06/20/88	N	0.45C	1U	12	0.007CZ	0.005UCZ	0.01CZ	0.05U	0.20U	0.17	0.20	0.03
RC-2000	06/20/88	N	0.30C	1U	16	0.005CZ	0.005UCZ	0.01UCZ	0.05U	0.20U	0.25	0.25	0.00
WF-0020	06/20/88	N	0.33C	1U	40	0.005CZ	0.005UCZ	0.01CZ	0.05U	0.20U	0.71	0.63	0.08
BC-0100	06/23/88	N	0.27C	1U	41	0.005UCZ	0.005UCZ	0.10CZ	0.05U	0.20U	0.83	0.75	0.08
LB-0100	06/22/88	N	0.27C	1U	1 Z	0.005UCZ	0.005UCZ	0.06CZ	0.05U	0.20U	0.13	0.25	0.12
LB-0200	06/22/88	N	0.25C	1U	1 Z	0.005CZ	0.016C	0.05CZ	0.07	0.20U	0.15	0.27	0.12
[illegible]0500	06/22/88	N	0.33C	1U	4	0.005UCZ	0.005UCZ	0.04CZ	0.05U	0.20U	0.15	0.27	0.12
LB-0800	06/23/88	D	0.26C	44	9	0.005CZ	0.007CZ	0.03CZ	0.05	0.20U	0.15	0.25	0.10
LB-0800	06/23/88	N	0.24C	1U	5	0.005UCZ	0.005UCZ	0.02CZ	0.05U	0.20U	0.17	0.25	0.08
LB-2000	06/23/88	N	0.25C	1U	16	0.005UCZ	0.005UCZ	0.02CZ	0.05U	0.20U	0.25	0.32	0.07
LB-3000	06/23/88	N	0.38C	1U	21	0.005UCZ	0.005UCZ	0.04CZ	0.07	0.20U	0.43	0.35	0.08
LC-0100	06/23/88	N	0.35C	1U	21	0.005UCZ	0.005UCZ	0.01UCZ	0.05U	0.20U	0.29	0.27	0.02
LC-0600	06/23/88	N	0.62C	22	23	0.007CZ	0.005UCZ	0.03CZ	0.12	0.20U	0.55	0.51	0.04
PM-0500	06/22/88	N	0.42C	1U	6	0.005UCZ	0.005UCZ	0.06CZ	0.05U	0.20U	0.37	0.30	0.07
PM-1000	06/22/88	N	0.30C	1U	17	0.005UCZ	0.005UCZ	0.03CZ	0.05U	0.20U	0.35	0.35	0.00
RA-0100	06/22/88	N	0.35C	1U	1 Z	0.007CZ	0.005UCZ	0.02CZ	0.07	0.20U	0.11	0.27	0.16
RA-0200	06/22/88	N	0.37C	1U	1 Z	0.005UCZ	0.005UCZ	0.02CZ	0.07	0.20U	0.11	0.27	0.16
RA-0600	06/22/88	N	0.41C	1U	3	0.005UCZ	0.005UCZ	0.03CZ	0.06	0.20U	0.15	0.27	0.12
BB-0100	06/24/88	BB		1U		0.005U	0.005U	0.01U	0.05U	0.20U			
CC-0100	06/24/88	CCB	0.15	1U	1	0.012	0.009	1.31	0.05U	0.20U			

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NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	ALKALINITY Bicarbonate as HCO3	ALKALINITY Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
			COMMON IONS											
EF-0200	06/21/88	N	6U	1U	1U	1U	1U	5	6	0	1U	1U	0.05U	
EF-0300	06/21/88	N	6U	1U	1U	1U	1	6	7	0	1U	1U	0.05U	
EF-0400	06/21/88	N	6U	1U	1U	1	1	6	7	0	1U	1U	0.05U	
EF-0800	06/20/88	N	6U	1U	1U	1	1	6	7	0	1U	1U	0.05U	
RC-0850	06/20/88	N	6U	1U	1U	1	1	6	7	0	1U	1U	0.05U	
RC-2000	06/20/88	N	3U	1	1U	2	1	10	12	0	1U	1U	0.05U	
WF-0020	06/20/88	N	26	7	2	2	1	33	40	0	1	1U	0.05U	
BC-0100	06/23/88	N	32	11	1	2	1	39	48	0	1U	1U	0.05U	
LB-0100	06/22/88	N	6U	1U	1U	2	1	4	5	0	1U	1U	0.05U	
LB-0200	06/22/88	N	6U	1U	1U	2	2	5	6	0	1U	1U	0.05U	
LB-0500	06/22/88	N	6U	1U	1U	2	2	5	6	0	1U	1U	0.05U	
LB-0800	06/23/88	D	6U	1U	1U	2	1	5	6	0	1U	1U	0.05U	
LB-0800	06/23/88	N	6U	1U	1U	2	1	6	7	0	1U	1U	0.05U	
LB-2000	06/23/88	N	5U	2	1U	2	2	10	12	0	1U	1U	0.05U	
LB-3000	06/23/88	N	10	4	1U	1	1	19	23	0	1U	1U	0.05U	
LC-0100	06/23/88	N	3U	1	1U	2	2	12	15	0	1U	1U	0.05U	
LC-0600	06/23/88	N	13	5	1U	3	2	25	31	0	1U	1U	0.05U	
PM-0500	06/22/88	N	8	3	1U	1	1	16	20	0	1U	1U	0.05U	
PM-1000	06/22/88	N	8	3	1U	2	1	15	18	0	1U	1U	0.05U	
RA-0100	06/22/88	N	6U	1U	1U	2	2	3	4	0	1U	1U	0.05U	
RA-0200	06/22/88	N	6U	1U	1U	2	2	3	4	0	1U	1U	0.05U	
RA-0600	06/22/88	N	6U	1U	1U	2	2	5	6	0	1U	1U	0.05U	
BB-0100	06/24/88	BB												
CC-0100	06/24/88	CCB	6U	1U	1U	1U	1U	2	2	0	1U	1U	0.05U	

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	06/21/88	N	0.1U	0.005U	0.0018BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	06/21/88	N	0.1U	0.005U	0.0011BCRZ	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	06/21/88	N	0.1U	0.005U	0.0022BCRZ	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	06/20/88	N	0.1U	0.005U	0.0008BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	06/20/88	N	0.1U	0.005U	0.0021BCRZ	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-2000	06/20/88	N	0.1U	0.005U	0.0022BCRZ	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
WF-0020	06/20/88	N	0.1U	0.005U	0.0006BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BC-0100	06/23/88	N	0.1U	0.005U	0.0010BCRZ	0.02U	0.001U	0.05	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0100	06/22/88	N	0.1U	0.005U	0.0022BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0200	06/22/88	N	0.1U	0.005U	0.0018BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0500	06/22/88	N	0.1U	0.005U	0.0008BCRZ	0.02U	0.005	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	06/23/88	D	0.1U	0.005U	0.0018BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	06/23/88	N	0.1U	0.005U	0.0011BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	06/23/88	N	0.1U	0.005U	0.0016BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	06/23/88	N	0.1U	0.005U	0.0010BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	06/23/88	N	0.1U	0.005U	0.0018BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	06/23/88	N	0.1U	0.005U	0.0007BCRZ	0.02U	0.001	0.05U	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	06/22/88	N	0.1U	0.005U	0.0011BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	06/22/88	N	0.1U	0.005U	0.0092BCR	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0100	06/22/88	N	0.1U	0.005U	0.0024BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	06/22/88	N	0.1U	0.005U	0.0008BCRZ	0.02U	0.004	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	06/22/88	N	0.1U	0.005U	0.0012BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-0100	06/24/88	BB	0.1U	0.005U	0.0049	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
CC-0100	06/24/88	CCB	0.1U	0.005U	0.0027	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.
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U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 6

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
EF-0200	07/21/88	1145	N	93418	EDI	N/G	4.4	METER	18.0	6.9	6.4	6	12
EF-0300	07/21/88	0930	N	93419	EDI	0.60	5.6	METER	13.0	6.4	6.3	12	13
EF-0400	07/21/88	1500	N	93420	EDI	--	13.6	METER	18.0	6.7	6.3	12	14
EF-0800	07/21/88	1820	N	93421	EDI	0.05	16.1	METER	15.5	7.2	6.4	13	14
RC-0850	07/21/88	1715	N	93423	GRAB	0.03	14.3	METER	16.5	7.3	6.6	16	17
RC-2000	07/21/88	2010	N	93424	EDI	--	7.6	METER	16.0	7.2	6.6	23	26
WF-0020	07/21/88	1625	N	93422	EDI	0.40	2.0	METER	12.0	7.7	7.3	67	78
BC-0100	07/20/88	1540	N	93442	EDI	0.16	9.9	METER	15.0	8.0	7.5	101	99
LB-0100	07/19/88	1140	N	93432	EDI	N/G	13.5	METER	10.0	7.0	6.3	9	10
LB-0200	07/19/88	0945	N	93433	EDI	0.0	10.3	METER	8.0	6.9	6.4	11	13
LB-0500	07/19/88	1340	N	93434	GRAB	0.42	12.5	METER	11.5	6.9	6.3	12	13
LB-0800	07/20/88	0930	N	93429	GRAB	--	24.4	METER	10.0	7.1	6.5	17	22
LB-2000	07/20/88	1650	N	93430	EDI	0.04	25.7	METER	19.0	7.8	6.9	33	54
LB-3000	07/18/88	1915	N	93431	EDI	0.61	43.9	METER	17.0	7.4	7.2	59	35
LC-0100	07/20/88	1245	N	93427	GRAB	N/G	0.2	BCKT	12.0	7.4	6.6	27	34
LC-0600	07/20/88	1345	N	93428	GRAB	0.34	0.4	METER	14.5	7.7	6.7	65	64
PM-0500	07/20/88	1030	N	93439	GRAB	N/G	6.1	METER	9.0	7.3	7	27	31
PM-1000	07/20/88	1145	N	93440	EDI	0.05	3.9	METER	11.0	7.3	7	29	33
RA-0100	07/19/88	1840	N	93435	GRAB	N/G	10.2	METER	13.0	6.5	6.1	9	7
RA-0200	07/19/88	1645	D	93436	GRAB	0.52	--	--	14.0	6.9	6.3	10	8
RA-0200	07/19/88	1630	N	93426	GRAB	0.52	8.2	METER	14.0	6.9	6.3	11	9
RA-0600	07/19/88	1500	N	93437	EDI	0.25	8.6	METER	12.0	7.0	6.4	13	12
BB-0100	07/19/88	1350	BB	93441	GRAB	--	--	--	--	--	5.7	--	2
BFS-0100	07/15/88	--	BFS	93425	GRAB	--	--	--	--	--	6.8	--	8
CC-0100	07/19/88	1700	CCB	93438	--	--	--	--	--	5.9	5.6	2	2

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	07/21/88	N	0.19	1U	1U	0.005U	0.006BZ	0.01U	0.05UBCZ	0.2U	0.15	0.20	0.05
EF-0[illegible]0	07/21/88	N	0.16	1U	2	0.005U	0.012B	0.04	0.05UBCZ	0.2U	0.15	0.20	0.05
EF-0400	07/21/88	N	0.30	2U	10	0.006	0.008BZ	0.01U	0.05UBCZ	0.2U	0.19	0.20	0.01
EF-0800	07/21/88	N	0.18	1U	10	0.005U	0.005UBZ	0.02	0.05UBCZ	0.2U	0.19	0.20	0.01
RC-0850	07/21/88	N	0.16	1U	4	0.008	0.008BZ	0.01	0.05UBCZ	0.2U	0.23	0.20	0.03
RC-2000	07/21/88	N	0.21	1U	14	0.006	0.008BZ	0.01U	0.05UBCZ	0.2U	0.33	0.25	0.08
WF-0020	07/21/88	N	0.14	1U	47	0.006	0.006BZ	0.01U	0.05UBCZ	0.2U	0.57	0.63	0.06
BC-0100	07/20/88	N	0.12	1U	60	0.006	0.006BZ	0.09	0.06 BCZ	0.2U	1.01	0.93	0.08
LB-0100	07/19/88	N	0.31	1U	10	0.005U	0.005UBZ	0.05	0.06 BCZ	0.2U	0.17	0.20	0.03
LB-0200	07/19/88	N	0.26	1U	14	0.005U	0.005UBZ	0.05	0.06 BCZ	0.2U	0.19	0.20	0.01
LB-0500	07/19/88	N	0.12U	1U	30	0.005U	0.005UBZ	0.03	0.05UBCZ	0.2U	0.19	0.20	0.01
LB-0800	07/20/88	N	0.12U	1U	6	0.006	0.006 BZ	0.02	0.06 BCZ	0.2U	0.27	0.23	0.04
LB-2000	07/20/88	N	0.14	1U	38	0.005U	0.005UBZ	0.02	0.06 BCZ	0.2U	0.65	0.53	0.12
LB-3000	07/18/88	N	0.31	1U	7	0.005U	0.006 BZ	0.01	0.06 BCZ	0.2U	0.41	0.33	0.08
LC-0100	07/20/88	N	0.15	1U	27	0.008	0.008 BZ	0.01U	0.06 BCZ	0.2U	0.37	0.28	0.09
LC-0600	07/20/88	N	0.50	1	37	0.008	0.006 BZ	0.01U	0.05UBCZ	0.2U	0.71	0.60	0.11
PM-0500	07/20/88	N	0.12U	1U	14	0.005U	0.005UBZ	0.06	0.05 BCZ	0.2U	0.41	0.30	0.11
PM-1000	07/20/88	N	0.12U	1U	25	0.005U	0.005UBZ	0.04	0.06 BCZ	0.2U	0.39	0.35	0.04
RA-0100	07/19/88	N	0.17	1	2	0.005U	0.005UBZ	0.02	0.05UBCZ	0.2U	0.15	0.20	0.05
RA-0200	07/19/88	D	0.22	1U	10	0.005U	0.005UBZ	0.02	0.05UBCZ	0.2U	0.15	0.20	0.05
RA-0200	07/19/88	N	0.18	1U	5	0.006	0.005UBZ	0.03	0.05UBCZ	0.2U	0.13	0.20	0.07
RA-0600	07/19/88	N	0.15	1U	10	0.005U	0.005UBZ	0.03	0.06 BCZ	0.2U	0.28	0.20	0.08
BB-0100	07/19/88	BB	0.12U	1U	1U	0.005U	0.006	0.01U	0.06	0.2U			
BFS-0100	07/15/88	BFS	0.12U		46	0.028	0.081U	0.01U	0.05U	0.25			
CC-0100	07/19/88	CCB	0.12U		1U	0.005U	0.005U	0.01U	0.06	0.2U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	07/21/88	N	6U	1U	1UAZ	1U	1U	5	6	0	1UBCZ	1U	0.05U	
EF-0300	07/21/88	N	6U	1U	1UAZ	1U	1U	5	6	0	1UBCZ	1U	0.05U	
EF-0400	07/21/88	N	6U	1U	1UAZ	1	1U	7	9	0	1BCZ	1U	0.05U	
EF-0800	07/21/88	N	6U	1U	1UAZ	1U	1U	7	9	0	1UBCZ	1U	0.05U	
RC-0850	07/21/88	N	3U	1	1UAZ	1U	1	8	10	0	2 BC	1U	0.05U	
RC-2000	07/21/88	N	5U	2	1UAZ	1U	1	13	16	0	2 BC	1U	0.05U	
WF-0020	07/21/88	N	28	8	2 AZ	1U	1U	25	31	0	2 BC	1U	0.05U	
BC-0100	07/20/88	N	43	14	2 AZ	1U	1	47	57	0	2 BC	1U	0.05U	
LB-0100	07/19/88	N	6U	1U	1UAZ	1U	1U	5	6	0	2 BC	1U	0.05U	
LB-0200	07/19/88	N	6U	1U	1UAZ	1U	1U	6	7	0	2 BC	1U	0.05U	
LB-0500	07/19/88	N	6U	1U	1UAZ	1U	1U	6	7	0	2 BC	1U	0.05U	
LB-0800	07/20/88	N	3U	1	1UAZ	1U	2	10	12	0	2 BC	1U	0.05U	
LB-2000	07/20/88	N	22	7	1 AZ	1U	2	29	35	0	2 BC	1U	0.05U	
LB-3000	07/18/88	N	8	3	1UAZ	1U	2	17	21	0	2 BC	1U	0.05U	
LC-0100	07/20/88	N	5U	2	1UAZ	1	2	16	20	0	1UBCZ	1U	0.05U	
LC-0600	07/20/88	N	23	6	2 AZ	2	2	33	40	0	1 BCZ	1U	0.05U	
PM-0500	07/20/88	N	8	3	1UAZ	1U	1	16	20	0	3 BC	1U	0.05U	
PM-1000	07/20/88	N	10	4	1UAZ	1U	1U	17	21	0	1 BCZ	1U	0.05U	
RA-0100	07/19/88	N	6U	1U	1UAZ	1U	1U	4	5	0	2 BC	1U	0.05U	
RA-0200	07/19/88	D	6U	1U	1UAZ	1U	1U	4	5	0	2 BC	1U	0.05U	
RA-0200	07/19/88	N	6U	1U	1UAZ	1U	1	4	5	0	1UBCZ	1U	0.05U	
RA-0600	07/19/88	N	6U	1U	1UAZ	1U	1U	6	7	0	6 BC	1U	0.05U	
BB-0100	07/19/88	BB	6U	1U	1U	1U	1U	3	4	0	1	1U	0.05U	
BFS-0100	07/15/88	BFS	13	5	1UZ	8	3	17	21	0	8	11	0.37	
CC-0100	07/19/88	CCB	6U	1U	1UZ	1U	1U	2	2	0	1	1U	0.05U	

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	07/21/88	N	0.1U	0.005U	0.0012 BCR	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	07/21/88	N	0.1U	0.005U	0.0006 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	07/21/88	N	0.1U	0.005U	0.0009 BCRZ	0.02U	0.002	0.09	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	07/21/88	N	0.1U	0.005U	0.0020 BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	07/21/88	N	0.1U	0.005U	0.0009 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-2000	07/21/88	N	0.1U	0.005U	0.0012 BCR	0.02U	0.004	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
WF-0020	07/21/88	N	0.1U	0.005U	0.0006 BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BC-0100	07/20/88	N	0.1U	0.005U	0.0008 BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0100	07/19/88	N	0.1U	0.005U	0.0016 BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0200	07/19/88	N	0.1U	0.005U	0.0006 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0500	07/19/88	N	0.1U	0.005U	0.0018 BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	07/20/88	N	0.1U	0.005U	0.0006 BCRZ	0.02U	0.001U	0.05U	0.002	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	07/20/88	N	0.1U	0.005U	0.0009 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	07/18/88	N	0.1U	0.005U	0.0014 BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	07/20/88	N	0.1U	0.005U	0.0010 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	07/20/88	N	0.1U	0.005U	0.0005 BCRZ	0.02U	0.002	0.05	0.002	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	07/20/88	N	0.1U	0.005U	0.0007 BCRZ	0.02U	0.001U	0.05U	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	07/20/88	N	0.1U	0.005U	0.0006 BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0100	07/19/88	N	0.1U	0.005U	0.0006 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	07/19/88	D	0.1U	0.005U	0.0006 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	07/19/88	N	0.1U	0.005U	0.0018 BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	07/19/88	N	0.1U	0.005U	0.0008 BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-0100	07/19/88	BB	0.1U	0.005U	0.0006	0.02	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	07/15/88	BFS	0.1U	0.024	0.0025 Z	0.02	0.001U	0.05U	0.020	0.02U	0.0007	0.05U	0.022	0.02U
CC-0100	07/19/88	CCB	0.1U	0.005U	0.0007 Z	0.02	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conduc-tance (umhos/cm) Field	Lab
EF-0200	08-18-88	1100	N	93866	GRAB	N/G	0.33	METER	15.0	6.6	7.1	11	6.5
EF-0300	08-18-88	1330	N	93865	GRAB	0.14	0.479	METER	12.0	7.1	7.2	18	21
EF-0400	08-18-88	1455	N	93864	EDI	-0.40	3.16	METER	16.5	6.8	7.0	12	19
EF-0800	08-18-88	1730	N	93862	GRAB	-0.59	1.64	METER	15.0	7.0	7.1	11	16
RC-0850	08-18-88	1645	N	93863	GRAB	DRY	0.279	METER	16.0	7.3	7.3	11	16
RC-2000	08-18-88	1730	--	--	--	--	0	--	--	--	--	--	--
WF-0020	08-18-88	1555	N	93867	GRAB	0.22	0.234	METER	12.0	7.7	7.8	66	72
BC-0100	08-17-88	0830	N	93868	EDI	-0.04	4.4	METER	12.0	7.7	8.0	111	112
LB-0100	08-16-88	1145	N	93848	EDI	N/G	5.3	METER	7.0	7.0	6.2	14	11
LB-0200	08-16-88	0920	N	93849	EDI	-0.30	3.3	METER	9.0	6.8	6.6	14	14
LB-0500	08-17-88	1245	N	93861	GRAB	0.16	2.7	METER	12.0	6.6	6.9	17	17
LB-0800	08-17-88	1600	D	93857	GRAB	-0.05	7.2	METER	12.0	6.4	7.4	32	31
LB-0800	08-17-88	1520	N	93858	GRAB	-0.05	7.3	METER	11.5	7.0	7.4	32	30
LB-2000	08-17-88	1020	N	93869	EDI	-0.24	9.8	METER	12.5	7.3	6.7	55	48
LB-3000	08-15-88	1615	N	93854	EDI	0.33	16.4	METER	16.5	7.8	7.8	92	86
LC-0100	08-16-88	1625	N	93850	GRAB	N/G	0.1	BUCKT	12.0	7.1	6.9	30	37
LC-0600	08-16-88	1740	N	93851	GRAB	0.26	0.3	METER	14.5	7.6	7.4	76	75
PM-0500	08-17-88	1815	N	93855	GRAB	N/G	1.4	METER	12.0	6.4	7.7	36	35
PM-1000	08-17-88	1710	N	93856	EDI	-0.11	1.2	METER	12.0	6.9	7.4	40	37
RA-0100	08-16-88	1415	N	93852	GRAB	N/G	3.2	METER	12.0	6.1	7.3	4	10
RA-0200	08-16-88	1525	N	93853	GRAB	0.34	3.2	METER	11.5	6.4	7.0	7	10
RA-0600	08-17-88	1350	N	93860	EDI	0.05	4.5	METER	12.0	5.7	6.8	15	14
BFS-100	8-11-88	--	BFS	93871	--	--	--	--	--	--	7.1	--	286
CCB-100	08-17-88	1420	CCB	93859	GRAB	--	--	--	23.0	5.5	6.0	0	3

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	08-18-88	N	0.42 C	1U	9 AZ	0.006	0.005	0.01UCZ	.05U	0.2U	0.17	0.20	0.03
EF-0300	08-18-88	N	0.15 CZ	1U	21 AZ	0.005U	0.005U	0.09 C	0.05U	0.2U	0.30	0.20	0.10
EF-0400	08-18-88	N	0.43 C	5	21 AZ	0.010	0.011	0.05 C	0.05U	0.2U	0.31	0.20	0.11
EF-0800	08-18-88	N	0.13 CZ	1U	14 AZ	0.005U	0.005	0.05 C	0.05U	0.2U	0.25	0.20	0.05
RC-0850	08-18-88	N	0.15 CZ	1U	11 AZ	0.005U	0.005	0.03 C	0.05U	0.2U	0.21	0.16	0.05
RC-2000	08-18-88	--									0.00	0.00	
WF-0020	08-18-88	N	0.16 CZ	1U	53 AZ	0.006	0.006	0.01UCZ	0.05U	0.2U	0.87	0.63	0.24
BC-0100	08-17-88	N	0.21 C	1U	72 AZ	0.006	0.005	0.09 C	0.05U	0.2U	1.23	1.07	0.16
LB-0100	08-16-88	N	0.31 C	3	7 AZ	0.005U	0.006	0.10 C	0.05U	0.2U	0.20	0.20	0.00
LB-0200	08-16-88	N	0.73 C	1U	9 AZ	0.005U	0.005	0.12 C	0.05U	0.2U	0.20	0.20	0.00
LB-0500	08-17-88	N	0.23 C	1U	14 AZ	0.005U	0.005U	0.05 C	0.05U	0.2U	0.23	0.20	0.03
LB-0800	08-17-88	D	0.17 CZ	1U	22 AZ	0.005U	0.005U	0.03 C	0.05U	0.2U	0.39	0.25	0.14
LB-0800	08-17-88	N	0.20 CZ	1U	25 AZ	0.006	0.006	0.03 C	0.05U	0.2U	0.37	0.25	0.12
LB-2000	08-17-88	N	0.22 C	1U	38 AZ	0.005U	0.005U	0.02 C	0.05U	0.2U	0.63	0.40	0.23
LB-3000	08-15-88	N	0.21 C	1U	45 AZ	0.005U	0.005	0.02 C	0.05U	0.2U	0.99	0.78	0.21
LC-0100	08-16-88	N	0.46 C	11	25 AZ	0.007	0.008	0.01UCZ	0.05U	0.2U	0.47	0.35	0.12
LC-0600	08-16-88	N	1.2 C	1	39 AZ	0.006	0.008	0.02 C	0.05U	0.2U	0.89	0.68	0.21
PM-0500	08-17-88	N	0.21 C	1U	18 AZ	0.006	0.006	0.10 C	0.05U	0.2U	0.46	0.39	0.07
PM-1000	08-17-88	N	0.18 CZ	1U	29 AZ	0.005U	0.005	0.04 C	0.05U	0.2U	0.49	0.35	0.14
RA-0100	08-16-88	N	0.25 C	1U	6 AZ	0.005U	0.005U	0.05 C	0.05U	0.2U	0.15	0.20	0.05
RA-0200	08-16-88	N	0.28 C	1U	6 AZ	0.005U	0.005	0.04 C	0.05U	0.2U	0.15	0.20	0.05
RA-0600	08-17-88	N	0.16 CZ	1U	13 AZ	0.008	0.005	0.05 C	0.05U	0.2U	0.21	0.20	0.01
BFS-100	8-11-88	BFS	.01U		80	0.046	0.042	0.14	0.29	0.34			
CCB-100	08-17-88	CCB	0.14	1U	1U	0.005U	0.005U	0.01	0.05U	0.2U			

NOTE: A - blind field standard outside advisory range.
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STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	08-18-88	N	6U	1U	1U	1U	1U	5	6	0	2	1U	.05UAZ	
EF-0300	08-18-88	N	3U	1	1U	1U	1U	11	13	0	2	1U	0.05UAZ	
EF-0400	08-18-88	N	6U	1U	1U	1	1	12	15	0	2	1U	0.05UAZ	
EF-0800	08-18-88	N	6U	1U	1U	1	1U	9	11	0	2	1U	0.05UAZ	
RC-0850	08-18-88	N	6U	1U	0U	2	1	8	10	0	1	1U	0.05UAZ	
RC-2000	08-18-88	--												
WF-0020	08-18-88	N	28	8	2	1	1	40	49	0	2	1U	0.05UAZ	
BC-0100	08-17-88	N	50	15	3	1U	1	58	71	0	2	1U	0.05UAZ	
LB-0100	08-16-88	N	6U	1U	1U	1U	1U	6	7	0	2	1U	0.05UAZ	
LB-0200	08-16-88	N	6U	1U	1U	1U	1U	6	7	0	2	1U	0.05UAZ	
LB-0500	08-17-88	N	6U	1U	1U	1	1	8	10	0	2	1U	0.05UAZ	
LB-0800	08-17-88	D	5U	2	1U	1	1U	16	20	0	2	1U	0.05UAZ	
LB-0800	08-17-88	N	5U	2	1U	1	1	16	20	0	1	1U	0.05UAZ	
LB-2000	08-17-88	N	13	5	1U	1	1	28	34	0	2	1U	0.05UAZ	
LB-3000	08-15-88	N	36	11	2	1	1U	46	56	0	2	1U	0.05UAZ	
LC-0100	08-16-88	N	8	3	1U	2	1U	21	26	0	1	1U	0.05UAZ	
LC-0600	08-16-88	N	28	8	2	2	1	41	50	0	2	1U	0.05 AZ	
PM-0500	08-17-88	N	8	3	1U	3	1U	18	22	0	3	1U	0.05UAZ	
PM-1000	08-17-88	N	10	4	1U	1	1U	20	24	0	3	1U	0.05UAZ	
RA-0100	08-16-88	N	6U	1U	1U	1U	1U	5	6	0	1	1U	0.05UAZ	
RA-0200	08-16-88	N	6U	1U	1U	1U	1U	5	6	0	1	1U	0.05UAZ	
RA-0600	08-17-88	N	6U	1U	1U	1	1	8	10	0	1	1U	0.05UAZ	
BFS-100	8-11-88	BFS	64	19	4	19	6	28	34	0	19	50	0.69	
CCB-100	08-17-88	CCB	6U	1U	1U	1U	1U	3	4	0	1U	1U	0.05U	

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TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	08-18-88	N	0.1U	0.005U	0.0014 CRZ	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	08-18-88	N	0.1U	0.005U	0.0023 CR	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
EF-0400	08-18-88	N	0.1U	0.005U	0.0046 CR	0.02U	0.002	0.34	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
EF-0800	08-18-88	N	0.1U	0.005U	0.0006 CRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002	0.02U
RC-0850	08-18-88	N	0.1U	0.005U	0.0009 CRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-2000	08-18-88	--												
WF-0020	08-18-88	N	0.1U	0.005U	0.0008 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0006	0.02U
SC-0100	08-17-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0010	0.02U
LB-0100	08-16-88	N	0.1U	0.005U	0.0010 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.06
LB-0200	08-16-88	N	0.1U	0.005U	0.0006 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0500	08-17-88	N	0.1U	0.005U	0.0007 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
LB-0800	08-17-88	D	0.1U	0.005U	0.0015 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0004	0.02U
LB-0800	08-17-88	N	0.1U	0.005U	0.0006 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0004	0.02U
LB-2000	08-17-88	N	0.1U	0.005U	0.0011 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0006	0.02U
LB-3000	08-15-88	N	0.1U	0.005U	0.0032 CR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0008U	0.02U
LC-0100	08-16-88	N	0.1U	0.005U	0.0063 CR	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
LC-0600	08-16-88	N	0.1U	0.005U	0.0005 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0010	0.02U
PM-0500	08-17-88	N	0.1U	0.005U	0.0018 CR	0.02U	0.002	0.05	0.001U	0.02U	0.0002U	0.05U	0.0004	0.02U
PM-1000	08-17-88	N	0.1U	0.005U	0.0017 CR	0.02U	0.001U	0.001U	0.001U	0.02U	0.0002U	0.05U	0.0005	0.02U
RA-0100	08-16-88	N	0.1U	0.005U	0.0007 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	08-16-88	N	0.1U	0.005U	0.0026 CR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002	0.02U
RA-0600	08-17-88	N	0.1U	0.005U	0.0011 CRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-100	8-11-88	BFS	0.5	0.11	0.024	0.09	0.091	0.10	0.097	0.10	0.0056	0.05U	0.0002U	0.10
CCB-100	08-17-88	CCB	0.1U	0.005U	0.0008	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conduc-tance (umhos/cm) Field	Lab
EF-0200	09-14-88	1115	N	94165	GRAB	N/G	NONE	--	13.0	6.4	6.3	5	9
EF-0300	09-14-88	1340	N	94166	GRAB	0.11	0.4	METER	9.0	6.7	6.5	18	28
EF-0400	09-14-88	1500	N	94167	GRAB	-0.66	1.9	METER	15.0	6.6	6.2	16	19
EF-0800	09-14-88	1615	N	94168	GRAB	-1.00	0.3	METER	12.0	7.0	6.5	12	16
RC-0850	09-14-88	--	--	--	--	--	0	--	--	--	--	--	--
RC-2000	09-14-88	1730	--	--	--	--	0	--	--	--	--	--	--
WF-0020	09-14-88	--	--	--	--	--	0	--	--	--	--	--	--
BC-0100	09-15-88	0850	N	94169	GRAB	-0.13	1.8	METER	8.0	7.0	7.6	105	118
LB-0100	09-13-88	1130	N	94174	GRAB	N/G	1.1	METER	8.0	6.8	6.4	8	13
LB-0200	09-13-88	1315	N	94175	EDI	--	2.1	METER	8.0	6.8	6.3	8	19
LB-0500	09-13-88	1030	N	94176	GRAB	0.06	1.0	METER	9.0	6.8	6.2	8	19
LB-0800	09-13-88	0910	N	94177	GRAB	-0.10	2.9	METER	9.5	6.8	7.0	35	41
LB-2000	09-15-88	0945	N	94170	GRAB	-0.54	5.8	METER	8.0	7.0	7.4	57	65
LB-3000	09-12-88	1815	N	94178	EDI	0.25	10.6	METER	12.0	7.0	7.7	101	111
LC-0100	09-15-88	1130	N	94171	GRAB	N/G	0.02	BUCKT	10.5	6.9	7.1	40	42
LC-0600	09-15-88	1055	N	94172	GRAB	0.26	0.2	METER	10.0	7.4	7.6	85	93
PM-0500	09-15-88	1235	D	94183	GRAB	N/G	--	--	9.0	7.0	6.9	27	35
PM-0500	09-15-88	1230	N	94182	GRAB	N/G	0.51	METER	9.5	6.9	6.9	27	35
PM-1000	09-15-88	1340	N	94184	GRAB	-0.17	0.7	METER	11.0	6.9	7.0	35	41
RA-0100	09-13-88	1530	N	94173	GRAB	N/G	0.9	METER	10.5	6.6	6.1	8	31
RA-0200	09-13-88	1720	N	94179	GRAB	0.21	1.1	METER	9.0	7.1	6.5	12	15
RA-0600	09-13-88	1400	N	94180	GRAB	-0.12	1.4	METER	8.5	6.8	6.6	13	17
BB-0100	09-16-88	1400	BB	94236	--	--	--	--	--	--	--	--	--
BFS-0100	09/22/88	--	BFS	94185	--	--	--	--	--	--	--	--	517
CCB-0100	09-20-88	1430	CCB	94235	--	--	--	--	--	--	--	--	--

NOTES:
1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	09-14-88	N	0.37	4U	8	0.005	0.007	0.01UBZ	0.05U	0.2	0.15	0.20	0.05
EF-0300	09-14-88	N	0.10U	1U	19	0.005U	0.007	0.11 B	0.05U	0.2U	0.34	0.20	0.14
EF-0400	09-14-88	N	0.48	1	19	0.005	0.009	0.01UBZ	0.05U	0.3	0.27	0.20	0.07
EF-0800	09-14-88	N	0.10U	1U	13	0.007	0.009	0.06 B	0.05U	0.2U	0.23	0.20	0.03
RC-0850	09-14-88	--									0.00	0.00	
RC-2000	09-14-88	--									0.00	0.00	
WF-0020	09-14-88	--									0.00	0.00	
BC-0100	09-15-88	N	0.11	1U	70	0.009	0.009	0.07 B	0.05U	0.2U	1.27	1.07	0.20
LB-0100	09-13-88	N	0.10U	1U	4	0.005U	0.005U	0.12 B	0.05U	0.2U	0.18	0.20	0.02
LB-0200	09-13-88	N	0.10U	1U	13	0.005	0.005	0.13 B	0.05U	0.2U	0.20	0.20	0.00
LB-0500	09-13-88	N	0.10U	1U	19	0.005	0.007	0.03 B	0.05U	0.2U	0.49	0.20	0.29
LB-0800	09-13-88	N	0.10U	1U	28	0.005U	0.007	0.04 B	0.05U	0.2U	0.49	0.30	0.19
LB-2000	09-15-88	N	0.19	1U	41	0.008	0.010	0.03 B	0.05U	0.2U	0.75	0.58	0.17
LB-3000	09-12-88	N	0.10U	1U	62	0.005	0.007	0.01UBZ	0.05U	0.2U	1.21	1.09	0.12
LC-0100	09-15-88	N	0.54	5	37	0.005	0.009	0.01 BZ	0.05U	0.2U	0.53	0.35	0.18
LC-0600	09-15-88	N	0.49	2	56	0.005	0.007	0.01UBZ	0.05U	0.2U	1.01	0.84	0.17
PM-0500	09-15-88	D	0.10U	1U	20	0.005	0.009	0.10 B	0.05U	0.2U	0.42	0.35	0.07
PM-0500	09-15-88	N	0.10U	1U	19	0.005U	0.007	0.10 B	0.05U	0.2U	0.42	0.35	0.07
PM-1000	09-15-88	N	0.25	1U	29	0.005U	0.010	0.04 B	0.05U	0.2U	0.47	0.40	0.07
RA-0100	09-13-88	N	0.15	1	17	0.005	0.006	0.08 B	0.05U	0.2U	0.15	0.20	0.05
RA-0200	09-13-88	N	0.19	1U	7	0.008	0.008	0.07 B	0.05U	0.2U	0.17	0.20	0.03
RA-0600	09-13-88	N	0.11	1U	15	0.005	0.007	0.07 B	0.05U	0.2U	0.23	0.20	0.03
BB-0100	09-16-88	BB			1U	0.005U	0.005U	0.02	0.05U	0.2U			
BFS-0100	09/22/88	BFS	0.10U		297	0.049	0.058	0.14	0.29	0.3			
CCB-0100	09-20-88	CCB				0.005U	0.005U	0.01U	0.05U	0.2U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	09-14-88	N	6U	1U	1U	1U	1U	5	6	0	1U	1U	0.05UAZ	
EF-0300	09-14-88	N	3U	1	1U	1U	1U	13	16	0	2	1U	0.05UAZ	
EF-0400	09-14-88	N	6U	1U	1U	1U	1U	11	13	0	1	1U	0.05UAZ	
EF-0800	09-14-88	N	6U	1U	1U	1U	1U	8	10	0	2	1U	0.05UAZ	
RC-0850	09-14-88	--												
RC-2000	09-14-88	--												
WF-0020	09-14-88	--												
BC-0100	09-15-88	N	50	15	3	1U	1U	60	73	0	2	1U	0.05UAZ	1.0U
LB-0100	09-13-88	N	6U	1U	1U	1U	1	5	6	0	2	1U	0.05UAZ	
LB-0200	09-13-88	N	6U	1U	1U	1U	1U	6	7	0	2	1U	0.05UAZ	1.0U
LB-0500	09-13-88	N	6U	1U	1U	1U	1U	21	26	0	2	1U	0.05UAZ	1.0U
LB-0800	09-13-88	N	8	3	1U	1	1U	21	26	0	2	1U	0.05 AZ	1.0U
LB-2000	09-15-88	N	26	7	2	1	1U	34	41	0	2	1U	0.05UAZ	1.0U
LB-3000	09-12-88	N	49	13	4	2	1U	57	70	0	2	1U	0.05UAZ	2.2
LC-0100	09-15-88	N	8	3	1U	2	1	23	28	0	2	1U	0.05UAZ	
LC-0600	09-15-88	N	35	9	3	2	2	47	57	0	2	1U	0.05UAZ	
PM-0500	09-15-88	D	8	3	1U	2	1U	17	21	0	2	1U	0.05UAZ	
PM-0500	09-15-88	N	8	3	1U	2	1U	17	21	0	2	1U	0.05UAZ	
PM-1000	09-15-88	N	10	4	1U	2	1U	20	24	0	2	1U	0.05UAZ	1.0U
RA-0100	09-13-88	N	6U	1U	1U	1U	1	5	6	0	1	1U	0.05UAZ	1.0U
RA-0200	09-13-88	N	4U	1U	1	1U	1U	6	7	0	1	1U	0.05UAZ	1.3
RA-0600	09-13-88	N	6U	1U	1U	1	1U	8	10	0	2	1U	0.05UAZ	
BB-0100	09-16-88	BB	6U	1U	1U	1U	1U	2	2	0		1U	0.05U	
BFS-0100	09/22/88	BFS						33		0			1.15	
CCB-0100	09-20-88	CCB												

NOTE: A - blind field standard outside advisory range.
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U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	09-14-88	N	0.1U	0.005U	0.0008 ABCZ	0.02U	0.005	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	09-14-88	N	0.1U	0.005U	0.0006 ABCZ	0.02U	0.001U	0.05U	0.002	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	09-14-88	N	0.1U	0.005U	0.0011 ABCZ	0.02U	0.001U	0.10	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	09-14-88	N	0.1U	0.005U	0.0004 ABCZ	0.02U	0.001U	0.05U	0.001	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	09-14-88	--												
RC-2000	09-14-88	--												
WF-0020	09-14-88	--												
BC-0100	09-15-88	N	0.1U	0.005U	0.0008 ABCZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
LB-0100	09-13-88	N	0.1U	0.005U	0.0005 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0004	0.02U
LB-0200	09-13-88	N	0.1U	0.005U	0.0005 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0500	09-13-88	N	0.1U	0.005U	0.0008 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
LB-0800	09-13-88	N	0.1U	0.005U	0.0006 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	09-15-88	N	0.1U	0.005U	0.0007 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0003	0.02U
LB-3000	09-12-88	N	0.1U	0.005U	0.0009 ABCZ	0.02U	0.003	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0004	0.02U
LC-0100	09-15-88	N	0.1U	0.005U	0.0011 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	09-15-88	N	0.1U	0.005U	0.0012 ABCZ	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	09-15-88	D	0.1U	0.005U	0.0008 ABC	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	09-15-88	N	0.1U	0.005U	0.0009 ABCZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	09-15-88	N	0.1U	0.005U	0.0019 ABCZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0004	0.02U
RA-0100	09-13-88	N	0.1U	0.005U	0.0006 ABCZ	0.02U	0.001	0.06	0.004	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	09-13-88	N	0.1U	0.005U	0.0012 ABCZ	0.02U	0.001U	0.05	0.001U	0.02U	0.0002U	0.05U	0.0002	0.02U
RA-0600	09-13-88	N	0.1U	0.005U	0.0010 ABCZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-0100	09-16-88	BB	0.1U	0.005U	0.0011	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	09/22/88	BFS	0.1U	0.022	0.0029	0.02U	0.003	0.05U	0.015	0.02U	0.0008	0.02U	0.0230	0.02U
CCB-0100	09-20-88	CCB	0.1U	0.005U	0.0012	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
EF-0200	10-20-88	1145	N	94609	GRAB	N/G	6.1	METER	6.0	6.3	6.6	7	8
EF-0300	10-20-88	1350	N	94610	EDI	0.39	6.5	METER	8.0	6.7	6.8	12	11
EF-0400	10-20-88	1515	N	94611	EDI	0.09	21.3	METER	7.0	6.6	6.7	15	12
EF-0800	10-20-88	1730	N	94613	EDI	0.34	26.4	METER	8.0	6.5	6.9	15	11
RC-0850	10-20-88	1700	N	94612	GRAB	0.12	24.2	METER	8.0	6.6	6.9	7	11
RC-2000	10-20-88	--	--				0						
WF-0020	10-20-88		--				0						
BC-0100	10-18-88	1600	N	94607	EDI	0.75	1.9	METER	5.5	6.8	7.5	41	40
LB-0100	10-18-88	1300	N	94601	GRAB	N/G	32.9	METER	5.5	7.3	6.9	13	10
LB-0200	10-18-88	1115	N	94602	EDI	0.55	55.5	METER	5.0	6.7	6.8	15	11
LB-0500	10-18-88	0930	N	94603	GRAB	0.85	59.9	METER	5.0	6.7	6.9	15	13
LB-0800	10-18-88	0910	N	94604	GRAB	-0.10	84.5	METER	9.5	6.8	7.0	35	17
LB-2000	10-18-88	1640	N	94605	EDI	0.76	110.0	METER	6.0	6.6	7.2	21	23
LB-3000	10-18-88	1800	N	94606	GRAB	*	160.1	METER	6.0	6.6	7.3	32	32
LC-0100	10-19-88	1100	N	94598	GRAB	N/G	1.2	METER	6.0	6.8	7.1	16	18
LC-0100	10-19-88	1110	D	94599	GRAB	N/G	--	--	6.0	6.9	7.3	16	18
LC-0600	10-19-88	0945	N	94600	GRAB	0.60	1.8	METER	5.5	6.7	6.9	37	37
PM-0500	10-19-88	1545	N	94593	GRAB	N/G	0.8	METER	5.0	6.3	7.2	29	23
PM-1000	10-19-88	1640	N	94594	EDI	0.55	12.3	METER	5.5	6.7	7.3	30	24
RA-0100	10-19-88	1230	N	94595	GRAB	N/G	13.2	METER	5.0	6.3	6.4	8	11
RA-0200	10-19-88	1420	N	94596	GRAB	0.62	13.9	METER	5.5	6.6	6.8	12	11
RA-0600	10-19-88	1740	N	94597	EDI	0.40	22.0	METER	6.0	6.5	6.9	16	13
BB-0100	10-24-88		BB	94615							6.4		3
BFS-0100	10-24-88		BFS	94614							7.7		271
CCB-0100	10-23-88		CCB	94608							6.3		3

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
EF-0200	10-20-88	N	0.44	1U	9BCZ	0.005U	0.005	0.03	0.07Z	0.2U	0.13	0.23	0.10
EF-0300	10-20-88	N	0.23	1	17BCZ	0.005U	0.005	0.04	0.07Z	0.2U	0.15	0.23	0.08
EF-0400	10-20-88	N	0.40	1	13BCZ	0.006	0.007	0.05	0.07Z	0.2U	0.17	0.25	0.08
EF-0800	10-20-88	N	0.15	1	19BCZ	0.005U	0.009	0.02	0.05UZ	0.2U	0.17	0.23	0.06
RC-0850	10-20-88	N	0.15	1	8BCZ	0.005U	0.005U	0.02	0.05UZ	0.2U	0.15	0.20	0.05
RC-2000	10-20-88	--									0.00	0.00	
WF-0020	10-20-88	--									0.00	0.00	
BC-0100	10-18-88	N	0.31	1U	29BC	0.005U	0.007	0.23	0.07Z	0.2U	0.46	0.45	0.01
LB-0100	10-18-88	N	0.40	2	12BCZ	0.005U	0.005U	0.19	0.05UZ	0.2U	0.16	0.20	0.04
LB-0200	10-18-88	N	0.29	2	11BCZ	0.006	0.006	0.16	0.05UZ	0.2U	0.12	0.20	0.08
LB-0500	10-18-88	N	0.51	2	16BCZ	0.005U	0.007	0.12	0.05UZ	0.2U	0.20	0.20	0.00
LB-0800	10-18-88	N	0.73	3	17BCZ	0.005	0.005	0.11	0.07Z	0.2U	0.20	0.25	0.05
LB-2000	10-18-88	N	0.56	2	22BCZ	0.005U	0.005U	0.09	0.07Z	0.2U	0.28	0.30	0.02
LB-3000	10-18-88	N	0.57	2	30BC	0.005U	0.007	0.13	0.07Z	0.2	0.38	0.40	0.02
LC-0100	10-19-88	N	0.48	1	26BCZ	0.005	0.005	0.01U	0.07Z	0.2U	0.25	0.25	0.00
LC-0100	10-19-88	D	0.46	1	24BCZ	0.008	0.009	0.01U	0.05UZ	0.2U	0.23	0.25	0.02
LC-0600	10-19-88	N	1.9	1	40BC	0.008	0.008	0.01U	0.05UZ	0.2U	0.45	0.40	0.05
PM-0500	10-19-88	N	0.17	1U	23BCZ	0.005U	0.005U	0.08	0.05UZ	0.2U	0.25	0.30	0.05
PM-1000	10-19-88	N	0.15	1U	29BC	0.005U	0.005U	0.05	0.05UZ	0.2U	0.29	0.30	0.01
RA-0100	10-19-88	N	0.26	1	20BCZ	0.005U	0.005U	0.15	0.05UZ	0.2U	0.14	0.20	0.06
RA-0200	10-19-88	N	0.24	2	15 BCZ	0.005U	0.005U	0.14	0.05UZ	0.2U	0.16	0.20	0.04
RA-0600	10-19-88	N	0.18	1	19BCZ	0.005U	0.005U	0.10	0.05UZ	0.2U	0.16	0.20	0.04
BB-0100	10-24-88	BB	0.1U		18	0.005U	0.005U	0.01U	0.05	0.2U			
BFS-0100	10-24-88	BFS	0.11		158	0.500	0.495	1.99	2.13	1.62			
CCB-0100	10-23-88	CCB	0.1U		11	0.005U	0.005U	0.01U	0.07	0.2U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
EF-0200	10-20-88	N	6U	1U	1U	1 BZ	2C	4	5	0	1U	1U	0.05UB	
EF-0300	10-20-88	N	3U	1	1U	1BZ	2C	5	6	0	1	1U	0.05UB	
EF-0400	10-20-88	N	5U	2	1U	1UBZ	1CZ	6	7	0	1U	1U	0.05B	
EF-0800	10-20-88	N	3U	1	1U	1BZ	2C	6	7	0	1	1U	0.05UB	
RC-0850	10-20-88	N	3U	1	1U	1BZ	1CZ	5	6	0	1	1U	0.05UB	
RC-2000	10-20-88	--												
WF-0020	10-20-88	--												
BC-0100	10-18-88	N	15	6	1U	1BZ	1CZ	20	24	0	1	1U	0.05UB	
LB-0100	10-18-88	N	3U	1	1U	1UBZ	1UCZ	5	6	0	1	1U	0.06B	
LB-0200	10-18-88	N	3U	1	1U	1BZ	1CZ	3	4	0	1	1U	0.05B	
LB-0500	10-18-88	N	3U	1	1U	1BZ	1CZ	6	7	0	2	1U	0.05UB	
LB-0800	10-18-88	N	5U	2	1U	1BZ	1CZ	7	9	0	1	1U	0.05UB	
LB-2000	10-18-88	N	8	3	1U	1BZ	1CZ	11	13	0	1	1U	0.05UB	
LB-3000	10-18-88	N	13	5	1U	1BZ	1CZ	16	20	0	1	1U	0.05UB	
LC-0100	10-19-88	N	5U	2	1U	1BZ	1CZ	10	12	0	1	1U	0.05UB	
LC-0100	10-19-88	D	5U	2	1U	1BZ	1CZ	9	11	0	1U	1U	0.05UB	
LC-0600	10-19-88	N	13	5	1U	1BZ	1CZ	20	24	0	1	1U	0.06B	
PM-0500	10-19-88	N	8	3	1U	1UBZ	1UCZ	10	12	0	1	1U	0.08B	
PM-1000	10-19-88	N	8	3	1U	1UBZ	1UCZ	12	15	0	1	1U	0.07B	
RA-0100	10-19-88	N	3U	1	1U	1UBZ	1UCZ	4	5	0	1	1U	0.06B	
RA-0200	10-19-88	N	3U	1	1U	1BZ	1UCZ	5	6	0	1	1U	0.05UB	
RA-0600	10-19-88	N	3U	1	1U	1UBZ	1UCZ	5	6	0	1	1U	0.05UB	
BB-0100	10-24-88	BB	6U	1U	1U	1	1U	2	2	0	1U	1U	0.05	
BFS-0100	10-24-88	BFS	73	21	5	20	5	27	33	0	18	48	0.9B	
CCB-0100	10-23-88	CCB	6U	1U	1U	1U	1	2	2	0	1U	1U	0.05U	

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
EF-0200	10-20-88	N	0.1U	0.005U	0.0009BCZ	0.02U	0.002B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0300	10-20-88	N	0.1U	0.005U	0.0003BCZ	0.02U	0.001BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0400	10-20-88	N	0.1U	0.005U	0.0003BCZ	0.02U	0.002B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
EF-0800	10-20-88	N	0.1U	0.005U	0.0006BCZ	0.02U	0.002B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-0850	10-20-88	N	0.1U	0.005U	0.0007BCZ	0.02U	0.002B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RC-2000	10-20-88	--												
WF-0020	10-20-88	--												
BC-0100	10-18-88	N	0.1U	0.005U	0.0010BCZ	0.02U	0.001UBZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0005	0.02U
LB-0100	10-18-88	N	0.1U	0.005U	0.0005BCZ	0.02U	0.001UBZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0200	10-18-88	N	0.1U	0.005U	0.0005BCZ	0.02U	0.001UBZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0500	10-18-88	N	0.1U	0.005U	0.0003 BCZ	0.02U	0.001UBZ	0.06	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	10-18-88	N	0.1U	0.005U	0.0004BCZ	0.02U	0.001UBZ	0.06	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-2000	10-18-88	N	0.1U	0.005U	0.0005BCZ	0.02U	0.001UBZ	0.06	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	10-18-88	N	0.1U	0.005U	0.0010BCZ	0.02U	0.002B	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	10-19-88	N	0.1U	0.005U	0.0009BCZ	0.02U	0.001UBZ	0.06	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	10-19-88	D	0.1U	0.005U	0.0005BCZ	0.02U	0.001UBZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	10-19-88	N	0.1U	0.005U	0.0011BCZ	0.02U	0.001BZ	0.11	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-0500	10-19-88	N	0.1U	0.005U	0.0006BCZ	0.02U	0.001BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PM-1000	10-19-88	N	0.1U	0.005U	0.0005BCZ	0.02U	0.001BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0100	10-19-88	N	0.1U	0.005U	0.0006BCZ	0.02U	0.001UBZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0200	10-19-88	N	0.1U	0.005U	0.0002 BCZ	0.02U	0.001BZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	10-19-88	N	0.1U	0.005U	0.0005BCZ	0.02U	0.001UBZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-0100	10-24-88	BB	0.1U	0.005U	0.0004	0.02U	0.001	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	10-24-88	BFS	0.4	0.09	0.026	0.09	0.09	0.09	0.09	0.09	0.0052	0.05U	0.0002U	0.09
CCB-0100	10-23-88	CCB	0.1U	0.005U	0.0012	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89 Run 10

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
LB-0500	11-29-88	1000	N	95128	GRAB	0.42	16.0	METER	3.0	6.1	6.4	6.5	16
LB-0800	11-29-88	1330	N	95125	GRAB	0.26	35.7	METER	3.0	6.8	6.7	19	26
LB-3000	11-29-88	1600	N	95129	EDI	1.10	69.2	METER	3.0	6.7	7.0	36	48
LC-0100	11-30-88	1545	N	95131	GRAB	N/G	0.6	METER	2.5	6.8	6.6	16	17
LC-0100	11-30-88	1600	D	95132	GRAB	N/G	--	--	2.5	6.4	6.5	15	22
LC-0600	11-30-88	1430	N	95127	GRAB	0.72	2.3	METER	1.5	6.9	6.6	27	30
PM-0500	11-30-88	1220	N	95123	GRAB	N/G	5.7	METER	1.0	6.8	6.4	20	22
PM-1000	11-30-88	1015	N	95130	EDI	0.46	8.0	METER	1.0	6.7	6.7	22	24
RA-0600	11-29-88	1130	N	95126	EDI	0.22	15.6	METER	3.0	6.7	6.5	23	18
BB-0100	11-29-88	1530	BB	95124	GRAB	--	--	--	--	--	5.4	--	2
BFS-0100	12-5-88	0930	BFS	95134	GRAB	--	--	--	--	--	7.2	--	529
CC-0100	11-30-88	1830	CCB	95133	GRAB	--	--	--	2.0	5.8	5.7	2	3

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample
BFS - blind field standard.
2) Sampling Method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) N/G - indicates that no staff gage was installed.

NORANDA MONTANA PROJECT SURFACE WATER DATA 02/03/89

SOLIDS AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Nitrate + Nitrite as N	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
LB-0500	11-29-88	N	0.35BC	1U	6C	0.005U	0.005U	0.07	0.05UCZ	0.20UBZ	0.15	0.25	0.10
LB-0800	11-29-88	N	0.26BCZ	1U	14C	0.005U	0.005	0.04	0.06CZ	0.21BZ	0.25	0.20	0.05
LB-3000	11-29-88	N	0.73BC	1U	21C	0.005U	0.005U	0.07	0.06CZ	0.20UBZ	0.51	0.40	0.11
LC-0100	11-30-88	N	0.26BCZ	1U	16C	0.005U	0.005	0.01U	0.05UCZ	0.34BZ	0.21	0.20	0.01
LC-0100	11-30-88	D	0.25BCZ	1U	10C	0.005U	0.005U	0.01U	0.09C	0.25UBZ	0.21	0.20	0.01
LC-0600	11-30-88	N	0.64BC	1U	28C	0.005U	0.005U	0.01U	0.07CZ	0.20UBZ	0.31	0.25	0.06
PM-0500	11-30-88	N	0.32BCZ	1U	11C	0.005U	0.006	0.08	0.05UCZ	0.51BZ	0.26	0.25	0.01
PM-1000	11-30-88	N	0.24BCZ	1U	10C	0.005U	0.005U	0.05	0.05UCZ	0.20UBZ	0.25	0.20	0.05
RA-0600	11-29-88	N	0.32BCZ	1U	9C	0.005U	0.005U	0.06	0.05UCZ	0.20UBZ	0.17	0.29	0.12
BB-0100	11-29-88	BB	0.23	--	1U	0.005U	0.005U	0.01U	0.05U	0.75			
BFS-0100	12-5-88	BFS	--	--	301	0.02	0.090	0.01U	0.05U	0.27			
CC-0100	11-30-88	CCB	0.23	--	3	0.005U	0.006U	0.01U	0.06	0.20U			

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	COMMON IONS: Total Hardness as CaCO3	Calcium	Magnesium	Sodium	Potassium	ALKALINITY: Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	OTHERS: Fluoride	Oil & Grease
LB-0500	11-29-88	N	6U	1U	1U	2	1U	5	6	0	1UBZ	1U	0.05UBZ	
LB-0800	11-29-88	N	3U	1	1U	1	1U	10	12	0	1UBZ	1U	0.05BZ	
LB-3000	11-29-88	N	17	5	1	1U	1U	23	28	0	1UBZ	1U	0.05UBZ	
LC-0100	11-30-88	N	6U	1U	1U	1U	1U	8	10	0	1UBZ	1U	0.06BZ	
LC-0100	11-30-88	D	6U	1U	1U	1U	1U	8	10	0	1UBZ	1U	0.05BZ	
LC-0600	11-30-88	N	5U	2	1U	1	1U	13	16	0	1UBZ	1U	0.05UBZ	
PM-0500	11-30-88	N	5U	2	1U	1U	1U	9	11	0	2B	1U	0.07BZ	
PM-1000	11-30-88	N	3U	1	1U	1U	1U	10	12	0	1UBZ	1U	0.05UBZ	
RA-0600	11-29-88	N	6U	1U	1U	3	1U	6	7	0	1BZ	1U	0.05UBZ	
BB-0100	11-29-88	BB	6U	1U	1U	1U	1U	1U	2U	0	1	1U	0.06	
BFS-0100	12-5-88	BFS	133	40	8	50	9	35	43	0	94	77	1.16	
CC-0100	11-30-88	CCB	6U	1U	1U	1U	1U	1U	2U	0	1U	1U	0.05U	

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
LB-0500	11-29-88	N	0.1U	0.005U	0.0018BCZ	0.02U	0.002ACZ	0.05U	0.001U	0.02U	0.0002ACZ	0.05U	0.0002U	0.02U
LB-0800	11-29-88	N	0.1U	0.005U	0.0013BCZ	0.02U	0.001ACZ	0.05U	0.001U	0.02U	0.0002UACZ	0.05U	0.0002U	0.02U
LB-3000	11-29-88	N	0.1	0.005U	0.0034BCZ	0.02U	0.001UACZ	0.11	0.001U	0.02U	0.0002UACZ	0.05U	0.0002U	0.02U
LC-0100	11-30-88	N	0.1U	0.005U	0.0026BCZ	0.02U	0.002ACZ	0.06	0.002	0.02U	0.0002UACZ	0.05U	0.0002U	0.02U
LC-0100	11-30-88	D	0.1	0.005U	0.0029BCZ	0.02U	0.001UACZ	0.10	0.001U	0.02U	0.0002ACZ	0.05U	0.0002U	0.02U
LC-0600	11-30-88	N	0.1	0.005U	0.0029BCZ	0.02U	0.001UACZ	0.10	0.001U	0.02U	0.0002UACZ	0.05U	0.0002U	0.02U
PM-0500	11-30-88	N	0.1U	0.005U	0.0053BC	0.02U	0.001ACZ	0.05U	0.001U	0.02U	0.0002UACZ	0.05U	0.0003	0.02U
PM-1000	11-30-88	N	0.1U	0.005U	0.0033BCZ	0.02U	0.001UACZ	0.05U	0.001U	0.02U	0.0002 ACZ	0.05U	0.0002U	0.02U
RA-0600	11-29-88	N	0.1U	0.005U	0.0029BCZ	0.02U	0.001UACZ	0.05U	0.001U	0.02U	0.0002UACZ	0.05U	0.0002U	0.02U
BB-0100	11-29-88	BB	0.1U	0.005U	0.0033	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	12-5-88	BFS	0.5	0.082	0.0260	0.10	0.087	0.10	0.11	0.09	0.0086	0.05U	0.0002U	0.10
CC-0100	11-30-88	CCB	0.1U	0.005U	0.0028	0.02U	0.009	0.05U	0.001U	0.02U	0.0002	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank above detection limit.
C - cross-contamination blank above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not used for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89 Run 11
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FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
LB-0500	12-15-88	0900	N	95260	GRAB	0.49	17.4	METER	2	5.9	5.9	15	15
LB-0800	12-15-88	1200	N	95262	GRAB	0.30	31.1	METER	2	6.9	6.4	27	26
LB-3000	12-15-88	1750	N	95264	EDI	1.9	93.2	METER	3	7.4	6.6	53	49
LC-0100	12-16-88	1300	N	95269	GRAB	N/G	0.9	METER	1	6.3	5.9	15	17
LC-0100	12-16-88	1330	D	95270	GRAB	N/G	--	--	1	6.2	6.0	15	17
LC-0600	12-16-88	1045	N	95268	GRAB	1.01	3.6	METER	0	6.0	6.3	26	30
PM-0500	12-15-88	1430	N	95263	GRAB	N/G	7.2	METER	1	6.4	6.3	20	22
PM-1000	12-15-88	1530	N	95265	EDI	0.53	7.2	METER	2	6.8	6.4	23	24
RA-0600	12-15-88	1030	N	95261	EDI	0.38	14.4	METER	0	6.4	6.0	19	18
BB-0100	12/16/88	0800	BB	95267	GRAB	--	--	--	--	--	4.6	--	2
BFS-0100	12-15-88	0930	BFS	95271	GRAB	--	--	--	--	--	7.3	--	274
CC-0100	12/16/88	0730	CCB	95266	GRAB	--	--	--	13	5.7	4.6	3	4

NOTES:
1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample.
2) Sampling method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) "--#" indicates that the gage was not read due to bank ice.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89 Run 11
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OIL AND GREASE, SOLIDS, AND NUTRIENTS *

'ATION	SAMPLE DATE	SAMPLE TYPE	Oil and Grease	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
-0500	12-15-88	N		0.20BCRZ	1U	22BC	0.005U	0.005UCRZ	0.07CZ	0.2U	0.18	0.20	0.02
-0800	12-15-88	N		0.29BCRZ	1U	26BC	0.005U	0.005UCRZ	0.05UCZ	0.2U	0.26	0.33	0.07
-1000	12-15-88	N		0.57BCRZ	1U	40BC	0.005U	0.007CRZ	0.07CZ	0.2U	0.32	0.48	0.16
-0100	12-16-88	N		1.08BCR	1U	26BC	0.005U	0.005CRZ	0.05UCZ	0.2U	0.17	0.33	0.16
-0100	12-16-88	D		0.30BCRZ	1U	26BC	0.005U	0.040CR	0.05UCZ	0.2U	0.21	0.29	0.08
-0600	12-16-88	N		1.88BCR	2	34BC	0.005U	0.007CRZ	0.05UCZ	0.2	0.31	0.29	0.02
-0500	12-15-88	N		0.25BCRZ	1U	29BC	0.008	0.007CRZ	0.05CZ	0.4	0.22	0.33	0.11
-1000	12-15-88	N		0.27BCRZ	1U	28BC	0.005U	0.005CRZ	0.07CZ	0.2U	0.27	0.29	0.02
-0600	12-15-88	N		0.30BCRZ	1U	13BCZ	0.010	0.010CRZ	0.07CZ	0.2U	0.20	0.33	0.13
-0100	12/16/88	BB		0.42		11	0.005U	0.005U	0.05U	0.2U			
S-0100	12-15-88	BFS		0.17	--	150	0.02	0.12	0.10	0.4			
-0100	12/16/88	CCB		0.20		10	0.005U	0.009	0.07	0.2U			

'TES: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
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R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3 **	COMMON IONS Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Chloride	Fluoride	Nitrate + Nitrite as N	Sulfate
LB-0500	12-15-88	N	6UAZ	1U	1U	1BCZ	1U	4	5	0	1UAZ	0.05UAZ	0.10BZ	3ACZ
LB-0800	12-15-88	N	3UAZ	1	1U	4BCZ	1U	9	11	0	1UAZ	0.05UAZ	0.18BZ	2ACZ
LB-3000	12-15-88	N	14AZ	4	1	4BCZ	1U	10	12	0	1UAZ	0.05UAZ	0.16BZ	4ACZ
LC-0100	12-16-88	N	6UAZ	1U	1U	4BCZ	1U	6	7	0	1UAZ	0.05UAZ	0.06BZ	1UACZ
LC-0100	12-16-88	D	6UAZ	1U	1U	3BCZ	1U	7	9	0	1UAZ	0.05UAZ	0.06BZ	2ACZ
LC-0600	12-16-88	N	3UAZ	1	1U	3BCZ	1U	11	13	0	1UAZ	0.05UAZ	0.01UBZ	3ACZ
PM-0500	12-15-88	N	3UAZ	1	1U	4BCZ	1U	7	9	0	1UAZ	0.05UAZ	0.10BZ	2ACZ
PM-1000	12-15-88	N	3UAZ	1	1U	3BCZ	1U	9	11	0	1UAZ	0.05UAZ	0.02BZ	3ACZ
RA-0600	12-15-88	N	6UAZ	1U	1U	4BCZ	1U	5	6	0	1UAZ	0.05UAZ	0.11BZ	3ACZ
BB-0100	12/16/88	BB	6UZ	1U	1U	2	1U	1U	0	0	1U	0.05U	0.18	1U
BFS-0100	12-15-88	BFS	64AZ	19	4	22	4	27	33	0	47	0.79	0.01U	27
CC-0100	12/16/88	CCB	6UZ	1U	1U	3	1U	1U	0	0	1U	0.05U	0.05U	2

NOTES:
A - blind field standard outside advisory range.
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C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
** - Hardness is a calculated value.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

TRACE METALS

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
LB-0500	12-15-88	N	0.1U	0.005U	0.0033BCRZ	0.02U	0.001BCRZ	0.05U	0.001U	0.02U	0.0002CZ	0.05U	0.0002U	0.02U
LB-0800	12-15-88	N	0.1U	0.005U	0.0024BCRZ	0.02U	0.001UBCRZ	0.05U	0.001U	0.02U	0.0002CZ	0.05U	0.0002U	0.02U
LB-3000	12-15-88	N	0.1U	0.005U	0.0036BCRZ	0.02U	0.001UBCRZ	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02
LC-0100	12-16-88	N	0.1	0.005U	0.0026BCRZ	0.02U	0.007BCRZ	0.05U	0.002	0.02U	0.0002CZ	0.05U	0.0002	0.02U
LC-0100	12-16-88	D	0.1U	0.005U	0.0050BCRZ	0.02U	0.018BCRZ	0.07	0.004	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
LC-0000	12-16-88	N	0.1	0.005U	0.0009BCRZ	0.02U	0.006BCRZ	0.13	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
PH-0500	12-15-88	N	0.1U	0.005U	0.0030BCRZ	0.02U	0.006BCRZ	0.05U	0.001U	0.02U	0.0002CZ	0.05U	0.0002U	0.02U
PH-1000	12-15-88	N	0.1U	0.005U	0.0037BCRZ	0.02U	0.007BCRZ	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
RA-0600	12-15-88	N	0.1U	0.005U	0.0014BCRZ	0.02U	0.001UBCRZ	0.05U	0.001U	0.02U	0.0002UCZ	0.05U	0.0002U	0.02U
BB-0100	12/16/88	BB	0.1U	0.005U	0.0041	0.02U	0.013	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	12-15-88	BFS	0.5	0.099	0.0240	0.10	0.10	0.12	0.10	0.09	0.0050	0.05U	0.0002U	0.09
CC-0100	12/16/88	CCB	0.1U	0.005U	0.0046	0.02U	0.015	0.05U	0.001U	0.02U	0.0002	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
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* - All values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Temperature (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
LB-0500	1-27-89	0845	N	95658	GRAB	0.30	5.9	METER	0	5.8	5.2	19	16
LB-0800	1-24-89	1300	N	95664	GRAB	--	15.1	METER	1	6.7	6.0	35	35
LB-3000	1-24-89	1600	N	95665	EDI	--	68.5	METER	1	7.4	6.7	65	76
LC-0100	1-26-89	1545	N	95659	GRAB	N/G	0.5	METER	0	6.5	5.6	20	21
LC-0600	1-26-89	1230	N	95657	GRAB	--	2.9	METER	0	6.8	5.8	30	34
PM-0500	1-27-89	1045	N	95661	GRAB	N/G	5.2	METER	0	6.2	5.7	31	25
PM-0500	1-27-89	1100	D	95656	GRAB	--	--	--	0	6.3	5.6	31	24
PM-1000	1-24-89	1530	N	95662	EDI	0.63	5.8	METER	0	6.9	5.7	25	26
RA-0600	1-24-89	1100	N	95663	GRAB	0.44	5.9	METER	1	6.8	5.5	24	20
BB-0100	1-26-89	2030	BB	95655	GRAB	--	--	--	--	--	3.6	--	5
BFS-0100	1-30-89	0930	BFS	95666	GRAB	--	--	--	--	--	6.2	--	264
CC-0100	1-26-89	1400	CCB	95660	GRAB	--	--	--	--	--	4.2	--	6

NOTES:
1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample.
2) Sampling method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) "--#" indicates that the gage was not read due to bank ice.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89

OIL AND GREASE, SOLIDS, AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Oil and Grease	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
LB-0500	1-27-89	N		0.26BCZ	1U	25BC	0.005U	0.005U	0.05U	0.20U	0.12	0.20	0.08
LB-0800	1-24-89	N		0.23BCZ	1U	19BC	0.005U	0.008	0.05U	0.20U	0.31	0.25	0.06
LB-3000	1-24-89	N		0.37BC	1U	47BC	0.005U	0.005U	0.05U	0.20U	0.75	0.58	0.17
LC-0100	1-26-89	N		0.27BCZ	1U	22BC	0.005U	0.005U	0.05U	0.20U	0.17	0.20	0.03
LC-0600	1-26-89	N		0.47BC	1U	34BC	0.005U	0.005U	0.05U	0.20U	0.27	0.20	0.07
PH-0500	1-27-89	N		0.24BCZ	1U	22BC	0.005U	0.005U	0.05U	0.20U	0.22	0.20	0.02
PH-0500	1-27-89	D		0.23BCZ	1U	19BC	0.005U	0.005U	0.05U	0.20U	0.24	0.25	0.01
PH-1000	1-24-89	N		0.20BCZ	1U	25BC	0.005U	0.005	0.05U	0.20U	0.23	0.20	0.03
RA-0600	1-24-89	N		0.21BCZ	1U	13BC	0.005U	0.005U	0.09	0.20U	0.17	0.25	0.08
BB-0100	1-26-89	BB		0.20	1U	6	0.005U	0.005U	0.05U	0.20U			
BFS-0100	1-30-89	BFS		0.18	--	137	0.50	0.50	2.13	1.80			
CC-0100	1-26-89	CCB		0.20	1U	7	0.005U	0.005U	0.05U	0.20U			

NOTES:
A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3 **	COMMON IONS Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Chloride	Fluoride	Nitrate + Nitrite as N	Sulfate
LB-0500	1-27-89	N	6UAZ	1U	1U	1U	1U	3	4	0	1U	0.05U	0.11	1U
LB-0800	1-24-89	N	6UAZ	1U	1U	2	1U	13	16	0	1U	0.05U	0.04	1U
LB-3000	1-24-89	N	26AZ	7	2	1	1U	33	40	0	1U	0.05U	0.03	3
LC-0100	1-26-89	N	6UAZ	1U	1U	1U	1U	6	7	0	1U	0.05U	0.01U	1
LC-0600	1-26-89	N	6UAZ	1U	1U	1U	1U	11	13	0	1U	0.05U	0.01U	1U
PM-0500	1-27-89	N	6UAZ	1U	1U	1U	1U	8	10	0	1U	0.05U	0.13	1U
PM-0500	1-27-89	D	6UAZ	1U	1U	2	1U	7	9	0	1	0.05U	0.12	3
PM-1000	1-24-89	N	6UAZ	1U	1U	1	1U	8	10	0	1U	0.05U	0.05	2
RA-0600	1-24-89	N	6UAZ	1U	1U	2	1U	4	5	0	1U	0.05U	0.06	3
BB-0100	1-26-89	BB	6U	1U	1U	1U	1U	1	0	0	1U	0.05U	0.01U	1U
BFS-0100	1-30-89	BFS	62	18	4	22	4	26	32	0	48	0.94	2.10	20
CC-0100	1-26-89	CCB	6U	1U	1U	1U	1U	1	0	0	1U	0.05U	0.01U	1U

NOTES:
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C - cross-contamination blank equal to or above detection limit.
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** - Hardness is a calculated value.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

TRACE METALS

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
LB-0500	1-27-89	N	0.1U	0.005U	0.0040BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0003BZ	0.05U	0.0002U	0.02U
LB-0800	1-24-89	N	0.1U	0.005U	0.0024BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0003BZ	0.05U	0.0002U	0.02U
LB-3000	1-24-89	N	0.1U	0.005U	0.0013BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002BZ	0.05U	0.0002U	0.02U
LC-0100	1-26-89	N	0.1U	0.005U	0.0020BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0003BZ	0.05U	0.0002U	0.02U
LC-0600	1-26-89	N	0.1U	0.005U	0.0027BCR	0.02U	0.001	0.05	0.001U	0.02U	0.0002BZ	0.05U	0.0002U	0.02U
PH-0500	1-27-89	N	0.1U	0.005U	0.0014BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0003BZ	0.05U	0.0002U	0.02U
PH-0500	1-27-89	D	0.1U	0.005U	0.0028BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002BZ	0.05U	0.0002U	0.02U
PH-1000	1-24-89	N	0.1U	0.005U	0.0009BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002BZ	0.05U	0.0002U	0.02U
RA-0600	1-24-89	N	0.1U	0.005U	0.0015BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002BZ	0.05U	0.0002U	0.02U
BB-0100	1-26-89	BB	0.1U	0.005U	0.0012	0.02U	0.001U	0.05U	0.001U	0.02U	0.0003	0.05U	0.0002U	0.02U
BFS-0100	1-30-89	BFS	0.5	0.101	0.028	0.10	0.09	0.10	0.10	0.10	0.0044	0.05U	0.0002U	0.10
CC-0100	1-26-89	CCB	0.1U	0.005U	0.0017	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
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* - All values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
LB-0500	2-22-89	1130	N	95933	GRAB	--	3.8	METER	2	8.3	5.3	17	19
LB-0800	2-22-89	0940	N	95934	GRAB	--	12.9	METER	1	8.2	5.8	37	37
LB-3000	2-23-89	1130	N	95941	GRAB	--	--	--	2	7.1	6.5	62	71
LC-0100	2-22-89	1430	N	95937	GRAB	N/G	--	--	2	8.4	5.5	21	24
LC-0600	2-22-89	1610	N	95938	GRAB	--	--	--	1	8.0	6.0	42	43
PM-0500	2-22-89	1250	N	95935	GRAB	N/G	1.6	METER	1	8.4	5.6	23	27
PM-1000	2-22-89	1720	N	95936	GRAB	--	--	--	1	8.7	5.5	28	31
RA-0600	2-23-89	0915	N	95939	GRAB	--	--	--	1	6.8	5.7	17	19
RA-0600	2-23-89	0915	D	95940	GRAB	--	--	--	1	7.0	5.7	17	20
BB-0100	2-23-89	1345	BB	95942	GRAB	--	--	--	--	--	4.1	--	4.5
BFS-0100	2-24-89	0900	BFS	95944	GRAB	--	--	--	--	--	7.3	--	550
CC-0100	2-24-89	1400	CCB	95943	GRAB	--	--	--	--	--	4.0	--	4.1

NOTES:
1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample.
2) Sampling method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) "--#" indicates that the gage was not read due to bank ice.

OIL AND GREASE, SOLIDS, AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Oil and Grease	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
LB-0500	2-22-89	N		0.15BCZ	1U	16	0.005UAZ	0.005UBZ	0.05U	0.20U	0.26	0.33	0.07
LB-0800	2-22-89	N		0.18BCZ	1U	23	0.005UAZ	0.088B	0.05U	0.20U	0.31	0.43	0.12
LB-3000	2-23-89	N		0.20BCZ	1U	29	0.005UAZ	0.008BZ	0.05U	0.20U	0.68	0.63	0.05
LC-0100	2-22-89	N		0.27BC	1U	18	0.006AZ	0.014BZ	0.05U	0.20U	0.21	0.42	0.21
LC-0600	2-22-89	N		1.4BC	4	27	0.010AZ	0.011BZ	0.05U	0.20U	0.55	0.48	0.07
PH-0500	2-22-89	N		0.24BC	1U	10	0.005UAZ	0.018BZ	0.05U	0.20U	0.25	0.38	0.13
PH-1000	2-22-89	N		0.16BCZ	1U	33	0.005UAZ	0.011BZ	0.05U	0.20U	0.26	0.47	0.21
RA-0600	2-23-89	N		0.25BC	1U	9	0.005UAZ	0.005UBZ	0.05U	0.20U	0.25	0.33	0.08
RA-0600	2-23-89	D		0.20BCZ	1U	10	0.005UAZ	0.005BZ	0.05U	0.20U	0.20	0.33	0.13
BB-0100	2-23-89	BB		0.15	--	1U	0.005U	0.020	0.05U	0.20U			
BFS-0100	2-24-89	BFS		--	--	288	0.45	0.42	2.09	1.55			
CC-0100	2-24-89	CCB		0.15	--	1U	0.005U	0.005U	0.05U	0.20U	0.09	0.20	0.11

NOTES: A - blind field standard outside advisory range.
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C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3 **	COMMON IONS Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Chloride	Fluoride	Nitrate + Nitrite as N	Sulfate
LB-0500	2-22-89	N	6U	1UAZ	1U	4	1U	4	5	0	1U	0.05U	0.38BCRZ	6
LB-0800	2-22-89	N	8	3AZ	1U	4	1U	13	16	0	1U	0.05U	0.08BCRZ	1
LB-3000	2-23-89	N	28	8AZ	2	1U	1U	30	37	0	1U	0.05U	0.12BCRZ	2
LC-0100	2-22-89	N	3	1AZ	1U	6	1U	8	10	0	1U	0.05U	0.01BCRZ	1U
LC-0600	2-22-89	N	14	4AZ	1	4	1U	18	22	0	1U	0.05U	2.00BCR	1
PH-0500	2-22-89	N	5	2AZ	1U	4	1U	8	10	0	1U	0.05U	0.22BCRZ	2
PH-1000	2-22-89	N	5	2AZ	1U	6	1U	10	12	0	1U	0.05U	0.10BCRZ	1
RA-0600	2-23-89	N	6U	1UAZ	1U	4	1U	6	7	0	1U	0.05U	0.50BCRZ	3
RA-0600	2-23-89	D	6U	1UAZ	1U	4	1U	6	7	0	1U	0.05U	0.11BCRZ	2
BB-0100	2-23-89	BB	6U	1U	1U	1U	1U	1	0	0	1U	0.05U	0.02	1U
BFS-0100	2-24-89	BFS	155	47	9	50	9	32	39	0	76	1.33	2.00	94
CC-0100	2-24-89	CCB	6U	1U	1U	1U	1U	1	0	0	1U	0.05U	0.28	1U

NOTES:
A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
** - Hardness is a calculated value.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

TRACE METALS

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
LB-0500	2-22-89	N	0.1U	0.005U	0.0016BCRZ	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	2-22-89	N	0.1U	0.005U	0.0020BCRZ	0.02U	0.004	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	2-23-89	N	0.1U	0.005U	0.0011BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0100	2-22-89	N	0.1U	0.005U	0.0040BCR	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LC-0600	2-22-89	N	0.1U	0.005U	0.0028BCRZ	0.02U	0.002	0.06	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PH-0500	2-22-89	N	0.1U	0.005U	0.0006BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PH-1000	2-22-89	N	0.1U	0.005U	0.0030BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002	0.02U
RA-0600	2-23-89	N	0.1U	0.005U	0.0021BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
RA-0600	2-23-89	D	0.1U	0.005U	0.0028BCRZ	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BB-0100	2-23-89	BB	0.1U	0.005U	0.0021	0.02U	0.001U	0.02U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	2-24-89	BFS	0.4	0.090	0.027	0.10	0.10	0.09	0.11	0.09	0.0050	0.05U	0.0002	0.10
CC-0100	2-24-89	CCB	0.1U	0.005U	0.0008	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89 Run 14

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
LB-0500	3-29-89	1540	N	96367	GRAB	0.48	16.2	METER	3.0	7.4	5.8	18	18
LB-0800	3-29-89	1820	N	96368	GRAB	0.42	33.5	METER	3.0	7.7	6.3	28	30
LB-3000	3-29-89	2015	N	96369	GRAB	--	155.2	METER	3.5	7.5	6.5	44	51
LC-0100	3-28-89	1100	N	96370	GRAB	N/G	1.3	METER	2.5	6.5	6.1	21	23
LC-0600	3-28-89	1545	N	96371	GRAB	0.85	9.0	METER	2.0	6.5	6.1	26	26
PH-0500	3-29-89	1700	N	96359	GRAB	N/G	4.5	METER	3.0	7.5	6.2	21	23
PH-1000	3-30-89	1925	N	96360	GRAB	0.5	8.0	METER	1.5	6.7	6.2	24	26
PH-1000	3-30-89	1930	D	96362	GRAB	--	--	--	1.5	7.3	6.2	24	25
RA-0600	3-30-89	1820	N	96361	GRAB	0.28	13.3	METER	2.0	8.0	6.2	16	18
BB-0100	3-30-89	1135	BB	96363	--	--	--	--	11.0	5.5	4.9	1	2.3
BFS-0100	4-3-89	0930	BFS	96365	GRAB	--	--	--	--	--	--	--	530
CC-0100	3-30-89	1125	CCB	96364	--	--	--	--	11.0	5.6	4.6	2	3.4

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample.
2) Sampling method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) "--#" indicates that the gage was not read due to bank ice.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89

OIL AND GREASE, SOLIDS, AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Oil and Grease	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
LB-0500	3-29-89	N		0.20BCZ	1U	14C	0.005	0.014	0.05U	0.20U	0.21	0.20	0.01
LB-0800	3-29-89	N		0.28BCZ	1U	26C	0.005	0.019	0.05U	0.20U	0.33	0.39	0.06
LB-3000	3-29-89	N		5.3BC	4	47C	0.010	0.010	0.05U	0.20U	0.57	0.49	0.08
LC-0100	3-28-89	N		0.20BCZ	1U	20C	0.018	0.018	0.05U	0.20U	0.23	0.20	0.03
LC-0600	3-28-89	N		3.0BC	4	26C	0.007	0.008	0.05U	0.20U	0.31	0.34	0.03
PH-0500	3-29-89	N		0.22BCZ	1U	10C	0.005U	0.008	0.05U	0.20U	0.10	0.25	0.15
PH-1000	3-30-89	N		0.20BCZ	1U	13C	0.005U	0.005U	0.05U	0.20U	0.29	0.25	0.04
PH-1000	3-30-89	D		0.25BCZ	1U	14C	0.005	0.005	0.05U	0.20U	0.29	0.25	0.04
RA-0600	3-30-89	N		0.29BCZ	1U	20C	0.005U	0.014	0.05U	0.20U	0.25	0.20	0.05
BB-0100	3-30-89	BB		0.20	-	1U	0.005U	0.005U	0.05U	0.20U			
BFS-0100	4-3-89	BFS		--	--	318	0.216	1.52	0.05U	4.46			
CC-0100	3-30-89	CCB		0.26	-	2	0.005U	0.005U	0.05U	0.20U			

NOTES:
A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3 **	COMMON IONS Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Chloride	Fluoride	Nitrate + Nitrite as N	Sulfate
LB-0500	3-29-89	N	6U	1U	1U	1AZ	1U	8	10	0	1U	0.05U	0.08BC	1U
LB-0800	3-29-89	N	8	3	1U	3AZ	1U	14	17	0	1U	0.05U	0.04BC	1U
LB-3000	3-29-89	N	17	5	1	3AZ	1U	24	29	0	1U	0.05U	0.05BC	3
LC-0100	3-28-89	N	6U	1U	1U	1AZ	1U	9	11	0	1U	0.05U	0.03BC	1
LC-0600	3-28-89	N	5	2	1U	3AZ	1U	13	16	0	1U	0.05U	0.03BC	1
PH-0500	3-29-89	N	5	2	1U	1AZ	1U	1	0	0	1U	0.05U	0.10BC	2
PH-1000	3-30-89	N	5	2	1U	1UAZ	1U	11	13	0	1U	0.05U	0.04BC	2
PH-1000	3-30-89	D	5	2	1U	1AZ	1U	11	13	0	1U	0.05U	0.04BC	2
RA-0600	3-30-89	N	6U	1U	1U	1AZ	1U	8	10	0	1U	0.05U	0.04BC	3
BB-0100	3-30-89	BB	6U	1U	1U	1U	1U	1	1	0	1U	0.05U	0.02	1U
BFS-0100	4-3-89	BFS	146	45	8	52	8	33	40	0	77	1.18	0.17	94
CC-0100	3-30-89	CCB	6U	1U	1U	1U	1U	2	2	0	1U	0.05U	0.02	1U

NOTES:
A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
** - Hardness is a calculated value.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89 Run 14
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TRACE METALS

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
LB-0500	3-29-89	N	0.1U	0.005U	0.0017BCZ	0.02U	0.001UCZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-0800	3-29-89	N	0.1U	0.005U	0.0006BCZ	0.02U	0.001UCZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
LB-3000	3-29-89	N	0.5	0.005U	0.0005BCZ	0.02U	0.001UCZ	0.36	0.001U	0.02U	0.0004	0.05U	0.0002U	0.02U
LC-0100	3-28-89	N	0.1U	0.005U	0.0004BCZ	0.02U	0.002CZ	0.05U	0.001U	0.02U	0.0002	0.05U	0.0002U	0.02U
LC-0600	3-28-89	N	0.2	0.005U	0.0005BCZ	0.02U	0.002CZ	0.21	0.001U	0.02U	0.0002	0.05U	0.0002U	0.02U
PH-0500	3-29-89	N	0.1U	0.005U	0.0009BCZ	0.02U	0.001UCZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PH-1000	3-30-89	N	0.1U	0.005U	0.0007BCZ	0.02U	0.001UCZ	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
PH-1000	3-30-89	D	0.1U	0.005U	0.0006BCZ	0.02U	0.002CZ	0.05U	0.001U	0.02U	0.0003	0.05U	0.0002U	0.02U
RA-0600	3-30-89	N	0.1U	0.005U	0.0008BCZ	0.02U	0.001UCZ	0.05U	0.001U	0.02U	0.0003	0.05U	0.0002U	0.002U
BB-0100	3-30-89	BB	0.1U	0.005U	0.0006	0.02U	0.001U	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	4-3-89	BFS	--	--	--	--	--	--	--	--	--	--	--	--
CC-0100	3-30-89	CCB	0.1U	0.005U	0.0017	0.02U	0.004	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89

FIELD MEASUREMENTS

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Staff Gage (ft)	Discharge (CFS)	Gaging Method	Water Tempera-ture (C)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
LB-0500	4-12-89	1430	N	96680	GRAB	0.78	42.0	METER	5.0	6.4	6.9	16	16
LB-0500	4-12-89	1435	D	96679	GRAB	--	--	--	5.0	6.4	6.9	16	18
LB-0800	4-11-89	1415	N	96683	GRAB	0.76	108.3	METER	5.0	7.1	7.0	29	25
LB-3000	4-11-89	0930	N	96673	GRAB		270.1	METER	2.5	7.2	7.4	43	37
LC-0100	4-12-89	1210	N	96678	GRAB	N/G	6.7	METER	3.0	6.5	6.8	17	23
LC-0600	4-12-89	0915	N	96676	GRAB	1.04	13.2	METER	3.0	6.5	6.9	18	20
PM-0500	4-12-89	1100	N	96675	GRAB	N/G	20.5	METER	4.0	6.6	7.0	20	21
PM-1000	4-11-89	1535	N	96674	EDI	0.86	31.8	METER	4.0	7.0	6.9	21	18
RA-0600	4-11-89	1700	N	96677	EDI	--	37.2	METER	5.0	6.7	7.0	19	19
BB-0100	4-11-89	1735	BB	96682	GRAB	--	--	--	--	--	5.4	--	4
BFS-0100	4-13-89	0930	BFS	96684	GRAB	--	--	--	--	--	138	--	1450
CC-0100	4-12-89	1600	CCB	96681	GRAB	--	--	--	10.0	4.7	5.4	1	4

NOTES:
1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample.
2) Sampling method: EDI - equal discharge integration, Grab - grab sample.
3) Gaging Method: Meter - flow meter, Est. - estimated, BUCKT - timed volumetric measurement.
4) "--" indicates that data was not collected.
5) "--#" indicates that the gage was not read due to bank ice.

NORANDA MONTANA PROJECT SURFACE WATER DATA 05/25/89 Run 15

OIL AND GREASE, SOLIDS, AND NUTRIENTS *

STATION	SAMPLE DATE	SAMPLE TYPE	Oil and Grease	Turbidity (NTU)	Total Suspended Solids	Total Dissolved Solids	Ortho-phosphate as P	Total Phosphorus as P	Ammonia as N	Total Kjeldahl Nitrogen as N	Cations (meq/L)	Anions (meq/L)	Difference (meq/L)
LB-0500	4-12-89	N		0.42BCRZ	1U	14BCZ	0.005U	0.008AZ	0.05	0.20U	0.18	0.29	0.11
LB-0500	4-12-89	D		0.68BCR	1U	14BCZ	0.005U	0.005UAZ	0.05U	0.20U	0.18	0.20	0.02
LB-0800	4-11-89	N		0.82BCR	3	22BC	0.005U	0.010AZ	0.05U	0.20U	0.30	0.34	0.04
LB-3000	4-11-89	N		1.62BCR	4	17BCZ	0.005	0.005AZ	0.05	0.20U	0.40	0.40	0.00
LC-0100	4-12-89	N		0.68UBCR	1U	20BCZ	0.005U	0.005UAZ	0.07	0.20U	0.19	0.25	0.06
LC-0600	4-12-89	N		2.69BCR	9	20BCZ	0.012	0.020AZ	0.05	0.20U	0.23	0.25	0.02
PM-0500	4-12-89	N		0.32BCRZ	1U	5BCZ	0.005U	0.005UAZ	0.05U	0.20U	0.22	0.20	0.02
PM-1000	4-11-89	N		0.53BCRZ	1U	10BCZ	0.005U	0.005UAZ	0.05U	0.20U	0.23	0.20	0.03
RA-0600	4-11-89	N		0.82BCR	1U	19BCZ	0.005U	0.005UAZ	0.05	0.20U	0.24	0.25	0.01
BB-0100	4-11-89	BB		0.38		5	0.005U	0.005U	0.05U	0.20U			
BFS-0100	4-13-89	BFS		0.82	138	137	0.240	1.03	0.09	5.52			
CC-0100	4-12-89	CCB		0.42		14	0.005U	0.005U	0.05U	0.20U			

NOTES:
A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3 **	COMMON IONS Calcium	Magnesium	Sodium	Potassium	ALKALINITY Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Chloride	Fluoride	Nitrate + Nitrite as N	Sulfate
LB-0500	4-12-89	N	6U	1	1U	3BCR	1U	6		0	1UAZ	0.05U	0.17BC	1CZ
LB-0500	4-12-89	D	6U	1U	1U	1BCRZ	1U	6		0	1UAZ	0.05U	0.17BC	1CZ
LB-0800	4-11-89	N	6U	2	1U	3BCR	1U	11		0	1UAZ	0.05U	0.10BC	2C
LB-3000	4-11-89	N	14	4	1	2BCRZ	1U	17		0	1UAZ	0.05U	0.11BC	1CZ
LC-0100	4-12-89	N	6U	1U	1U	2BCRZ	1U	7		0	1UAZ	0.05U	0.01UBCZ	1CZ
LC-0600	4-12-89	N	6U	1	1U	2BCRZ	1U	9		0	1UAZ	0.05U	0.01UBCZ	1CZ
PM-0500	4-12-89	N	6U	1	1U	1BCRZ	1U	8		0	1UAZ	0.05U	0.15BC	1CZ
PM-1000	4-11-89	N	6U	1	1U	1BCRZ	1U	9		0	1UAZ	0.05U	0.08BC	1CZ
RA-0600	4-11-89	N	6U	1U	1U	2BCR	1U	8		0	1UAZ	0.05U	0.08UBC	2C
BB-0100	4-11-89	BB	6U	1U	1U	2	1U	1		0	1U	0.05U	0.04	1U
BFS-0100	4-13-89	BFS	351	88	32	44	4	147		0	229	2.18	0.21	9
CC-0100	4-12-89	CCB	6U	1U	1U	2	1U	2		0	1U	0.05U	0.04	1

NOTES:
A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
** - Hardness is a calculated value.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

TRACE METALS

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
LB-0500	4-12-89	N	0.1U	0.005U	0.0001UBCZ	0.02UAZ	0.001ABCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
LB-0500	4-12-89	D	0.1U	0.005U	0.0002BCZ	0.02UAZ	0.001UABCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
LB-0800	4-11-89	N	0.1U	0.005U	0.0001UBCZ	0.02UAZ	0.001ABCZ	0.05AZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
LB-3000	4-11-89	N	0.1U	0.005U	0.0001UBCZ	0.02UAZ	0.004UBCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
LC-0100	4-12-89	N	0.1U	0.005U	0.0002BCZ	0.02UAZ	0.012ABCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
LC-0600	4-12-89	N	0.3	0.005U	0.0002BCZ	0.02UAZ	0.001ABCZ	0.29AZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
PM-0500	4-12-89	N	0.1U	0.005U	0.0001UBCZ	0.02UAZ	0.001UABCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
PM-1000	4-11-89	N	0.1U	0.005U	0.0001BCZ	0.02UAZ	0.004ABCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
RA-0600	4-11-89	N	0.1U	0.005U	0.0002BCZ	0.02UAZ	0.002ABCZ	0.05UAZ	0.001U	0.02U	0.0002UAZ	0.05U	0.0002U	0.02UAZ
BB-0100	4-11-89	BB	0.1U	0.005U	0.0002	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U
BFS-0100	4-13-89	BFS	0.4	0.105	0.0215	0.07	0.085	0.07	0.090	0.08	0.0035	0.05U	0.0002U	0.07
CC-0100	4-12-89	CCB	0.1U	0.005U	0.0002	0.02U	0.002	0.05U	0.001U	0.02U	0.0002U	0.05U	0.0002U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
S - value obtained indirectly by calculation.
U - value less than detection limit.
Z - value not usable for statistics.

APPENDIX G2

TSS DATA FROM AUTOMATIC SAMPLER

NORANDA MONTANA PROJECT
DAILY TOTAL SUSPENDED SOLIDS

From May 26, 1988
through September 9, 1988

SAMPLE DATE	SAMPLE TIME	LAB NUMBER	TSS MG/L	AVERAGE DISCHARGE (CFS)
05/26/88	1900	92925	1	392.5
05/27/88	1900	92926	1	305.2
05/28/88	1900	92927	<1	305.2
05/29/88	1900	92928	<1	220.8
05/30/88	1900	92929	<1	171.7
05/31/88	1900	92930	<1	165.6
06/01/88	1900	92931	<1	159.8
06/02/88	1900	92932	<1	205.5
06/03/88	1900	92933	<1	352.4
06/04/88	1900	92934	<1	339.9
06/05/88	1900	92935	2	273.9
06/06/88	1900	92936	1	305.2
06/07/88	1900	92937	2	255.0
06/08/88	1900	93126	30	242.4
06/09/88	1900	93127	8	180.4
06/10/88	1900	93128	4	196.3
06/11/88	1900	93129	8	165.4
06/12/88	1900	93130	3	159.0
06/13/88	1900	93131	2	173.0
06/14/88	1900	93132	3	173.0
06/15/88	1900	63133	9	204.8
06/16/88	1900	63134	<1	252.8
06/17/88	1900	63135	<1	312.1
06/18/88	1900	63136	<1	196.3
06/19/88	1900	63137	<1	146.1
06/20/88	1900	63138	<1	159.0
06/21/88	1900	63139	<1	140.1
06/22/88	1900	63140	3	146.2
06/23/88	1900	93372	<2	121.8
06/24/88	1900	93373	3	90.6
06/25/88	1900	93374	11	83.3
06/26/88	1900	93375	6	86.9
06/27/88	1900	93376	5	83.3
06/28/88	1900	93377	3	83.3
06/29/88	1900	93378	2	70.4
06/30/88	1900	93379	2	57.0
07/01/88	1900	93380	3	50.3
07/02/88	1900	93381	3	52.4
07/03/88	1900	93382	3	54.7
07/04/88	1900	93383	3	50.3

NOTES:
a) Could not filter more than 500 mL.
b) Very difficult to filter.
c) Detection limit will vary for samples 94100 - 94107 because of varying amounts of sample volume received in the laboratory.

NORANDA MONTANA PROJECT
DAILY TOTAL SUSPENDED SOLIDS

From May 26, 1988
through September 9, 1988

SAMPLE DATE	SAMPLE TIME	LAB NUMBER	TSS MG/L	AVERAGE DISCHARGE (CFS)
07/05/88	1900	93384	10	210.7
07/06/88	1900	93385	2	70.4
07/07/88	1900	93386	2	50.3
07/08/88	1900	93387	5	48.2
07/09/88	1900	93388	4	48.2
07/10/88	1900	93389	3	48.2
07/11/88	1900	93390	3	46.2
07/12/88	1900	93391	7	44.3
07/13/88	1900	93392	5	42.5
07/14/88	1900	93393	9	70.4
07/15/88	1900	93394	9	46.2
07/16/88	1900	93395	5	39.0
07/18/88	1900	93443	<2a	37.4
07/19/88	1900	93444	4a	32.8
07/20/88	1900	93345	<1	34.3
07/21/88	1900	93346	7	32.9
07/22/88	1900	93702	3	34.3
07/23/88	1900	93703	3	32.9
07/24/88	1900	93704	4	30.2
07/25/88	1900	93705	12	30.2
07/26/88	1900	93706	8	29.0
07/27/88	1900	93707	10	29.0
07/28/88	1900	93708	7	25.5
07/29/88	1900	93709	11	26.6
07/30/88	1900	93710	8	24.5
07/31/88	1900	93711	7	24.5
08/01/88	1900	93712	6	24.5
08/02/88	1900	93713	6	24.5
08/03/88	1900	93714	5	23.5
08/04/88	1900	93715	3	23.5
08/05/88	1900	93716	3	23.5
08/06/88	1900	93717	5	22.5
08/07/88	1900	93718	5	23.5
08/08/88	1900	93719	4	23.5
08/09/88	1900	93720	3	25.5
08/10/88	1900	93721	<1	23.5
08/11/88	1900	93722	5	23.5
08/12/88	1900	93723	<1	23.5
08/15/88	1900	93892	<2b	19.8
08/16/88	1900	93893	7	19.8

NOTES:
a) Could not filter more than 500 mL.
b) Very difficult to filter.
c) Detection limit will vary for samples 94100 - 94107 because of varying amounts of sample volume received in the laboratory.

NORANDA MONTANA PROJECT
DAILY TOTAL SUSPENDED SOLIDS

From May 26, 1988
through September 9, 1988

SAMPLE DATE	SAMPLE TIME	LAB NUMBER	TSS MG/L	AVERAGE DISCHARGE (CFS)
08/17/88	1900	93894	8	19.8
08/18/88	1900	93895	10	19.8
08/19/88	1900	94090	5	19.8
08/20/88	1900	94091	9	19.8
08/21/88	1900	94092	6	19.8
08/22/88	1900	94093	7	19.8
08/23/88	1900	94094	7	19.8
08/24/88	1900	94095	4	19.8
08/25/88	1900	94096	5	19.8
08/26/88	1900	94097	3	19.8
08/27/88	1900	94098	3	19.8
08/28/88	1900	94099	2	19.8
08/29/88	1900	94100	5	19.8
08/30/88	1900	94101	4	19.8
08/31/88	1900	94102	4	19.8
09/01/88	1900	94103	15	19.8
09/02/88	1900	94104	<6c	19.8
09/03/88	1900	94105	5	19.8
09/04/88	1900	94106	5	19.8
09/05/88	1900	94107	<4c	19.8

NOTES:
a) Could not filter more than 500 mL.
b) Very difficult to filter.
c) Detection limit will vary for samples 94100 - 94107 because of varying amounts of sample volume received in the laboratory.

APPENDIX G3

SURFACE WATER

STATISTICAL SUMMARY

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: EF-0200

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0012	0.0040	0.0029	0.0015	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	0.0010	0.0080	0.0036	0.0024	8
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	9
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	< 0.0002	< 0.0002	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.7778	1.5635	9
14	Total Dissolved Solids	< 1.0000	17.0000	< 7.6667	4.2898	6
15	Turbidity-NTU	0.1900	1.4500	0.4925	0.3943	8
16	Nitrate/Nitrite as N	< 0.0100	0.0700	< 0.0375	0.0156	4
17	Sulfate	< 1.0000	2.0000	< 1.1667	0.2357	6
18	Total Phosphorus	< 0.0050	0.0070	< 0.0054	0.0007	5
19	Orthophosphate	< 0.0050	0.0090	< 0.0057	0.0011	7
20	Ammonia	< 0.0500	< 0.1000	< 0.0750	0.0274	6
21	Total Kjeldahl Nitrogen	< 0.2000	0.2400	< 0.2044	0.0063	9
22	Total Hardness as $CaCO_3$	< 6.0000	< 6.0000	< 6.0000	0.0000	9
23	Calcium	< 1.0000	< 1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	1.0000	< 1.0000	0.0000	7
26	Potassium	< 1.0000	2.0000	< 1.1667	0.2357	6
27	Total Alkalinity as $CaCO_3$	4.0000	6.0000	5.2222	0.6667	9
28	Bicarbonate as HCO_3	5.0000	7.0000	6.2222	0.6667	9
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.1100	< 0.0600	0.0000	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.3000	7.0000	6.5750	0.2712	8
34	Field Specific Conductance-umhos/cm	5.0000	14.000	10.2222	3.3082	9
35	Lab pH	6.1000	7.1000	6.6111	0.3219	9
36	Lab Specific Conductance-umhos/cm	6.5000	12.000	8.9444	1.6667	9
37	Temperature-deg. C	1.0000	18.0000	8.9444	6.4925	9

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: EF-0300

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0017	0.0023	0.0020	0.0004	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0060	< 0.0026	0.0014	7
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	9
7	Lead	< 0.0010	0.0020	< 0.0011	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0003	< 0.0002	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.4444	1.3333	9
14	Total Dissolved Solids	2.0000	20.0000	11.0000	8.3066	5
15	Turbidity-NTU	< 0.1000	1.5500	< 0.4157	0.4568	7
16	Nitrate/Nitrite as N	0.0400	0.1100	0.0750	0.0302	6
17	Sulfate	< 1.0000	2.0000	< 1.3333	0.2887	6
18	Total Phosphorus	< 0.0050	0.0120	< 0.0065	0.0018	6
19	Orthophosphate	< 0.0050	0.0050	< 0.0050	0.0000	6
20	Ammonia	< 0.0500	< 0.1000	< 0.0750	0.0274	6
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	9
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 5.0000	1.5000	9
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	1.0000	< 1.0000	0.0000	7
26	Potassium	< 1.0000	2.0000	< 1.1667	0.2887	6
27	Total Alkalinity as $CaCO_3$	5.0000	13.0000	7.1111	2.8916	9
28	Bicarbonate as HCO_3	6.0000	16.0000	8.5556	3.5746	9
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.0500	< 0.0500	0.0000	5
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.4000	7.1000	6.8000	0.2268	8
34	Field Specific Conductance-umhos/cm	11.0000	18.000	13.6667	2.5981	9
35	Lab pH	5.9000	7.2000	6.6778	0.3993	9
36	Lab Specific Conductance-umhos/cm	9.0000	28.000	13.7778	6.4377	9
37	Temperature-deg. C	3.0000	14.0000	9.3750	3.7009	8

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: EF-0400

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0026	0.0046	0.0036	0.0014	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0030	< 0.0020	0.0006	8
6	Iron	< 0.0500	0.3400	< 0.0922	0.0472	9
7	Lead	< 0.0010	0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0003	< 0.0002	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	2.0000	1.7321	9
14	Total Dissolved Solids	8.0000	19.0000	11.0000	4.0988	6
15	Turbidity-NTU	0.3000	1.0000	0.4800	0.2199	8
16	Nitrate/Nitrite as N	< 0.0100	0.0900	< 0.0460	0.0201	5
17	Sulfate	< 1.0000	5.0000	< 1.8333	1.0408	6
18	Total Phosphorus	< 0.0050	0.0110	< 0.0074	0.0012	5
19	Orthophosphate	< 0.0050	0.0100	< 0.0066	0.0015	7
20	Ammonia	< 0.0500	< 0.1000	< 0.0750	0.0274	6
21	Total Kjeldahl Nitrogen	< 0.2000	0.3000	< 0.2111	0.0000	9
22	Total Hardness as $CaCO_3$	< 5.0000	< 6.0000	< 5.8889	0.3333	9
23	Calcium	< 1.0000	2.0000	< 1.1111	0.0000	9
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	1.0000	< 1.0000	0.0000	7
26	Potassium	< 1.0000	2.0000	< 1.3333	0.3849	6
27	Total Alkalinity as $CaCO_3$	< 1.0000	12.0000	< 6.6667	2.3246	9
28	Bicarbonate as HCO_3	< 2.0000	15.0000	< 8.1111	2.9457	9
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.1100	< 0.0600	0.0173	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.5000	6.9000	6.6875	0.1356	8
34	Field Specific Conductance-umhos/cm	11.0000	16.000	12.7778	1.7873	9
35	Lab pH	4.6000	7.0000	6.4000	0.7280	9
36	Lab Specific Conductance-umhos/cm	9.0000	19.000	13.5556	4.3333	9
37	Temperature-deg. C	5.5000	18.0000	11.4375	4.8583	8

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: EF-0800

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0007	0.0034	0.0020	0.0014	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0220	< 0.0047	0.0063	7
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	9
7	Lead	< 0.0010	0.0240	< 0.0039	0.0050	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0002	< 0.0002	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.4444	1.3333	9
14	Total Dissolved Solids	< 1.0000	16.0000	<10.8000	2.0000	5
15	Turbidity-NTU	< 0.1000	0.8500	< 0.3200	0.2229	7
16	Nitrate/Nitrite as N	0.0200	0.0600	0.0340	0.0195	5
17	Sulfate	< 1.0000	2.0000	< 1.3333	0.2887	6
18	Total Phosphorus	< 0.0050	0.0090	< 0.0066	0.0014	5
19	Orthophosphate	< 0.0050	0.0070	< 0.0053	0.0000	6
20	Ammonia	< 0.0500	< 0.1000	< 0.0750	0.0274	6
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	9
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 5.6667	1.0000	9
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	2.0000	< 1.1429	0.2857	7
26	Potassium	< 1.0000	2.0000	< 1.3333	0.2887	6
27	Total Alkalinity as $CaCO_3$	5.0000	9.0000	6.3333	1.4142	9
28	Bicarbonate as HCO_3	6.0000	11.0000	7.6667	1.8708	9
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.0900	< 0.0567	0.0000	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.5000	7.2000	6.8375	0.2669	8
34	Field Specific Conductance-umhos/cm	8.0000	15.000	12.2222	1.9861	9
35	Lab pH	6.4000	7.1000	6.7444	0.2351	9
36	Lab Specific Conductance-umhos/cm	8.0000	16.000	12.0000	3.2016	9
37	Temperature-deg. C	5.5000	15.5000	10.9375	3.5400	8

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: WF-0020

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	7
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	7
3	Cadmium	0.0013	0.0013	0.0013	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	7
5	Copper	< 0.0010	0.0030	< 0.0018	0.0003	5
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	7
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	6
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	7
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	6
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	7
11	Silver	< 0.0002	0.0006	< 0.0003	0.0000	7
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	7
13	Total Suspended Solids	1.0000	5.0000	1.5714	1.5119	7
14	Total Dissolved Solids	29.0000	47.0000	38.6667	6.7725	6
15	Turbidity-NTU	0.1400	0.8500	0.4860	0.3307	5
16	Nitrate/Nitrite as N	< 0.0100	0.0300	< 0.0200	0.0000	2
17	Sulfate	1.0000	3.0000	1.8333	0.7528	6
18	Total Phosphorus	< 0.0050	0.0170	< 0.0083	0.0039	4
19	Orthophosphate	< 0.0050	0.0170	< 0.0078	0.0038	5
20	Ammonia	< 0.0500	< 0.1000	< 0.0800	0.0274	5
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	7
22	Total Hardness as $CaCO_3$	<17.0000	26.0000	<24.5714	3.7818	7
23	Calcium	5.0000	8.0000	6.7143	1.2536	7
24	Magnesium	1.0000	2.0000	1.8333	0.4082	6
25	Sodium	< 1.0000	2.0000	< 1.5000	0.3333	6
26	Potassium	< 1.0000	2.0000	< 1.4000	0.4619	5
27	Total Alkalinity as $CaCO_3$	25.0000	40.0000	32.0000	5.4772	7
28	Bicarbonate as HCO_3	31.0000	49.0000	39.1429	6.6690	7
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	7
30	Chloride	< 1.0000	1.0000	< 1.0000	0.0000	7
31	Fluoride	< 0.0500	0.1200	< 0.0640	0.0000	5
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	7.6000	7.7000	7.6667	0.0516	6
34	Field Specific Conductance-umhos/cm	55.0000	70.000	63.5714	4.9281	7
35	Lab pH	7.3000	7.9000	7.5857	0.2478	7
36	Lab Specific Conductance-umhos/cm	51.0000	78.000	62.1429	10.1231	7
37	Temperature-deg. C	5.5000	12.0000	9.2143	2.3427	7

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: RC-0850

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	8
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	8
3	Cadmium	0.0004	0.0004	0.0004	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	8
5	Copper	< 0.0010	0.0070	< 0.0026	0.0022	5
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	8
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	7
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	8
9	Mercury	< 0.0002	0.0002	< 0.0002	0.0000	7
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	8
11	Silver	< 0.0002	< 0.0002	< 0.0002	0.0000	8
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	8
13	Total Suspended Solids	1.0000	5.0000	1.5000	1.4142	8
14	Total Dissolved Solids	4.0000	13.0000	10.0000	3.6742	5
15	Turbidity-NTU	0.1500	0.9500	0.4083	0.3002	6
16	Nitrate/Nitrite as N	0.0100	0.0500	0.0260	0.0152	5
17	Sulfate	< 1.0000	2.0000	< 1.1667	0.2887	6
18	Total Phosphorus	< 0.0050	0.0050	< 0.0050	0.0000	4
19	Orthophosphate	< 0.0050	0.0080	< 0.0056	0.0000	5
20	Ammonia	< 0.0500	< 0.1000	< 0.0800	0.0274	5
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	8
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 4.8750	1.5526	8
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	8
24	Magnesium	< 0.0000	< 1.0000	< 0.8571	0.3780	7
25	Sodium	< 1.0000	2.0000	< 1.3333	0.3849	6
26	Potassium	1.0000	2.0000	1.2000	0.4472	5
27	Total Alkalinity as $CaCO_3$	4.0000	11.0000	6.5000	2.3299	8
28	Bicarbonate as HCO_3	5.0000	13.0000	7.8750	2.7999	8
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	8
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	8
31	Fluoride	< 0.0500	< 0.0500	< 0.0500	0.0000	5
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.0000	7.3000	6.9000	0.4690	7
34	Field Specific Conductance-umhos/cm	7.0000	17.000	12.2500	3.1510	8
35	Lab pH	6.3000	7.3000	6.7875	0.3044	8
36	Lab Specific Conductance-umhos/cm	8.0000	23.000	13.0000	5.2915	8
37	Temperature-deg. C	5.5000	16.5000	10.8125	3.9545	8

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: RC-2000

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	6
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	6
3	Cadmium	0.0012	0.0013	0.0013	0.0001	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	6
5	Copper	0.0010	0.0040	0.0030	0.0014	5
6	Iron	< 0.0500	0.0900	< 0.0567	0.0000	6
7	Lead	< 0.0010	0.0020	< 0.0012	0.0000	6
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	6
9	Mercury	< 0.0002	0.0002	< 0.0002	0.0000	5
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	6
11	Silver	< 0.0002	0.0002	< 0.0002	0.0000	6
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	6
13	Total Suspended Solids	1.0000	7.0000	3.0000	2.4495	6
14	Total Dissolved Solids	2.0000	19.0000	12.8000	6.4576	5
15	Turbidity-NTU	0.2100	2.4000	0.8817	0.8039	6
16	Nitrate/Nitrite as N	< 0.0100	0.0200	< 0.0150	0.0000	2
17	Sulfate	< 1.0000	2.0000	< 1.5000	0.4330	4
18	Total Phosphorus	< 0.0050	< 0.0050	< 0.0050	0.0000	2
19	Orthophosphate	< 0.0050	0.0060	< 0.0053	0.0000	3
20	Ammonia	< 0.0500	< 0.1000	< 0.0875	0.0250	4
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	6
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 4.3333	1.5055	6
23	Calcium	< 1.0000	2.0000	< 1.1667	0.3333	6
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	5
25	Sodium	< 1.0000	2.0000	< 1.6000	0.0000	5
26	Potassium	1.0000	2.0000	1.5000	0.5774	4
27	Total Alkalinity as $CaCO_3$	9.0000	13.0000	10.1667	1.6021	6
28	Bicarbonate as HCO_3	11.0000	16.0000	12.3333	1.9664	6
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	6
30	Chloride	< 1.0000	1.0000	< 1.0000	0.0000	6
31	Fluoride	< 0.0500	< 0.0500	< 0.0500	0.0000	4
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.8000	7.2000	7.0200	0.1483	5
34	Field Specific Conductance-umhos/cm	14.0000	31.000	21.8000	6.3797	5
35	Lab pH	6.6000	7.3000	6.8667	0.2658	6
36	Lab Specific Conductance-umhos/cm	15.0000	26.000	18.5000	4.0373	6
37	Temperature-deg. C	6.0000	16.0000	10.8333	3.4303	6

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LB-0100

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0008	0.0016	0.0012	0.0006	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0020	< 0.0012	0.0000	5
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	9
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0004	< 0.0002	0.0000	9
12	Zinc	< 0.0200	0.0600	< 0.0244	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.7778	1.3944	9
14	Total Dissolved Solids	4.0000	14.0000	9.4000	3.5777	5
15	Turbidity-NTU	< 0.1000	1.3000	< 0.4186	0.3509	7
16	Nitrate/Nitrite as N	0.0500	0.2000	0.1229	0.0565	7
17	Sulfate	< 1.0000	3.0000	< 1.6250	0.5646	8
18	Total Phosphorus	< 0.0050	0.0060	< 0.0052	0.0000	5
19	Orthophosphate	< 0.0050	< 0.0050	< 0.0050	0.0000	6
20	Ammonia	< 0.0500	0.1000	< 0.0750	0.0228	6
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	9
22	Total Hardness as CaCO3	< 3.0000	< 6.0000	< 5.6667	1.0000	9
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	2.0000	< 1.2857	0.0000	7
26	Potassium	< 1.0000	2.0000	< 1.1667	0.2887	6
27	Total Alkalinity as CaCO3	3.0000	6.0000	4.7778	0.9718	9
28	Bicarbonate as HCO3	4.0000	7.0000	5.7778	0.9718	9
29	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.0900	< 0.0583	0.0104	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.6000	7.3000	6.8667	0.2236	9
34	Field Specific Conductance-umhos/cm	6.0000	14.000	9.6667	2.7839	9
35	Lab pH	6.2000	6.9000	6.5000	0.2500	9
36	Lab Specific Conductance-umhos/cm	9.0000	13.000	10.4444	1.2360	9
37	Temperature-deg. C	4.5000	10.0000	6.5000	1.7678	9

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LB-0200

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0018	0.0018	0.0018	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0040	< 0.0020	0.0005	7
6	Iron	< 0.0200	< 0.0500	< 0.0467	0.0100	9
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	< 0.0008	< 0.0003	0.0002	9
12	Zinc	< 0.0200	0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.5556	1.3333	9
14	Total Dissolved Solids	8.0000	16.0000	11.0000	2.5495	5
15	Turbidity-NTU	< 0.1000	0.8000	< 0.3750	0.2111	8
16	Nitrate/Nitrite as N	0.0500	0.2800	0.1300	0.0779	7
17	Sulfate	< 1.0000	2.0000	< 1.4286	0.2857	7
18	Total Phosphorus	< 0.0050	0.0160	< 0.0070	0.0036	6
19	Orthophosphate	< 0.0050	0.0160	< 0.0067	0.0026	7
20	Ammonia	< 0.0500	0.0700	< 0.0783	0.0228	6
21	Total Kjeldahl Nitrogen	< 0.2000	0.2200	< 0.2022	0.0000	9
22	Total Hardness as CaCO3	< 3.0000	< 6.0000	< 5.6667	1.0000	9
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	2.0000	< 1.1429	0.2020	7
26	Potassium	< 1.0000	2.0000	< 1.3333	0.0000	6
27	Total Alkalinity as CaCO3	3.0000	6.0000	5.1111	1.2693	9
28	Bicarbonate as HCO3	4.0000	7.0000	6.1111	1.2693	9
29	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.0900	< 0.0567	0.0094	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	6.3000	6.9000	6.7444	0.1810	9
34	Field Specific Conductance-umhos/cm	4.0000	20.000	11.8889	4.8848	9
35	Lab pH	5.8000	6.8000	6.4667	0.3000	9
36	Lab Specific Conductance-umhos/cm	9.0000	19.000	11.8889	3.1002	9
37	Temperature-deg. C	3.5000	9.0000	6.2222	1.8559	9

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LB-0500

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0015	0.0040	0.0024	0.0014	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0050	< 0.0020	0.0007	8
6	Iron	< 0.0500	0.0600	< 0.0507	0.0000	14
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0022	< 0.0003	0.0002	15
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	5.0000	1.3333	1.0465	15
14	Total Dissolved Solids	4.0000	30.0000	15.5833	8.7330	12
15	Turbidity-NTU	< 0.1000	0.5100	< 0.3011	0.0694	9
16	Nitrate/Nitrite as N	0.0300	0.1700	0.0910	0.0493	10
17	Sulfate	< 1.0000	6.0000	< 2.0909	0.9520	11
18	Total Phosphorus	< 0.0050	0.0140	< 0.0066	0.0015	8
19	Orthophosphate	< 0.0050	0.0050	< 0.0050	0.0000	11
20	Ammonia	< 0.0500	0.0500	< 0.0650	0.0225	10
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	14
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 5.7692	0.8321	13
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	14
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	14
25	Sodium	< 1.0000	4.0000	< 1.8182	0.6053	11
26	Potassium	< 1.0000	2.0000	< 1.2500	0.1667	12
27	Total Alkalinity as $CaCO_3$	3.0000	21.0000	6.5333	4.2572	15
28	Bicarbonate as HCO_3	4.0000	26.0000	8.0714	5.4837	14
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.0900	< 0.0540	0.0000	10
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	5.8000	8.3000	6.7088	0.5999	16
34	Field Specific Conductance-umhos/cm	6.5000	19.000	14.5938	3.5366	16
35	Lab pH	5.2000	6.9000	6.3267	0.5775	15
36	Lab Specific Conductance-umhos/cm	10.0000	19.000	14.7333	2.9873	15
37	Temperature-deg. C	0.0000	12.0000	5.6563	3.4143	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LB-0800

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0007	0.0007	0.0007	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0050	< 0.0023	0.0002	8
6	Iron	< 0.0200	0.0600	< 0.0493	0.0074	14
7	Lead	< 0.0010	0.0020	< 0.0011	0.0001	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0004	< 0.0002	0.0000	15
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	5.0000	1.6667	1.2344	15
14	Total Dissolved Solids	5.0000	28.0000	16.9231	8.6358	13
15	Turbidity-NTU	< 0.1000	0.8200	< 0.4263	0.1685	8
16	Nitrate/Nitrite as N	0.0200	0.1900	0.0680	0.0522	10
17	Sulfate	< 1.0000	2.0000	< 1.2727	0.2988	11
18	Total Phosphorus	< 0.0050	0.0880	< 0.0181	0.0251	9
19	Orthophosphate	< 0.0050	0.0060	< 0.0052	0.0002	11
20	Ammonia	< 0.0500	0.1100	< 0.0691	0.0220	11
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	14
22	Total Hardness as $CaCO_3$	< 3.0000	8.0000	< 5.6154	1.0541	13
23	Calcium	< 1.0000	3.0000	< 1.5000	0.5357	14
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	14
25	Sodium	< 1.0000	4.0000	< 1.8182	0.9040	11
26	Potassium	< 1.0000	2.0000	< 1.2500	0.2282	12
27	Total Alkalinity as $CaCO_3$	6.0000	21.0000	10.7333	4.1827	15
28	Bicarbonate as HCO_3	7.0000	26.0000	13.1429	5.3903	14
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1100	< 0.0600	0.0013	11
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	6.7000	8.2000	7.0800	0.3932	15
34	Field Specific Conductance-umhos/cm	14.0000	37.000	26.1875	7.6526	16
35	Lab pH	5.8000	7.4000	6.6933	0.4713	15
36	Lab Specific Conductance-umhos/cm	12.0000	41.000	24.6000	8.9187	15
37	Temperature-deg. C	1.0000	11.5000	6.4375	3.7986	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LB-2000

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0004	0.0004	0.0004	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0030	< 0.0015	0.0002	6
6	Iron	< 0.0500	0.0600	< 0.0511	0.0000	9
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0006	< 0.0003	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.5556	1.3333	9
14	Total Dissolved Solids	< 1.0000	41.0000	<20.0000	12.1106	6
15	Turbidity-NTU	0.1400	1.1300	0.5113	0.4011	8
16	Nitrate/Nitrite as N	0.0200	0.1200	0.0550	0.0414	6
17	Sulfate	< 1.0000	2.0000	< 1.4286	0.4695	7
18	Total Phosphorus	< 0.0050	0.0100	< 0.0060	0.0014	5
19	Orthophosphate	< 0.0050	0.0080	< 0.0055	0.0000	6
20	Ammonia	< 0.0500	< 0.1000	< 0.0750	0.0274	6
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	9
22	Total Hardness as CaCO3	< 3.0000	8.0000	< 9.7778	8.2706	9
23	Calcium	1.0000	7.0000	3.2222	2.4889	9
24	Magnesium	< 1.0000	2.0000	< 1.1250	0.0000	8
25	Sodium	< 1.0000	2.0000	< 1.4286	0.3912	7
26	Potassium	< 1.0000	2.0000	< 1.6667	0.3727	6
27	Total Alkalinity as CaCO3	9.0000	34.0000	17.2222	10.0595	9
28	Bicarbonate as HCO3	11.0000	41.0000	20.7778	12.1838	9
29	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	< 0.0500	< 0.0500	0.0000	5
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	6.6000	7.8000	7.1333	0.3428	9
34	Field Specific Conductance-umhos/cm	16.0000	57.000	30.4444	15.5090	9
35	Lab pH	6.6000	7.4000	6.9778	0.2728	9
36	Lab Specific Conductance-umhos/cm	18.0000	65.000	32.5556	18.0147	9
37	Temperature-deg. C	6.0000	19.0000	10.4444	4.1791	9

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LB-3000

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.5000	< 0.1267	0.0377	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0009	0.0032	0.0018	0.0012	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0080	< 0.0023	0.0012	8
6	Iron	< 0.0500	0.3600	< 0.0764	0.0253	14
7	Lead	< 0.0010	0.0010	< 0.0010	0.0000	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	0.0004	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0005	< 0.0003	0.0002	15
12	Zinc	< 0.0200	0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	5.0000	1.9333	1.4864	15
14	Total Dissolved Solids	7.0000	62.0000	29.0000	15.6578	13
15	Turbidity-NTU	< 0.1000	5.3000	< 0.9015	1.3023	13
16	Nitrate/Nitrite as N	0.0100	0.2500	0.0940	0.0836	10
17	Sulfate	< 1.0000	3.0000	< 1.8000	0.4830	10
18	Total Phosphorus	< 0.0050	0.0100	< 0.0061	0.0010	8
19	Orthophosphate	< 0.0050	0.0130	< 0.0061	0.0013	12
20	Ammonia	< 0.0500	0.0700	< 0.0670	0.0235	10
21	Total Kjeldahl Nitrogen	< 0.2000	0.2000	< 0.2000	0.0000	14
22	Total Hardness as $CaCO_3$	<10.0000	28.0000	<17.5385	11.4576	13
23	Calcium	3.0000	13.0000	5.3571	3.0283	14
24	Magnesium	< 1.0000	4.0000	< 1.4286	0.5915	14
25	Sodium	< 1.0000	2.0000	< 1.3000	0.3286	10
26	Potassium	< 1.0000	2.0000	< 1.2500	0.1667	12
27	Total Alkalinity as $CaCO_3$	10.0000	57.0000	23.8667	12.8834	15
28	Bicarbonate as HCO_3	12.0000	70.0000	29.7857	16.1635	14
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1400	< 0.0590	0.0000	10
32	Oil and Grease	1.0000	2.2000	1.6000	0.8485	2
33	Field pH	6.5000	7.8000	7.1800	0.3895	15
34	Field Specific Conductance-umhos/cm	30.0000	101.000	53.2500	23.7360	16
35	Lab pH	6.5000	7.8000	7.0800	0.4296	15
36	Lab Specific Conductance-umhos/cm	27.0000	111.000	50.7333	24.4583	15
37	Temperature-deg. C	1.0000	17.0000	7.0000	5.0133	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: RA-0100

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0006	0.0006	0.0006	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0030	< 0.0015	0.0005	6
6	Iron	< 0.0500	0.0700	< 0.0533	0.0016	9
7	Lead	< 0.0010	0.0040	< 0.0015	0.0004	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0002	< 0.0002	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	8.0000	2.2222	2.5386	9
14	Total Dissolved Solids	2.0000	17.0000	9.0000	7.6158	4
15	Turbidity-NTU	0.1500	0.4500	0.2717	0.1129	6
16	Nitrate/Nitrite as N	0.0200	0.1500	0.0850	0.0459	6
17	Sulfate	< 1.0000	2.0000	< 1.1429	0.3499	7
18	Total Phosphorus	< 0.0050	0.0060	< 0.0052	0.0000	5
19	Orthophosphate	< 0.0050	0.0050	< 0.0050	0.0000	6
20	Ammonia	< 0.0500	0.0700	< 0.0783	0.0228	6
21	Total Kjeldahl Nitrogen	< 0.2000	0.3000	< 0.2111	0.0000	9
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 5.6667	1.0000	9
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	2.0000	< 1.2857	0.2474	7
26	Potassium	< 1.0000	2.0000	< 1.3333	0.3849	6
27	Total Alkalinity as $CaCO_3$	2.0000	6.0000	4.1111	1.2693	9
28	Bicarbonate as HCO_3	2.0000	7.0000	5.0000	1.5000	9
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.1400	< 0.0667	0.0189	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	5.8000	6.6000	6.3000	0.2507	8
34	Field Specific Conductance-umhos/cm	4.0000	13.000	9.0000	2.8723	9
35	Lab pH	5.9000	7.3000	6.3556	0.4126	9
36	Lab Specific Conductance-umhos/cm	6.0000	31.000	10.8889	7.8333	9
37	Temperature-deg. C	5.0000	13.0000	9.1875	2.8150	8

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: RA-0200

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0003	0.0026	0.0016	0.0012	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0050	< 0.0023	0.0008	6
6	Iron	< 0.0500	0.0800	< 0.0533	0.0047	9
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0002	< 0.0002	0.0000	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	7.0000	2.2222	2.2236	9
14	Total Dissolved Solids	1.0000	7.0000	5.0000	2.8284	4
15	Turbidity-NTU	0.1800	0.7500	0.3456	0.1729	9
16	Nitrate/Nitrite as N	0.0300	0.1400	0.0767	0.0403	6
17	Sulfate	< 1.0000	3.0000	< 1.2857	0.6389	7
18	Total Phosphorus	< 0.0050	0.0150	< 0.0072	0.0026	6
19	Orthophosphate	< 0.0050	0.0100	< 0.0063	0.0009	7
20	Ammonia	< 0.0500	0.0700	< 0.0783	0.0228	6
21	Total Kjeldahl Nitrogen	< 0.2000	0.2200	< 0.2022	0.0000	9
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 5.4444	1.1304	9
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	9
24	Magnesium	< 1.0000	1.0000	< 1.0000	0.0000	8
25	Sodium	< 1.0000	2.0000	< 1.2857	0.3299	7
26	Potassium	< 1.0000	2.0000	< 1.4000	0.3464	5
27	Total Alkalinity as $CaCO_3$	3.0000	6.0000	4.5556	1.1304	9
28	Bicarbonate as HCO_3	4.0000	7.0000	5.5556	1.1304	9
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.1200	< 0.0617	0.0000	6
32	Oil and Grease	< 1.0000	1.3000	< 1.1500	0.0000	2
33	Field pH	6.4000	7.1000	6.6889	0.2571	9
34	Field Specific Conductance-umhos/cm	7.0000	22.000	13.6667	4.1833	9
35	Lab pH	6.0000	7.0000	6.5444	0.3468	9
36	Lab Specific Conductance-umhos/cm	7.0000	15.000	9.8889	2.5221	9
37	Temperature-deg. C	5.5000	14.0000	9.5000	3.2842	8

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: RA-0600

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0003	0.0003	0.0003	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0070	< 0.0023	0.0012	9
6	Iron	< 0.0500	0.0600	< 0.0507	0.0000	14
7	Lead	< 0.0010	0.0020	< 0.0011	0.0000	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	0.0003	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0008	< 0.0002	0.0000	15
12	Zinc	< 0.0020	< 0.0200	< 0.0187	0.0048	14
13	Total Suspended Solids	1.0000	5.0000	1.4000	1.1212	15
14	Total Dissolved Solids	3.0000	20.0000	10.6000	4.6236	10
15	Turbidity-NTU	0.1100	0.8200	0.3478	0.2246	9
16	Nitrate/Nitrite as N	< 0.0800	0.1000	< 0.0660	0.0207	10
17	Sulfate	< 1.0000	6.0000	< 2.1818	1.1622	11
18	Total Phosphorus	< 0.0050	0.2650	< 0.0351	0.0570	9
19	Orthophosphate	< 0.0050	0.0940	< 0.0131	0.0144	12
20	Ammonia	< 0.0500	0.0900	< 0.0700	0.0250	10
21	Total Kjeldahl Nitrogen	< 0.2000	1.4300	< 0.2929	0.1172	14
22	Total Hardness as $CaCO_3$	< 3.0000	< 6.0000	< 5.7692	0.8321	13
23	Calcium	< 1.0000	1.0000	< 1.0000	0.0000	14
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	14
25	Sodium	< 1.0000	4.0000	< 1.7273	0.8624	11
26	Potassium	< 1.0000	2.0000	< 1.1667	0.1925	12
27	Total Alkalinity as $CaCO_3$	4.0000	8.0000	6.2000	1.4243	15
28	Bicarbonate as HCO_3	5.0000	10.0000	7.3571	1.8232	14
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1000	< 0.0550	0.0000	10
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	5.7000	8.0000	6.6733	0.5230	15
34	Field Specific Conductance-umhos/cm	12.0000	26.000	17.1875	4.4003	16
35	Lab pH	5.5000	7.0000	6.4333	0.4608	15
36	Lab Specific Conductance-umhos/cm	10.0000	20.000	15.2000	3.4682	15
37	Temperature-deg. C	0.0000	12.0000	5.6875	3.8204	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: PM-0500

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0017	0.0053	0.0029	0.0021	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0060	< 0.0020	0.0008	9
6	Iron	< 0.0500	0.0500	< 0.0500	0.0000	14
7	Lead	< 0.0010	0.0010	< 0.0010	0.0000	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0004	< 0.0002	0.0000	15
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	5.0000	1.2667	1.0328	15
14	Total Dissolved Solids	3.0000	29.0000	13.1667	7.7908	12
15	Turbidity-NTU	< 0.1000	0.4200	< 0.2488	0.0798	8
16	Nitrate/Nitrite as N	0.0500	0.1500	0.0930	0.0302	10
17	Sulfate	< 1.0000	3.0000	< 1.7500	0.4272	12
18	Total Phosphorus	< 0.0050	0.0080	< 0.0059	0.0005	8
19	Orthophosphate	< 0.0050	0.0080	< 0.0054	0.0003	11
20	Ammonia	< 0.0500	0.2400	< 0.0790	0.0198	10
21	Total Kjeldahl Nitrogen	< 0.2000	0.4000	< 0.2143	0.0000	14
22	Total Hardness as CaCO3	< 3.0000	8.0000	< 6.1538	1.3706	13
23	Calcium	< 1.0000	3.0000	< 2.0714	0.8345	14
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	14
25	Sodium	< 1.0000	4.0000	< 1.6000	0.8505	10
26	Potassium	< 1.0000	1.0000	< 1.0000	0.0000	11
27	Total Alkalinity as CaCO3	1.0000	18.0000	10.6667	4.5774	15
28	Bicarbonate as HCO3	0.0000	22.0000	13.2857	5.9927	14
29	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1400	< 0.0620	0.0085	10
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.2000	8.4000	7.0000	0.5750	16
34	Field Specific Conductance-umhos/cm	17.0000	37.000	25.5625	6.0988	16
35	Lab pH	5.6000	7.7000	6.7067	0.5982	15
36	Lab Specific Conductance-umhos/cm	16.0000	35.000	24.8667	5.6678	15
37	Temperature-deg. C	0.0000	12.0000	5.5313	3.8274	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: PM-1000

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0009	0.0092	0.0039	0.0046	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0050	< 0.0019	0.0009	8
6	Iron	< 0.0010	< 0.0500	< 0.0465	0.0131	14
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0005	< 0.0002	0.0000	15
12	Zinc	< 0.0200	0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	5.0000	1.2667	1.0328	15
14	Total Dissolved Solids	7.0000	33.0000	20.0000	9.2047	12
15	Turbidity-NTU	< 0.1200	0.3000	< 0.2160	0.0510	5
16	Nitrate/Nitrite as N	0.0300	0.0800	0.0470	0.0134	10
17	Sulfate	< 1.0000	3.0000	< 1.5556	0.5018	9
18	Total Phosphorus	< 0.0050	0.0100	< 0.0056	0.0011	8
19	Orthophosphate	< 0.0050	< 0.0050	< 0.0050	0.0000	11
20	Ammonia	< 0.0500	< 0.1000	< 0.0650	0.0242	10
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	14
22	Total Hardness as $CaCO_3$	< 3.0000	8.0000	< 6.2308	2.6792	13
23	Calcium	< 1.0000	4.0000	< 2.1429	1.1469	14
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	14
25	Sodium	< 1.0000	6.0000	< 1.8000	1.2410	10
26	Potassium	< 1.0000	2.0000	< 1.0909	0.1286	11
27	Total Alkalinity as $CaCO_3$	8.0000	20.0000	12.2667	3.9364	15
28	Bicarbonate as HCO_3	10.0000	24.0000	15.2143	4.7585	14
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1000	< 0.0570	0.0042	10
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	6.3000	8.7000	7.0375	0.5214	16
34	Field Specific Conductance-umhos/cm	17.0000	40.000	26.2500	5.8023	16
35	Lab pH	5.5000	7.4000	6.7133	0.5705	15
36	Lab Specific Conductance-umhos/cm	16.0000	41.000	25.9333	7.1760	15
37	Temperature-deg. C	0.0000	12.0000	5.5938	4.1078	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LC-0100

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.1000	< 0.1000	0.0000	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0009	0.0063	0.0037	0.0027	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0080	< 0.0024	0.0014	8
6	Iron	< 0.0500	0.0600	< 0.0514	0.0016	14
7	Lead	< 0.0010	0.0020	< 0.0011	0.0000	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	0.0002	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0010	< 0.0003	0.0001	15
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	11.0000	2.2000	2.8082	15
14	Total Dissolved Solids	14.0000	37.0000	21.6364	6.4385	11
15	Turbidity-NTU	< 0.6800	1.1000	< 0.5267	0.2830	12
16	Nitrate/Nitrite as N	< 0.0100	0.0300	< 0.0140	0.0000	5
17	Sulfate	< 1.0000	2.0000	< 1.2000	0.3416	10
18	Total Phosphorus	< 0.0050	0.0180	< 0.0075	0.0033	8
19	Orthophosphate	< 0.0050	0.0180	< 0.0070	0.0025	12
20	Ammonia	< 0.0500	0.0700	< 0.0670	0.0225	10
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	14
22	Total Hardness as $CaCO_3$	< 3.0000	8.0000	< 5.6923	1.4137	13
23	Calcium	< 1.0000	3.0000	< 1.4286	0.2988	14
24	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	14
25	Sodium	< 1.0000	6.0000	< 2.1000	1.2048	10
26	Potassium	< 1.0000	2.0000	< 1.3333	0.1863	12
27	Total Alkalinity as $CaCO_3$	6.0000	23.0000	10.6000	5.2617	15
28	Bicarbonate as HCO_3	7.0000	28.0000	13.3571	6.6287	14
29	Carbonate as $CaCO_3$	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1300	< 0.0580	0.0000	10
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.3000	8.4000	6.9063	0.5039	16
34	Field Specific Conductance-umhos/cm	14.0000	93.000	25.4375	19.3217	16
35	Lab pH	5.5000	7.3000	6.5667	0.5627	15
36	Lab Specific Conductance-umhos/cm	12.0000	42.000	22.2000	8.9139	15
37	Temperature-deg. C	0.0000	13.0000	6.1563	4.4186	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: LC-0600

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.3000	< 0.1200	0.0298	15
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	15
3	Cadmium	0.0004	0.0045	0.0025	0.0021	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	14
5	Copper	< 0.0010	0.0060	< 0.0021	0.0015	9
6	Iron	< 0.0500	0.2100	< 0.0829	0.0355	14
7	Lead	< 0.0010	0.0040	< 0.0013	0.0003	14
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	15
9	Mercury	< 0.0002	0.0002	< 0.0002	0.0000	10
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	15
11	Silver	< 0.0002	0.0010	< 0.0003	0.0000	15
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	14
13	Total Suspended Solids	1.0000	9.0000	2.4667	2.2318	15
14	Total Dissolved Solids	18.0000	56.0000	30.5833	10.4921	12
15	Turbidity-NTU	0.4700	3.0000	1.3513	0.8259	15
16	Nitrate/Nitrite as N	< 0.0100	2.0000	< 0.2986	0.4887	7
17	Sulfate	< 1.0000	5.0000	< 1.6000	0.9295	10
18	Total Phosphorus	< 0.0050	0.0160	< 0.0083	0.0024	9
19	Orthophosphate	< 0.0050	0.0160	< 0.0073	0.0022	12
20	Ammonia	< 0.0500	0.1200	< 0.0720	0.0306	10
21	Total Kjeldahl Nitrogen	< 0.2000	0.2000	< 0.2000	0.0000	14
22	Total Hardness as CaCO3	< 3.0000	14.0000	<12.5385	9.7392	13
23	Calcium	< 1.0000	9.0000	< 3.4286	2.5299	14
24	Magnesium	< 1.0000	3.0000	< 1.2143	0.2143	14
25	Sodium	< 1.0000	4.0000	< 2.1000	0.7500	10
26	Potassium	< 1.0000	2.0000	< 1.4167	0.2041	12
27	Total Alkalinity as CaCO3	9.0000	47.0000	19.8667	11.6550	15
28	Bicarbonate as HCO3	13.0000	57.0000	25.1429	14.2065	14
29	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	15
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	13
31	Fluoride	< 0.0500	0.1300	< 0.0590	0.0099	10
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	1
33	Field pH	6.0000	8.0000	7.0625	0.5749	16
34	Field Specific Conductance-umhos/cm	18.0000	156.000	46.6875	35.1088	16
35	Lab pH	5.8000	7.6000	6.7867	0.5475	15
36	Lab Specific Conductance-umhos/cm	20.0000	93.000	40.3333	21.3330	15
37	Temperature-deg. C	0.0000	14.5000	6.7813	5.5044	16

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

Noranda Montana Project Surface Water Quality Analysis - April 1988-April 1989

Station: BC-0100

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	9
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	9
3	Cadmium	0.0009	0.0030	0.0020	0.0015	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	9
5	Copper	< 0.0010	0.0030	< 0.0018	0.0003	6
6	Iron	< 0.0500	0.0500	< 0.0500	0.0000	9
7	Lead	< 0.0010	< 0.0010	< 0.0010	0.0000	8
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	9
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	8
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	9
11	Silver	< 0.0002	0.0010	< 0.0003	0.0001	9
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	9
13	Total Suspended Solids	1.0000	5.0000	1.4444	1.3333	9
14	Total Dissolved Solids	19.0000	70.0000	40.8571	18.2705	7
15	Turbidity-NTU	0.1100	1.2200	0.3688	0.3593	8
16	Nitrate/Nitrite as N	0.0700	0.4900	0.1943	0.1497	7
17	Sulfate	< 1.0000	2.0000	< 1.5000	0.4677	8
18	Total Phosphorus	< 0.0050	0.0090	< 0.0062	0.0012	5
19	Orthophosphate	< 0.0050	0.0090	< 0.0060	0.0009	6
20	Ammonia	< 0.0500	< 0.1000	< 0.0750	0.0274	6
21	Total Kjeldahl Nitrogen	< 0.2000	< 0.2000	< 0.2000	0.0000	9
22	Total Hardness as CaCO3	<15.0000	50.0000	<30.2222	13.9458	9
23	Calcium	6.0000	15.0000	10.2222	3.8006	9
24	Magnesium	< 1.0000	3.0000	< 1.5000	0.5774	8
25	Sodium	< 1.0000	2.0000	< 1.1429	0.2857	7
26	Potassium	< 1.0000	2.0000	< 1.2000	0.4000	5
27	Total Alkalinity as CaCO3	20.0000	60.0000	37.3333	14.9164	9
28	Bicarbonate as HCO3	24.0000	73.0000	45.5556	18.2490	9
29	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	9
30	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	9
31	Fluoride	< 0.0500	0.1100	< 0.0600	0.0000	6
32	Oil and Grease	< 1.0000	< 1.0000	< 1.0000	0.0000	2
33	Field pH	6.8000	8.0000	7.4889	0.3983	9
34	Field Specific Conductance-umhos/cm	41.0000	111.000	72.4444	27.0237	9
35	Lab pH	7.1000	8.0000	7.5000	0.3000	9
36	Lab Specific Conductance-umhos/cm	40.0000	118.000	72.8889	30.0185	9
37	Temperature-deg. C	5.5000	15.0000	8.7778	3.2988	9

NOTES: All quantities are in mg/L unless otherwise noted.

Revised - June 23, 1989

APPENDIX G4

SURFACE WATER DATA VALIDATION

APPENDIX H

Chen-Northern, Inc.

APPENDIX H

WELL COMPLETION LOGS

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: LCTM-8

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive (Champion property) Location: east side L. Ch. site, south of L. Ch. Ck

Recorded By: M. Corbett Hole Started: Time: 1035 Date: 07/26/88 Hole Completed: Time: 1730 Date: 07/27/88 Driller : B & B

Drill Method: Air Rotary Drilling Fluids Used: water as needed Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 140 ft. Total Depth Reamed: ____ Total Depth Cased Below G.S.: 93' Diameter and Type of Casing: 6" steel with 4" PVC liner

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 33-93; etc. for 48'-43' and 58'-53' and 88'-93'; total 45' screened Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened

- ____ No casing in hole
- ____ Open bottom
- X Slotted with Mill's Knife outside steel casing
- ____ Slotted with a torch
- ____ Screened by pulling casing
- ____ Field saw cut
- X Mechanical slots .016 (size) exc. .03; bet. 48'-53'. Total 45'.
- ____ Other (specify) ____

Static Fluid Level Below Measuring Point: ____ Date/Time Measured: +2.5'

Measuring Point Description/Elevation: Top well protector MP Height Above (+/-) or Below G.S.: ____

Well Annulus Completion Description: Backfilled with cement sand 140' to 94'; set screen column between 88' and 33', filter packed with Colo 10.20 sand from 94' to 26'; volclay grout from 25' to 6' (on top 1' cement sand); cemented 6' to surface

Well Development Description: ____

Remarks: Screen column = 88' to 33' w 10S, 5t, 5s, 5t, 30s (top dn); Steel casing could not be jacked. Effort resulted in lift and removal of 7' casing plus bending of upper above ground (?) segment. Slotting made of steel casing 2/ft. over total screened segments, 33-88 ft.

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

LCTM-8

(Depth to G.S.) From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
surface	4	Silt rich soil.
4	5	Boulder? minor gravel pebbles mixed with silt
5	11	Mostly silt with occasional cobbles or gravel pebbles. Drilling boulder at 6'-9'; switched to hammer.
11	13	Pea gravel, relatively clean
13	15.5	Silty gravel, medium size clasts, very clayey/silty
15.5	16	Silt, slight chocolate brown colors, dry
16	18	Clean gravel pea size, slt water
18	20	Very silty gravel (?). Still with hammer
20	--	Very silty gravel; switch to tricone
--	23	Chocolate brown silts followed by coarse gravel; cobbles silty gravels with yellow/orange brown colors
23	--	Large boulder followed by more silty gravel with chocolate color and cobbles. Continued gray, dark gray, cobbles, boulders etc., with brown, orange brown, buff, silty/clayey matrix; medium/coarse grained, small clasts are brown, buff to orange and orange brown; coarse material gray-dark gray
--	30	Change to yellow brown matrix material
30	35	More of same
35	38	Cleaner more rounded/subrounded gravels, medium coarse grained with multi color clasts (gray, red, brown, tan) Fluvial gravel; making fair amount water at 37'. Not much silt matrix.
38	50	Back to coarse gravel with silty matrix. Boulders
50	51	Clean well rounded pebble gravel -- make slt. water
51	54	Silty gravel? Pebble gravel with silt matrix - making more water??
54	58	Boulders, silty gravel. Water dec. to nothing
58	59	Clean gravel -- some water (well rouned to subangular)
59	67	Coarse cobbles and boulders. Tough drilling
67	68	Small pea gravel - dirty. No visible water
68	74	Silty gravel, coarse, boulders

DRILLING AND LITHOLOGIC LOG

LCTM-8

(Depth to G.S.) From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
74	75	Clean gravel, minor water
75	79	Silty gravel as above
79	80	Clean gravel, small-medium brownish clasts
80	84	Silty gravel
84	85	Pea gravel (added more water)
85	92	Silty gravel, boulders, etc. Drilled large quartzite boulder
92	94	Cleaner medium gray gravel with some pea size clasts. No obvious water addit.
94	96	Drilling quartzite boulder
96	98	Pea gravel change to clasts 1" or more. No water
98	99	Drilling boulder
99	110	Back into gravel, boulders etc. Clean without silt matrix but not making much water (if any); highly variable clast compositions and colors (quartz, quartzite, argillite, and carbonate)
110	114	Some silty gravel for short distance
114	116	More gravel, boulders? bedrock?
116	--	Tripped out and in with hammer bit
116	120	Tough rock (bedrock?) Hole drilled ahead
120	125	Real dirty silty pea gravel -- made water? hole drilled ahead
125	140 TD	Very silty with pea gravel, with minor water, still open hole, silty content increasing.

Note: Driller added heavy amounts water to drill clean thru very silty gravel. Silty very much like lacustrine silts elsewhere. Gravel mostly all fine gravel sub to well rounded. Very low permeability due to silt.

Also, driller notes same mixture silt and fine pea gravel in Libby valley (recent well) down to 615' to bedrock

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: PM-2

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: In edge clear cut, 278V

Recorded By: M. Corbett Hole Started: Time: 0910 Date: 07/25/88 Hole Completed: Time: 1500 Date: 07/26/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: water as needed Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 39.5' Total Depth Reamed: ____ Total Depth Cased Below G.S.: 39' Diameter and Type of Casing: 4" PVC

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 39'-24' Target Aquifer: ____ Packer Type and Depth Below G.S.: ---

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened	
	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut
X	Mechanical slots 0.030 (size) 15'
	Other (specify) ____

Static Fluid Level Below Measuring Point: 17.1 Date/Time Measured: 1500;07/26/88

Measuring Point Description/Elevation: Top of Steel Well Protector MP Height Above (+/-) or Below G.S.: +2.3'

Well Annulus Completion Description: 39.5' - 22', Colorado Silica Sand, 10/20 mesh; 22'-19', bentonite pellets; 19'-3', concrete sand. 6" steel well protector, -4.7' to +2.3' (cement with neat Portland).

Well Development Description: ____

Remarks: 15 ft. 4" .03 screen 39.5' to 24.5'.

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

PM-2

(Depth Below G.S.)

From	To	DRILLING LOG	Geological, Drilling, and Water Conditions and Sampling
surface	7	Colluvial soil with boulders -- using hammer bit.	
7	16	Silty gravel small-medium "pea" gravel, much medium orange brown silt and minor coarse cobbles. Alluvial for material.?	
16	17	Cleaner, small-medium "pea" gravel, light gray matrix (not orange brown)	
17	19	Minor water at 17'. Change back to tricone bit; subangular medium gravel, light-dark gray; air blew fair quantity of water	
19	23.5	Silty gravel, boulders (gray-green)	
23.5	25	Silt only, thin layer. Yellow brown	
25	26.5	Silty gravel and boulders	
26.5	31.5	Cleaner medium gravel with more water. No silt; very coarse cobbles boulders and 0.5-1" pebbles; clean of silt but slight dirty gray matrix; large light brown to fawn colored boulder at 29.5' and at 30'	
31.5	32.5	Silty gravel, yellow brown muddy matrix, dark gray fragments and pebbles mixed with brown and light tan fragments	
32.5	36.5	Lots of water, coarse gravel, booulders and cobbles; dark gray argillites and light brown-whitish sandstone.	
36.5	39.5	Silty gravel, much less water. Light yellow-brown silt matrix and medium gravel.	

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: PM-2 OB

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: 40 feet from PM-2

Recorded By: M. Corbett Hole Started: Time: 1330 Date: 07/28/88 Hole Completed: Time: 1530 Date: 07/28/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: water Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 39' Total Depth Reamed: ____ Total Depth Cased Below G.S.: 39' Diameter and Type of Casing: 6" steel

Weight or Gage of Casing: ____ Interval Perforated or Screened Below G.S.: ____ Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened

- ____ No casing in hole
- ____ Open bottom
- X Slotted with Mill's Knife 2/ft over lower 14 ft.
- ____ Slotted with a torch
- ____ Screened by pulling casing
- ____ Field saw cut
- ____ Mechanical slots ____ (size)
- ____ Other (specify) ____

Static Fluid Level Below Measuring Point: ____ Date/Time Measured: ____

Measuring Point Description/Elevation: Top well protector MP Height Above (+/-) or Below G.S.: 2.3'

Well Annulus Completion Description: well casing cemented at surface

Well Development Description: For use as observation well during pump test of PM-2

Remarks: 1 hour additional time for slotting

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

PM-02 OB

(Depth Below G.S.) From	To	DRILLING LOG	Geological, Drilling, and Water Conditions and Sampling
surface	39	See log PM-2	

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: PM-3

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: Poorman tailings site (gravel pit)

Recorded By: M. Corbett Hole Started: Time: 1200 Date: 07/19/88 Hole Completed: Time: 1700 Date: 07/19/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: minor water in silt Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 48' Total Depth Reamed: -- Total Depth Cased Below G.S.: 44.9' Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 34.9-44.9' Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened

- ____ No casing in hole
- ____ Open bottom
- ____ Slotted with Mill's Knife
- ____ Slotted with a torch
- ____ Screened by pulling casing
- ____ Field saw cut
- X Mechanical slots
  - 0.010 (size) 44.9'-39.9';
  - 0.030 (size) 39.9'-34.9'
- ____ Other (specify) ____

Static Fluid Level Below Measuring Point: 11.15 below ground; -14.65 after completed Date/Time Measured: 0845; 07/20/88; 1520; 07/20/88

Measuring Point Description/Elevation: Top well protector MP Height Above (+/-) or Below G.S.: +3.0'

Well Annulus Completion Description: 48'-44', concrete sand; 44'-33', 10/20 Colorado Silica Sand; 33'-31', bentonite pellets 31'-3', volclay grout; 3'- surface, concrete. 6" steel surface casing 8' to +2.9'

Well Development Description: ____

Remarks: 4.5 hour completion time

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

PM-3

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	7	Coarse dirty gravel (borrow pit material)
7	19	Yellow brown-buff silt
19	25	Silt mixed with small-medium gravel (pea)
25	36	Fine sand/silt damp. About Poorman Creek level
36	44	Medium gravel (pea) water. Drilling ahead, coarser gravels, water level rising?
44	48	Dirty silty gravel. TD @ 48 with 53′ casing 5′ above ground

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: PM-5

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: Poorman tailings site (weather station)

Recorded By: M. Corbett Hole Started: Time: 1255 Date: 07/18/88 Hole Completed: Time: 1600 Date: 07/19/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: none Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 43' Total Depth Reamed: --- Total Depth Cased Below G.S.: 41.5 Diameter and Type of Casing: 2" PVC

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 31.5-41.5 Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO	
Well Developed?	X		Air pumped a few minutes
Well Test Pumped?		X	
Water Samples Taken?		X	
Material Samples Taken?		X	
E-Logs?		X	

Method Perforated or Screened	
	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
X	Screened by pulling casing
	Field saw cut
	Mechanical slots ____ (size)
X	Other (specify) .03 cont. slot, 10 ft

Static Fluid Level Below Measuring Point: +3.2' (above ground) Date/Time Measured: 900; 07/19/88

Measuring Point Description/Elevation: north edge of steel casing MP Height Above (+/-) or Below G.S.: MP +4.1'

Well Annulus Completion Description: Bottom of hole caved -- took larger amount filter pack (10/20 sand) than normal 43-31.5, 10/20 Colorado Silica Sand; 31.5-30', concrete sand; 30'-27', 1/4" bentonite pellets; 27'-18', volclay bentonite; 18'-0' neat Portland Cement, 6" steel 10' BGS, cement surface seal

Well Development Description: Air pumped for 5-10 minutes, water began to run clear

Remarks: Artesian flow - under head. Possible gravel lens under silt. Total head at time hit first water approximately at 42.2 ft. Volclay grout pumped down well at 22' to 3' below ground surface. Artesian flow continued around steel casing. Pumped 3.5 sacks of neat cement down hole at 18 feet deep. Pumping neat cement caused bentonite to overflow 6" steel. Water head at 8.5' above ground surface and flowing slightly. Some bentonite remains inside 6" steel above ground surface.

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

PM-5

(Depth Below G.S.)

From	To	DRILLING LOG	Geological, Drilling, and Water Conditions and Sampling
surface	15	Yellow brown/buff, slightly moist silt, minor light gray lenses. Very moist 8-15'	
15	23	Minor pebbles in silt, subrounded	
23	26	Medium-coarse gravel, sand and silt	
26	27	Dry silt	
27	29	Pea gravel, light gray, subrounded. Dry, mixed in minor silt/sand	
29	30	Increase coarseness (Boulders?)	
30	33	Silt (yellow brown-buff)	
33	39	Pea gravel, medium gray increase coarseness to broken pebbles	
39	43	Water (top water came up in 1/2 hour +)	
		Into cobbles at base of hole. 07/18/88; 1900	
		SWL 0900; 07/19/88 -- +3.2 (above ground)	

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: PLCM-6 Dual

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: Little Ch. Ck. Loop Rd., (Between Poorman & L.Ch. Sites)

Recorded By: M. Corbett Hole Started: Time: 1000 Date: 07/21/88 Hole Completed: Time: 1500 Date: 07/21/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: water in silty sections Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 56' Total Depth Reamed: ____ Total Depth Cased Below G.S.: 55.5 56 ft (deep) Diameter and Type of Casing: 2" PVC tube + screen

Weight or Gage of Casing: SLH 40 Interval Perforated or Screened Below G.S.: A5.5 - 55.5 8-18' Target Aquifer: Bedrock & shallow gravel zone Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?	X	
E-Logs?		X

Bedrock

Method Perforated or Screened

- ____ No casing in hole
- ____ Open bottom
- ____ Slotted with Mill's Knife
- ____ Slotted with a torch
- ____ Screened by pulling casing
- ____ Field saw cut
- X Mechanical slots
  - Dual Completion
    - 5 ft. 0.03 cont slot deep
    - 10 ft. 0.01 cont slot, shallow
- ____ Other (specify) ____

Static Fluid Level Measured shallow SWL as 9.9' below MP (above ground-waiting to measure later) 07/23/88 0845
Below Measuring Point: Approx. 9.5' above ground before flow slows much on deep Date/Time Measured: 07/23/88 1000

Measuring Point Description/Elevation: north side steel casing, top MP Height Above (+/-) or Below G.S.: +2.5'

Well Annulus Completion Description: 56' to 52'8" Colorado 10/20 sand; 52'8" to 47'8" PVC .03 cont. slot screen with Colorado 10/20 sand filter pack; 47'8" to 46'4" Colorado 10/20 sand; 46'4" to 45'10" bentonite pellets; 45'10" to 44'10" Colorado 10/20 sand; 44'10" to 32'8" volclay grout; 32'8" to 19'6" cement sand; 19'6" to 7'. Silica sand Colorado 10/20; 18' to 8' PVC .01 cont. slot screen; 7' to 6.5' bentonite pellets; 6.5' to 6' cement sand; neat cement inside and outside surface casing from 6' to ground level (3 sacks)

Well Development Description: ____

Remarks: Use 5' 0.03 screen for bottom interval (approx. 48-57'); use 10' 0.01 screen for top (approx. 8-18) Put 10/20 sand over pellets to keep tremie pipe away -- pump 75 gal. Volclay grout include 2-3 quarts bentonite mixed in to thicken -- probe will not stabilize at a given depth -- water displaced up but void present and volclay grout remains fluid. Shut down at 1700 to let set overnite (Don't wish to have grout invade zone for upper screen

*Note: Lower screen moved up 4" on 1st pipe jacking -- then stablized

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

PCLM-6

(Depth Below G.S.)

From	To	DRILLING LOG	Geological, Drilling, and Water Conditions and Sampling
ground	4	Soil layer	
4	7	Gravelly colluvium	
7	9	Silty, some pebbles	
9	13	Clean gravel, medium coarse gravel. Water at 9.5'	
13	17	Dirty, silty gravel, fine-medium, tan-brown colors	
17	45.5	Silt, minor gravel in upper portion, Clean silt below 20', Buff to light yellow-orange browns	
45.5	49	Silty-clayey gravel, dark gray, medium coarse. Drilled a boulder at top. Let sit few minutes -- air blew water at 45.5'	
49	50	Very coarse sand-fine gravel, dark gray with coaser buff subrounded fragments	
50	52	Highly fractured coarse chips - bedrock. Dark gray argillite with	
52	55.5	fracture fillings (?). Changes to pinkish or brown. Making lots of water. Cleaning fast.	

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: LCM-9

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: L. Ch. - Bear Creek area (on Champion northline)

Recorded By: M. Corbett Hole Started: Time: 1033 Date: 07/20/88 Hole Completed: Time: 1645 Date: 07/20/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: mix or water Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 72 Total Depth Reamed: ____ Total Depth Cased Below G.S.: 72 Diameter and Type of Casing: 2" PVC, flush joint threaded

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 57'-67' Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO	
Well Developed?		X	
Well Test Pumped?		X	
Water Samples Taken?		X	
Material Samples Taken?	X		Bedrock
E-Logs?		X	

Method Perforated or Screened

- ____ No casing in hole
- ____ Open bottom
- ____ Slotted with Mill's Knife
- ____ Slotted with a torch
- ____ Screened by pulling casing
- ____ Field saw cut
- X Mechanical slots .010 (size)
- ____ Other (specify) ____

Static Fluid Level Below Measuring Point: 15.3' BGS Date/Time Measured: 0900; 07/21/88

Measuring Point Description/Elevation: Top of steel, northside MP Height Above (+/-) or Below G.S.: +3.1

Well Annulus Completion Description: 72-64', concrete sand; 64'-56', 10/20 Colorado Silica Sand; 56'-55.5', bentonite pellets 55.5'-45', volclay grout; 45'-7', concrete sand; 1'-0' concrete surface seal; 6" steel from 10' to +3.1'

Well Development Description: ____

Remarks: Started completion at 1100 hours; 07/21/88, finished completion at 1530 hours

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

LCM-9

(Depth Below G.S.)

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
ground	5	Residual soil
5	10	Dirty clay-silt rich gravel; yellow brown to red-orange brown
10	11	Medium-coarse gravel, gray-tan
11	15	Dirty clay/silt rich gravelly material; buff to orange-brown (colluvium); pebbles light-dark gray, clays/silts more orange yellow browns
15	19	Orange-brown silt (medium dark tones rather than lighter buff of other wells to south. Very dry; very little clay or sand
19	25	More yellow brown silt with more clay sticky and damp. Slight light gray mottling, water added by driller at 23 ft. in silt; silt getting richer in clays; medium yellow brown
25	28	Hit boulder -- gravel and clay/silt mixed
28	34	Clean medium gravel light-medium gray; drilling easy
34	38	Coarse gravel (boulders) drilling slow. Had very light water show at 32 ft.
38	43	Dirty gravel, clayey
43	48	Silty, dry, orange brown (drilled light gray boulder 44-45')
48	51	Silty - buff, minor rocks
51	58	Gravelly, with silts light gray rock chips alternating with silt (buff to orange brown)
58	59	Silt, buff, damp? clayey
59	61	Clean pea gravel - gray to dark gray. Damp; shut down for added drill stem and casing. Back in 2 ft. water (57 ft)
61	64	Silt, minor gravel. Dry. Driller adding water.
64	65	More gravel, dirty
65	65.5	Bedrock -- casing not driving. No water noted.
65.5	72	Drilled ahead for sample. Still no water.
		Note: Completion with 10 ft. screen on bedrock + up?

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: LCM-10

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: ____

Recorded By: D. Hazen Hole Started: Time: 0900 Date: 07/24/88 Hole Completed: Time: 1400 Date: 07/25/88 Driller : B & B Drilling

Drill Method: air rotary Drilling Fluids Used: minor water Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 40' Total Depth Reamed: ____ Total Depth Cased Below G.S.: ____ Diameter and Type of Casing: 2" PVC flush joint threaded

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 25'-40' Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?	X	
E-Logs?		X

Method Perforated or Screened	
	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut
X	Mechanical slots 0.010 (size)
	Other (specify) ____

Static Fluid Level Below Measuring Point: ____ Date/Time Measured: ____

Measuring Point Description/Elevation: Top of steel well protector MP Height Above (+/-) or Below G.S.: +3.0

Well Annulus Completion Description: 40'-23', 10/20 Colorado Silica Sand; 23-19', bentonite pellets; 19'-3', cement sand; 3'-surface, concrete surface seal

Well Development Description: ____

Remarks: 1' piece of rebar left in sand pack

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

LCM-10

(Depth Below G.S.)

From	To	DRILLING LOG	Geological, Drilling, and Water Conditions and Sampling
0	1	Top soil, organic material	
1	20	Gravel, silty, sandy, light brown, slightly moist, subangular to subrounded gravel clasts to 1"; occasional cobbles and boulders of gray argillte; 40% gravel, 30% sand, 30% silt; boulders at 6', 8', 15'	
20	27	Gravel, silty, sandy, light brown, moist at 20', slight moist below	
27	32	Gravel, bouldery, sandy, some gray-brown silt. Predominantly gray argillite clasts with minor yellow and green clasts. Approximately 0.5 gpm water at 32'	
32	39	Gravel, silty sandy, light gray brown. Mostly gray clasts with some orange-yellow, green, and light brown clasts. Making approximately 1 gpm at 36'	
39	40	Gravel, silty, sandy, orange silt, gray gravel clasts	

Northern Engineering and Testing, Inc.

WELL COMPLETION LOG

State: Montana County: Lincoln Project: Montana Silver Venture Hole Name or Number: LCM-11

Legal Location: T ____ R ____ Sec ____ Tract ____ Descriptive Location: Upper Little Cherry Creek site, northend

Recorded By: M. Corbett & D. Hazen Hole Started: Time: 0930 Date: 07/22/88 Hole Completed: Time: 1600 Date: 07/22/88 Driller : B & B

Drill Method: air rotary Drilling Fluids Used: minor water Pilot Hole Diameter: 6" Reamed Hole Diameter: ____

Total Depth Drilled: 62.5' Total Depth Reamed: ____ Total Depth Cased Below G.S.: ____ Diameter and Type of Casing: 2" PVC with 5' of 0.03 screen

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 57-62' Target Aquifer: ____ Packer Type and Depth Below G.S.: ____

DURING INSTALLATION WAS:	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened

- ____ No casing in hole
- ____ Open bottom
- ____ Slotted with Mill's Knife
- ____ Slotted with a torch
- ____ Screened by pulling casing
- ____ Field saw cut
- X Mechanical slots 0.03 (size) 1-5 ft. 2" sect.
- ____ Other (specify) ____

Static Fluid Level Below Measuring Point: 46.6' BGS Date/Time Measured: 07/24/88 1115

Measuring Point Description/Elevation: north side steel casing MP Height Above (+/-) or Below G.S.: +2.7'

Well Annulus Completion Description: 62'6" to 62', Colorado 10/20 Silica Sand; Base screen at 62' with top at 57', filter pack Colorado 10/20 sand from base to 54'7"; 54'7" to 53'7" volclay pellets; 53'7" to 27' cement sand; 44'7" to 27' caved; 27' to 20' volclay grout; 20' to surface cement sand; Neat Portland cement surface casing outside (sack)

Well Development Description: ____

Remarks: Some caving of hole after 10 ft. cement sand placed above Volclay pellet seal. Steel jacked at 10 ft. increments (20 ft. sections)

Northern Engineering and Testing, Inc.

DRILLING AND LITHOLOGIC LOG

LCM-11

(Depth Below G.S.)

From	To	DRILLING LOG	Geological, Drilling, and Water Conditions and Sampling
surface	1	Soil (brown)	
1	2	Boulder	
2	9	Gravel with silt (tan)	
9	13	Gravel water; small-medium size	
13	16	Gravel + silt; light brown	
16	28	Gravel, cobbles, water	
28	31	Silty, gravel;	
31	34	boulders (clay filling) dark gray to black argillites with yellow brown (acts as if very coarse talus mat. with 2-3 feet rocks	
34	41	Boulders (clay filling) clays filling, boulders. Lost water 28-41 ft.	
41	48	Orange-brown silt with angular gravel clasts; some sand; gravel is dark gray argillite with some light gray mottling	
48	55	Silty gravel with minor clay, gravel is angular, gray argillite with light brown friable sandstone, orange brown silt	
55	57	As above with orange silt	
57	58	Silt with minor gravel + sand, orange	
58	60.5	Sandy gravel with silt, light gray brown, subangular; subrounded gravel clasts, to 1", making water approximately 1 gpm gravel is light gray argillite and sandstone	
60.5	62.5	Light gray (boulder?), argillite, very hard drilling with tricone	
	TD	62.5'	
		6" casing to 62.5' (pulled)	

Please place these well logs in

Appendix B
Water Resources Baseline Investigation, Volume 4.

Within this report they should be put at the end of Appendix H, Well Completion Logs

HYDROMETRICS

TEST HOLE LOG

Helena, MT

State: Mt County: Lincoln Project: Nevada Mt Hole Name or Number: Pere Pond 1

Legal Location: T 27N R 31W Sec. 2? Tract ____ Descriptive Location: Jct of FS Rd 6012 and 4781A

Recorded by: DOP Date Hole Started: 9/8/89 Date Hole Completed: 9/8/89 Driller: JE Drilling Company: Ruen

Drill Method: Air Rotary Drilling Fluids Used: Air Pilot Hole Diameter: 5 7/8 Reamed Hole Diameter: ____

Total Depth Drilled: 72 Total Depth Reamed: ____ Total Depth Cased Below G.S.: 72 Diameter and Type of Casing: 2" PVC Flush thread

Weight or Gage of Casing: Sch 40 Interval Perforated or Screened Below G.S.: 62-72 Target Aquifer: Qal Packer Type and Depth Below G.S.: ____

	YES	NO
Well Developed?		X
Well Test Pumped?		X
Water Samples Taken?		X
Material Samples Taken?		
E - Logs?		X

Method Perforated or Screened:
- ____ No casing in hole.
- ____ Open bottom only.
- ____ Slotted with Mill's Knife.
- ____ Slotted with a torch.
- ____ Screened by pulling casing.
- ____ Saw cut
- X Other (specify) factory slot - .020

Static Water Level: 48.16 Date: 9/9/89

Measuring Point Description/Elevation: TOC MP Height Above (±) or Below G.S.: +2.4'

Well Annulus Completion Description: Sandpack 56-72 (sand), Bentonite Chips 25-56 (8 bags)

Remarks: 6" steel to 18', open hole below, cap on bottom, 10' screen 020 slot

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	43	GRAVEL, cobbles, occasional boulders to 1-2 ft, fine silty yellow brown matrix, cobbles and gravel are medium to dark gray argillite, hard drilling
43	69	SAND, silty, vf grained, tan to light yellow brown, weakly cemented, occasional gravelly zones, moist, appears wet below ≈ 55 to 60', gray
69	72	SAND, silty, vf grained, yellow brown, wet after sitting 10 min

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Form No. 603 (R 2-89)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP.

2. CURRENT MAILING ADDRESS
P.O. Box 1486
Libby, MT 59923

3. WELL LOCATION
SE ¼ NE ¼ NE ¼ Section 15
Township 27 N/S Range 31 E/W County Lincoln
Gov't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify Monitor # ~~JMP-1~~ JPM-2

5. TYPE OF WORK:

New well	☒	Method: Dug	☐	Bored	☐
Deepened	☐	Cable	☐	Driven	☐
Reconditioned	☐	Rotary	☒	Jetted	☐

6. DIMENSIONS: Diameter of Hole
Dia. 7.5 in. from 0 ft. to 40 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. 4" from 30 ft. to +2 ft.
Weight sch 40 Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☐ No ☒
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

SCREENS: Yes ☒ No ☐
Manufacturer's Name Monoflex
Type PVC Model No. _____
Dia. 4" Slot size .020 from 30 ft. to 23 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.

GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.

GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air x Pump _____ Bailer _____
b) Static water level immediately before testing 27 ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: 10 gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes x No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	1	rock fill
1	26	Gravel,cobbles,silty clay
26	40	Gravel,cobbles,sand and water
		Completion
30	19	silica sand
19	5	bentonite
5	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 12-2-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

1-9-92
Date

B&B DRILLING
Firm Name

P.O. Box 967 Libby, MT. 59923
Address

David M Miff
Signature

MWC-014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6810

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

Form No. 603 (R 2-88)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP.

2. CURRENT MAILING ADDRESS
P.O. BOX ~~11~~ 1486
Libby, MT. 59923

3. WELL LOCATION
NW ¼ SE ¼ NE ¼ Section 15
Township 27 N/S Range 31 E/W County Lincoln
Govn't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify Monitor ~~JMP-3~~ JPM-3

5. TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

6. DIMENSIONS: Diameter of Hole
Dia. 7.5 in. from 0 ft. to 39 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. 4" from 20.5 ft. to +2.5 ft.
Weight sch 40 Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☐ No ☒
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name Monoflex
Type PVC triloc Model No. _____
Dia. 4" Slot size .020 from 35.5 ft. to 20.5 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air XX Pump _____ Bailer _____
b) Static water level immediately before testing 25 ft. if flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: 10 gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	1	rock fill
1	27	Gravel,cobbles,silty clay
27	39	Gravel,silty sand,water
Comletion		
35.5	16	silica sand
16	5	bentonite
5	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 11-26-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

1-9-92
Date

B & B DRILLING
Firm Name

P.O. BOX 967 Libby, MT. 59923
Address

David M. Cliff
Signature

MWC-014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

Form No. 603 (R 2-88)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP

2. CURRENT MAILING ADDRESS
P.O. BOX 1406
Libby, Mt. 59923

3. WELL LOCATION
NEK ¼ SW ¼ NE ¼ Section 15
Township 27 N/S Range 31 E/W County Lincoln
Gov't Lot _____ or Lot _____ Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify Monitoring JPM-4

5. TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

6. DIMENSIONS: Diameter of Hole
Dia. 7.5 in. from 0 ft. to 39 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. 4" from 21 ft. to + 3 ft.
Weight sch 40 Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☐ No ☒
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name Monoflex
Type PVC trilok Model No. _____
Dia. 4" Slot size .020 from 36 ft. to 21 ft.
Dia. _____ Slot size x from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air xx Pump _____ Bailer _____
b) Static water level immediately before testing 24 ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: 10 gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	2	rock fill
2	19	silty clay, gravel
19	27	gravel, cobbles, water
27	39	silty sand, water, gravel, cobbles
Completion		
37	15	silica sand
15	7	bentonite
7	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 11-25-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date 1-9-92
B & B DRILLING
Firm Name
P.O. BOX 967 Libby, MT. 59923
Address
Signature David M Sliff
MWC-014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610
DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

WDS-2

Form No. 603 (R 2-89)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP

2. CURRENT MAILING ADDRESS
P O Box 1486
Libby, MT 59923

3. WELL LOCATION
NW ¼ NW ¼ SE ¼ Section 35
Township 28 N/S Range 31 E/W County Lincoln
Govn't Lot _____ or Lot _____ Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify monitoring # 5

5. TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

6. DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 75 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. 4" from 55 ft. to +2 ft.
Weight sch 40 Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☐ No ☐
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name Horizon
Type PVC Model No. _____
Dia. 4" Slot size .030 from 75 ft. to 55 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No ☐ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☐ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air _____ Pump _____ Bailer _____
b) Static water level immediately before testing 40 ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: 10-12 gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.
Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.
NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	5	road bed & fill
5	10	silt & gravel
10	13	clay
13	58	gravel & silty clay, cobbles and small boulders
58	75	cobbles, gravel, silty sand & water
Completion		
55	51	sand
51	3	bentonite
3	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 9-12-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

11-8-91
Date

B & B DRILLING
Firm Name

P O BOX 967, LIBBY, MT 59923
Address

David M. Cliff
Signature

MWC-014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6810

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

WDS-3

Form No. 602 (R 2-88)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP

2. CURRENT MAILING ADDRESS
P O BOX 1486
LIBBY, MT 59923

3. WELL LOCATION
SE ¼ NW ¼ NE ¼ Section 2
Township 27 N/S Range 31 E/W County Lincoln
Gov't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify monitoring # 6

5. TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

6. DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 25 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. 4" from 10 ft. to +2 ft.
Weight sch 40 Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☐ No ☐
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name Horizon
Type PVC Model No. _____
Dia. 4" Slot size .020 from 25 ft. to 10 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air _____ Pump _____ Bailer _____
b) Static water level immediately before testing 11 ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: 15 gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.
Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.
NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	7	road bed fill
7	12	gravel, cobbles
12	14	gravel, cobbles, silty sand and water
14	16	silty clay, some gravel
16	25	gravel, sandy clay, water
Completion		
10	7	sand
7	3	bentonite
3	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 9-19-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

11-8-91
Date

B & B DRILLING
Firm Name

P O BOX 967, LIBBY, MT 59923
Address

Signature

MWC-014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

WDS-4

Form No. 803 (R 2-89)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP

2. CURRENT MAILING ADDRESS
P O BOX 1486
LIBBY, MT 59923

3. WELL LOCATION
NE ¼ SE ¼ SE ¼ Section 35
Township 28 N/S Range 31 E/W County Lincoln
Govn't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify monitoring # 7

5. TYPE OF WORK:

New well	X	Method: Dug	☐	Bored	☐
Deepened	☐	Cable	☐	Driven	☐
Reconditioned	☐	Rotary	X	Jetted	☐

6. DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 65 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia 6 5/8 from +2 ft. to 32 ft.
Threaded ☐ Welded X Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness .250
Casing; Plastic Dia. 4" from 65 ft. to 45 ft.
Weight sch 40 Dia. 4" from 20 ft. to +2 ft.
PERFORATIONS: Yes ☐ No ☐
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes X No ☐
Manufacturer's Name Horizon PVC
Type _____ Model No. _____
Dia. 4" Slot size .020 from 45 ft. to 20 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No X Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes X No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air _____ Pump _____ Bailer _____
b) Static water level immediately before testing 1 ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: 3-4 gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.
Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.
NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	9	gravel,cobbles,silty sand
9	12	gravel,sandy clay/silt(wet)
12	24	cobbles,gravel(loose),
		sandy silt
24	26	gravel,cobbles,water(very
		little) 1 gpm?
26	34	cobbles,boulders,gravel,
		silty clay
34	65	cobbles,gravel,boulders,
		water?
		Completion
65	50	bentonite
50	15	sand
15	5	bentonite
*34	0	6" steel casing
		(could not pull)

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 9-24-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

11-8-91
Date

B & B DRILLING
Firm Name

P O BOX 967, LIBBY, MT 59923
Address

Signature _____ MWC-#014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6810

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

WDS-5

Form No. 603 (R 2-89)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP

2. CURRENT MAILING ADDRESS
P O BOX 1486
LIBBY, MT 59923

3. WELL LOCATION
SW ¼ SE ¼ NW ¼ Section 36
Township 28 N/S Range 31 E/W County Lincoln
Gov't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify monitoring # 9

5. TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

6. DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 100 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia 4" from 90 ft. to +2 ft.
Weight sch 40 Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☐ No ☒
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name Horizon
Type PVC Model No. _____
Dia. 4" Slot size .020 from 100 ft. to 90 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air _____ Pump _____ Bailer _____
b) Static water level immediately before testing none det ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: _____ gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.
Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.
NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	15	gravel,cobbles,silty clay
15	92	gravel,clay,some boulders
92	100	bedrock
		Completion
90	86	sand
86	3	bentonite
3	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 9-23-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

11-8-91
Date

B & B DRILLING
Firm Name

P O BOX 967, LIBBY, MT 59923
Address

David M. Iff
Signature

MWC #014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6810

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

WDS-6

Form No. 603 (R 2-89)

WELL LOG REPORT

File No. _____

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name NORANDA MINERALS CORP

2. CURRENT MAILING ADDRESS
P O BOX 1486
LIBBY, MT 59923

3. WELL LOCATION
NE ¼ SE ¼ NW ¼ Section xx36
Township 28 N/S Range 31 E/W County Lincoln
Gov't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☐ specify monitoring # 10

5. TYPE OF WORK:

New well	☒	Method: Dug	☐	Bored	☐
Deepened	☐	Cable	☐	Driven	☐
Reconditioned	☐	Rotary	☒	Jetted	☐

6. DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 49 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. _____ from _____ ft. to _____ ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. _____ from _____ ft. to _____ ft.
Weight sch 40 Dia. 4" from 32 ft. to + 2 ft.
PERFORATIONS: Yes ☐ No ☒
Type of perforator used _____
Size of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

SCREENS: Yes ☒ No ☐
Manufacturer's Name Horizon
Type PVC Model No. _____
Dia. 4" Slot size .020 from 47 ft. to 32 ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.

GRAVEL PACKED: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.

GROUTED: To what depth? _____ ft.
Material used in grouting _____

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☐ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air _____ Pump _____ Bailer _____
b) Static water level immediately before testing none det ft. If flowing; closed-in pressure _____ psi. _____ gpm.
Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test _____
d) The pumping rate: _____ gpm.
e) Pumping water level _____ ft. at _____ hrs. after pumping began.
f) Duration of test: Pumping time _____ hrs.
g) Recovery time _____ hrs.
h) Recovery water level _____ ft. at _____ hrs. after pumping stopped.
Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.
NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	9	silty clay
9	39	clay,cobbles,boulders,some grav
39	42	silty clay (wet)
42	49	bedrock
Completion		
49	47	sand
47	32	screen
32	28	sand
28	3	bentonite
3	0	cement

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 9-23-91

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

11-8-91
Date

B & B DRILLING
Firm Name

P O BOX 967, LIBBY, MT 59923
Address

David McCliff
Signature

MWC-014
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6810

DNRC

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side and send to DNRC when the well is completed and the water has been used beneficially for the intended purpose.

Chen-Northern, Inc.

APPENDIX I

APPENDIX I

AQUIFER TEST DATA

Northern
Engineering
and Testing, Inc.
130 Neill Avenue
P.O. Box 4699
Helena, Montana 59604
(406) 443-5210

AQUIFER TEST DATA

WELL OBSERVED PM-2
(Data Reported on This Form)
WELL TESTED PM-2
TEST DATE 8/16/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT. County Lincoln Location: T___ R___ Sec. ___ Tract ___

Borehole Diam.(in) 6 Well Diam.(in) 4 Well Depth(ft) 39.5 Perforated Zone(s)(ft) 24-39

Desc. of MP ___ Stick-up(ft) ___ SWL below MP(ft) ___ SWL below GS(ft) ___

Aquifer Name ___ Aquifer Description (Lithology, Thickness, Depth to Top) Glaciofluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ___

Distance of Observation Well from Pumping Well(ft) ___ Pump hp. & type ___ Pump Depth(ft) ___

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ___ Temp(°C) ___ Time ___

Avg. Discharge(gpm) 10.1 Test Duration(min) ___ Max WL Change(ft) ___ Transmissivity (gpd/ft) ___

Storativity ___ Hydraulic Conductivity(gpd/ft^2) ___ Specific Capacity(gpm/ft of drawdown) ___

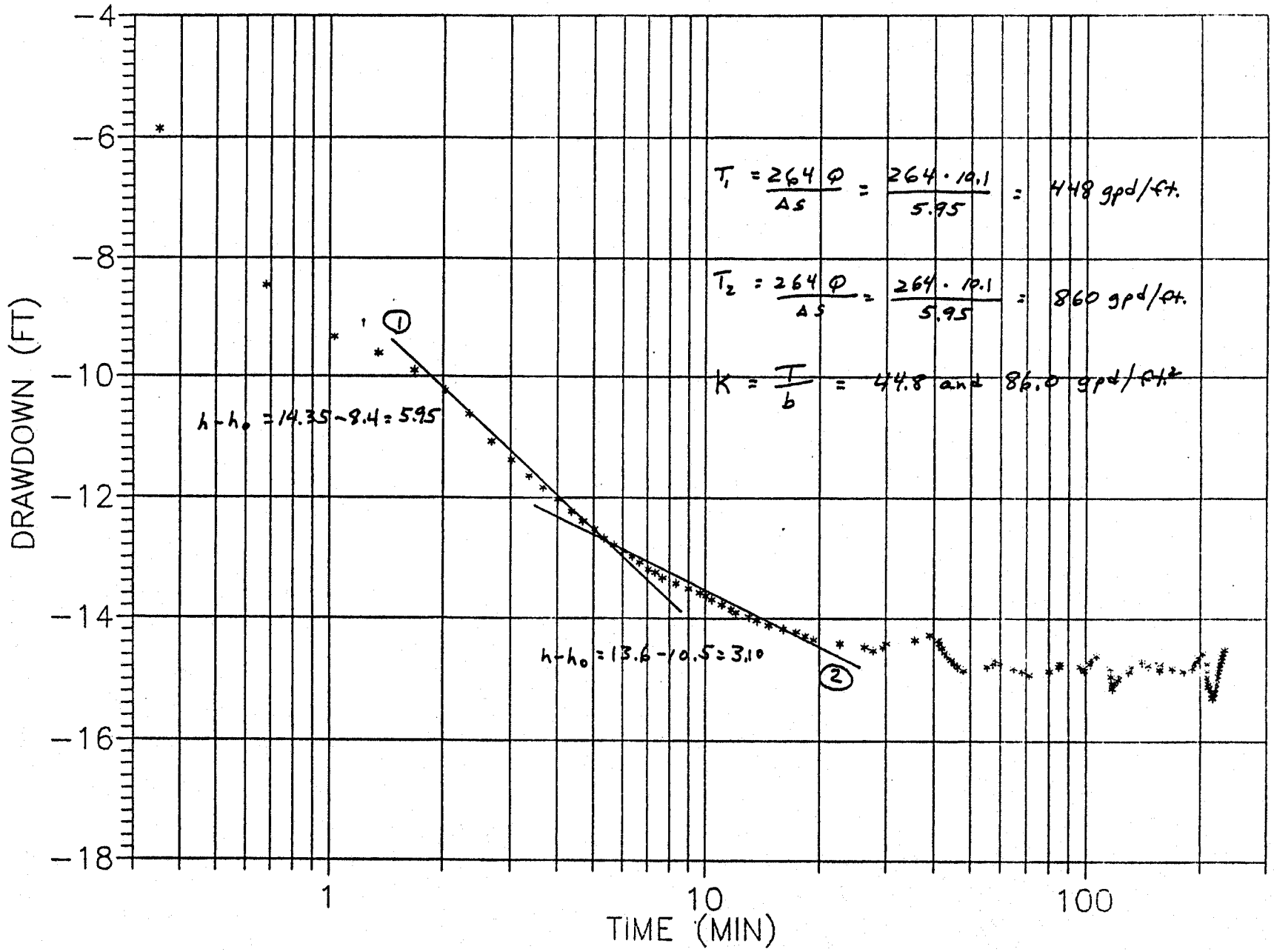
REMARKS ___

881	14.68	14.11	-14.11
961	16.02	14.17	-14.17
1041	17.35	14.22	-14.22
1101	18.35	14.29	-14.29
1161	19.35	14.35	-14.35
1361	22.68	14.41	-14.41
1581	26.35	14.46	-14.46
1661	27.68	14.52	-14.52
1761	29.35	14.46	-14.46
1801	30.02	14.41	-14.41
2141	35.68	14.35	-14.35
2341	39.02	14.27	-14.27
2461	41.02	14.35	-14.35
2481	41.35	14.41	-14.41
2521	42.02	14.48	-14.48
2562	42.70	14.55	-14.55
2602	43.37	14.60	-14.60
2662	44.37	14.67	-14.67
2721	45.35	14.73	-14.73
2781	46.35	14.78	-14.78
2881	48.02	14.84	-14.84
3321	55.35	14.78	-14.78
3441	57.35	14.73	-14.73
3481	58.02	14.67	-14.67
3621	60.35	14.73	-14.73
3901	65.02	14.80	-14.80
4101	68.35	14.85	-14.85
4281	71.35	14.91	-14.91
4821	80.35	14.85	-14.85
5101	85.02	14.78	-14.78
5141	85.68	14.73	-14.73
5801	96.68	14.78	-14.78
5941	99.02	14.84	-14.84
6161	102.68	14.74	-14.74
6201	103.35	14.66	-14.66
6401	106.68	14.60	-14.60
6981	116.35	14.80	-14.80
7001	116.68	14.94	-14.94
7021	117.02	15.06	-15.06
7041	117.35	15.14	-15.14
7121	118.68	15.05	-15.05
7281	121.35	14.99	-14.99
7341	122.35	14.91	-14.91
7781	129.68	14.85	-14.85
7922	132.03	14.78	-14.78
8441	140.68	14.70	-14.70
8761	146.02	14.76	-14.76
9361	156.02	14.83	-14.83
9401	156.68	14.74	-14.74
10161	169.35	14.80	-14.80
10901	181.68	14.85	-14.85
11441	190.68	14.80	-14.80
11561	192.68	14.74	-14.74
11721	195.35	14.69	-14.69
11841	197.35	14.62	-14.62
12201	203.35	14.56	-14.56

12541	209.02	14.74	-14.74
12561	209.35	14.85	-14.85
12581	209.68	14.95	-14.95
12601	210.02	15.01	-15.01
12621	210.35	15.06	-15.06
12641	210.68	15.12	-15.12
12781	213.02	15.06	-15.06
12881	214.68	15.15	-15.15
12921	215.35	15.22	-15.22
12961	216.02	15.29	-15.29
13101	218.35	15.21	-15.21
13141	219.02	15.14	-15.14
13221	220.35	15.06	-15.06
13282	221.37	14.99	-14.99
13341	222.35	14.92	-14.92
13401	223.35	14.85	-14.85
13481	224.68	14.80	-14.80
13541	225.68	14.74	-14.74
13661	227.68	14.69	-14.69
13761	229.35	14.62	-14.62
13821	230.35	14.56	-14.56
13921	232.02	14.50	-14.50

3.867 hrs.

COOPER–JACOB DRAWDOWN PLOT
PUMPING WELL PM–2



"SECONDS"	"MINUTES"	"DRAWDOWN"	"NEGATIVE DRAWDOWN"
21	.35	5.86	-5.86
41	.68	8.46	-8.46
62	1.03	9.33	-9.33
81	1.35	9.61	-9.61
101	1.68	9.90	-9.90
122	2.03	10.23	-10.23
141	2.35	10.62	-10.62
161	2.68	11.07	-11.07
181	3.02	11.38	-11.38
202	3.37	11.64	-11.64
221	3.68	11.83	-11.83
241	4.02	12.02	-12.02
262	4.37	12.23	-12.23
281	4.68	12.39	-12.39
301	5.02	12.53	-12.53
321	5.35	12.68	-12.68
341	5.68	12.79	-12.79
362	6.03	12.89	-12.89
381	6.35	12.98	-12.98
401	6.68	13.07	-13.07
422	7.03	13.19	-13.19
441	7.35	13.24	-13.24
461	7.68	13.33	-13.33
501	8.35	13.42	-13.42
541	9.02	13.51	-13.51
581	9.68	13.58	-13.58
601	10.02	13.63	-13.63
622	10.37	13.69	-13.69
661	11.02	13.77	-13.77
701	11.68	13.86	-13.86
722	12.03	13.91	-13.91
781	13.02	13.98	-13.98
821	13.68	14.04	-14.04
881	14.68	14.11	-14.11
961	16.02	14.17	-14.17
1041	17.35	14.22	-14.22
1101	18.35	14.29	-14.29
1161	19.35	14.35	-14.35
1361	22.68	14.41	-14.41
1581	26.35	14.46	-14.46
1661	27.68	14.52	-14.52
1761	29.35	14.46	-14.46
1801	30.02	14.41	-14.41
2141	35.68	14.35	-14.35
2341	39.02	14.27	-14.27
2461	41.02	14.35	-14.35
2481	41.35	14.41	-14.41
2521	42.02	14.48	-14.48
2562	42.7	14.55	-14.55
2602	43.37	14.6	-14.6
2662	44.37	14.67	-14.67
2721	45.35	14.73	-14.73
2781	46.35	14.78	-14.78
2881	48.02	14.84	-14.84
3321	55.35	14.78	-14.78
3441	57.35	14.73	-14.73
3481	58.02	14.67	-14.67
3621	60.35	14.73	-14.73
3901	65.02	14.8	-14.8

4101	68.35	14.85	-14.85
4281	71.35	14.91	-14.91
4821	80.35	14.85	-14.85
5101	85.02	14.78	-14.78
5141	85.68	14.73	-14.73
5801	96.68	14.78	-14.78
5941	99.02	14.84	-14.84
6161	102.68	14.74	-14.74
6201	103.35	14.66	-14.66
6401	106.68	14.6	-14.6
6981	116.35	14.8	-14.8
7001	116.68	14.94	-14.94
7021	117.02	15.06	-15.06
7041	117.35	15.14	-15.14
7121	118.68	15.05	-15.05
7281	121.35	14.99	-14.99
7341	122.35	14.91	-14.91
7781	129.68	14.85	-14.85
7922	132.03	14.78	-14.78
8441	140.68	14.7	-14.7
8761	146.02	14.76	-14.76
9361	156.02	14.83	-14.83
9401	156.68	14.74	-14.74
10161	169.35	14.8	-14.8
10901	181.68	14.85	-14.85
11441	190.68	14.8	-14.8
11561	192.68	14.74	-14.74
11721	195.35	14.69	-14.69
11841	197.35	14.62	-14.62
12201	203.35	14.56	-14.56
12541	209.02	14.74	-14.74
12561	209.35	14.85	-14.85
12581	209.68	14.95	-14.95
12601	210.02	15.01	-15.01
12621	210.35	15.06	-15.06
12641	210.68	15.12	-15.12
12781	213.02	15.06	-15.06
12881	214.68	15.15	-15.15
12921	215.35	15.22	-15.22
12961	216.02	15.29	-15.29
13101	218.35	15.21	-15.21
13141	219.02	15.14	-15.14
13221	220.35	15.06	-15.06
13282	221.37	14.99	-14.99
13341	222.35	14.92	-14.92
13401	223.35	14.85	-14.85
13481	224.68	14.8	-14.8
13541	225.68	14.74	-14.74
13661	227.68	14.69	-14.69
13761	229.35	14.62	-14.62
13821	230.35	14.56	-14.56
13921	232.02	14.50	-14.50

Northern
Engineering and Testing, Inc.
120 Neill Avenue
P.O. Box 4699
Helena, Montana 59631
(406) 443-5211

AQUIFER TEST DATA

WELL OBSERVED (Data Reported on This Form) PM-20B
WELL TESTED PM-2
TEST DATE 8/16/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT. County Lincoln Location: T___ R___ Sec. ___ Tract ___

Borehole Diam.(in) 6 Well Diam.(in) 6 Well Depth(ft) 39 Perforated Zone(s)(ft) 24-39

Desc. of MP ___ Stick-up(ft) ___ SWL below MP(ft) ___ SWL below GS(ft) ___

Aquifer Name ___ Aquifer Description (Lithology, Thickness, Depth to Top) Glaciofluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown (circled)
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ___

Distance of Observation Well from Pumping Well(ft) 40 Pump hp. & type ___ Pump Depth(ft) ___

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ___ Temp(°C) ___ Time ___

Avg. Discharge(gpm) 10.1 Test Duration(min) ___ Max WL Change(ft) ___ Transmissivity (gpd/ft) ___

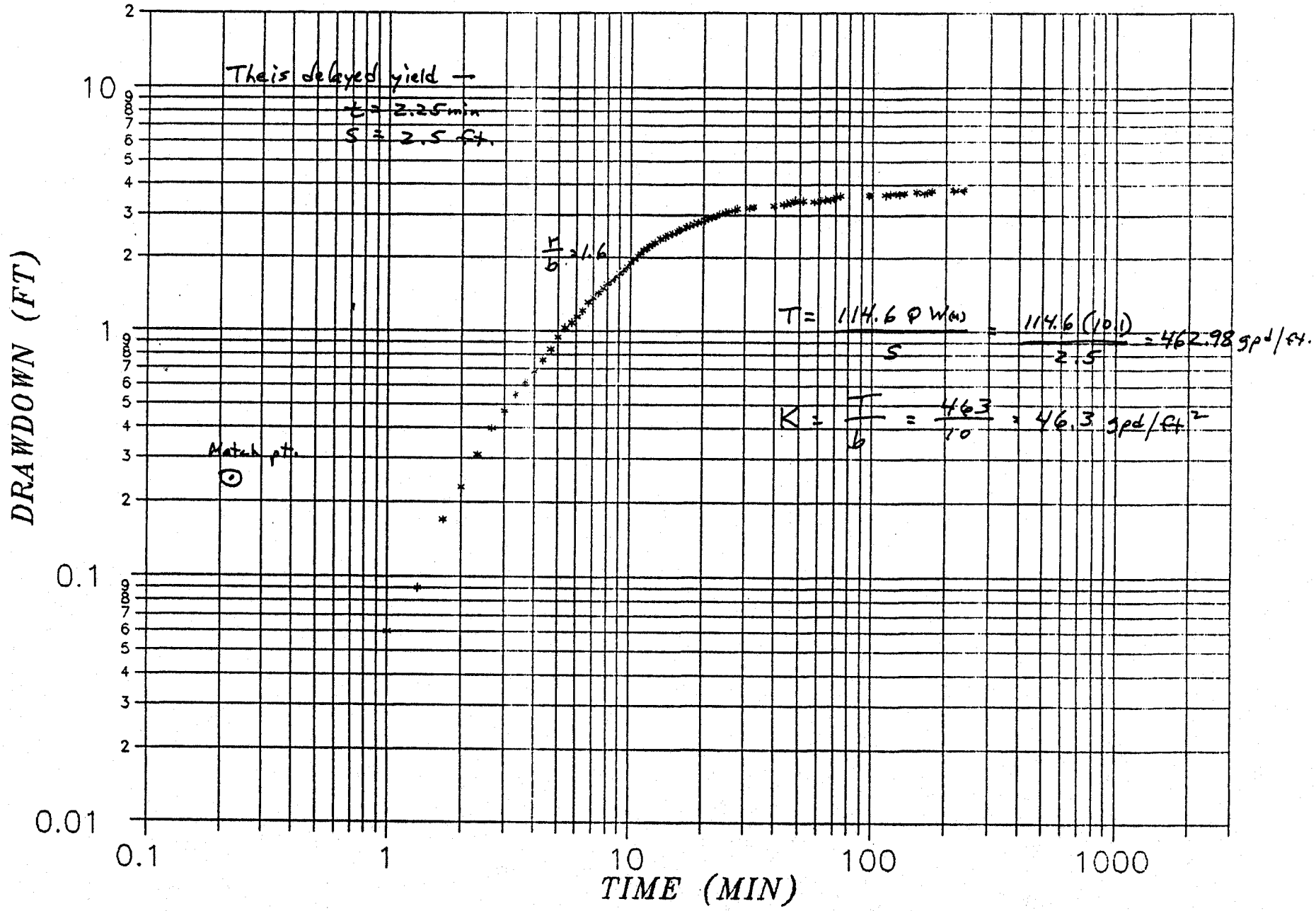
Storativity ___ Hydraulic Conductivity(gpd/ft^2) ___ Specific Capacity(gpm/ft of drawdown) ___

REMARKS ___

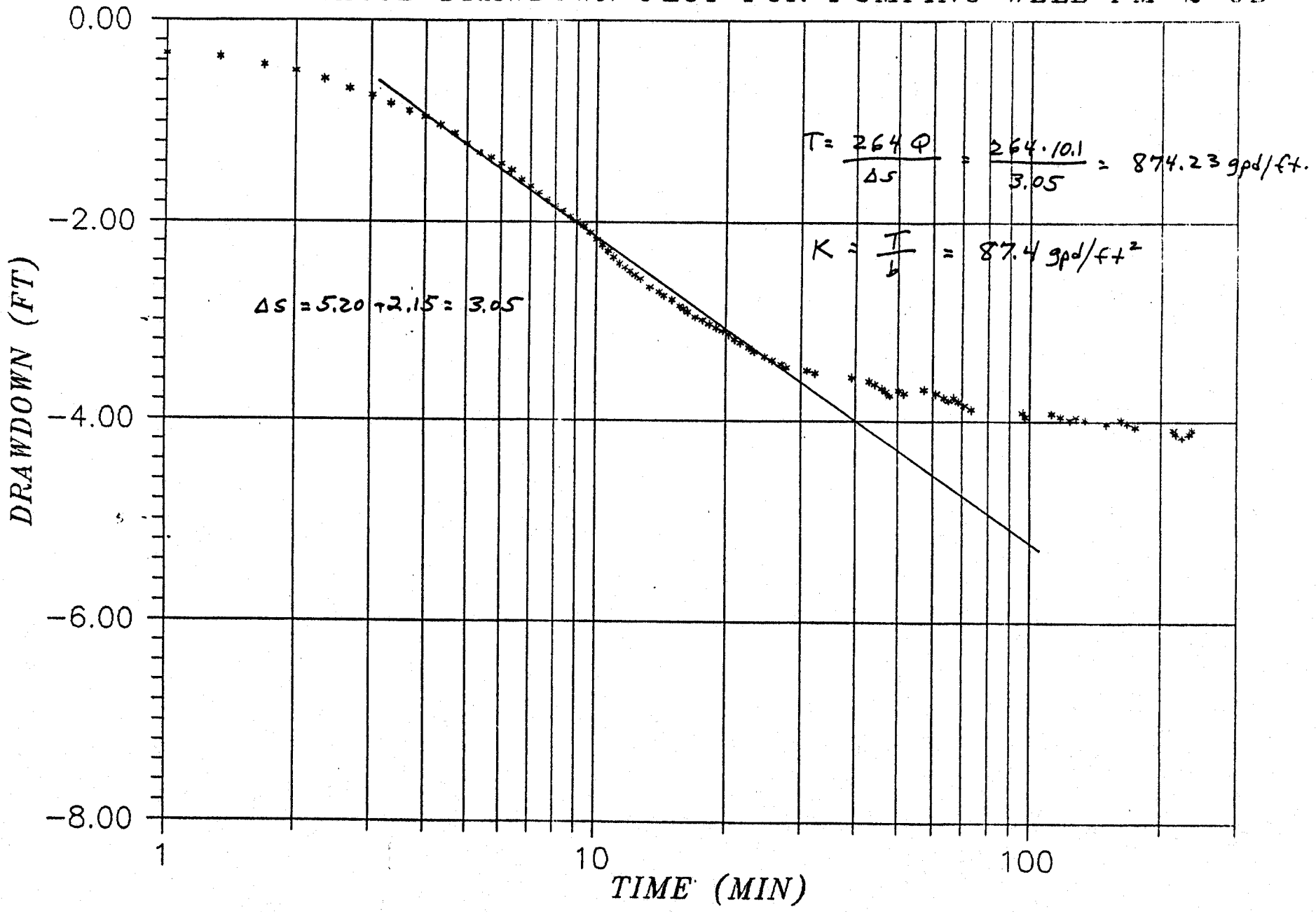
"SECONDS"	"MINUTES"	"DRAWDOWN"	"NEGATIVE DRAWDOWN"
60	1.00	0.06	-0.06
80	1.33	0.09	-0.09
101	1.68	0.17	-0.17
120	2.00	0.23	-0.23
140	2.33	0.31	-0.31
160	2.67	0.40	-0.40
181	3.02	0.47	-0.47
200	3.33	0.55	-0.55
220	3.67	0.62	-0.62
240	4.00	0.68	-0.68
260	4.33	0.76	-0.76
280	4.67	0.84	-0.84
300	5.00	0.94	-0.94
321	5.35	1.03	-1.03
341	5.68	1.08	-1.08
360	6.00	1.14	-1.14
380	6.33	1.21	-1.21
401	6.68	1.31	-1.31
420	7.00	1.37	-1.37
440	7.33	1.43	-1.43
460	7.67	1.50	-1.50
480	8.00	1.56	-1.56
500	8.33	1.61	-1.61
520	8.67	1.67	-1.67
540	9.00	1.72	-1.72
560	9.33	1.77	-1.77
580	9.67	1.83	-1.83
601	10.02	1.90	-1.90
620	10.33	1.96	-1.96
640	10.67	2.02	-2.02
660	11.00	2.08	-2.08
681	11.35	2.14	-2.14
701	11.68	2.18	-2.18
720	12.00	2.22	-2.22
740	12.33	2.26	-2.26
760	12.67	2.30	-2.30
800	13.33	2.38	-2.38
841	14.02	2.43	-2.43
861	14.35	2.47	-2.47
900	15.00	2.51	-2.51
940	15.67	2.57	-2.57
960	16.00	2.60	-2.60
981	16.35	2.63	-2.63
1021	17.02	2.68	-2.68
1060	17.67	2.71	-2.71
1100	18.33	2.75	-2.75
1140	19.00	2.79	-2.79
1180	19.67	2.82	-2.82
1220	20.33	2.86	-2.86
1260	21.00	2.91	-2.91
1300	21.67	2.94	-2.94
1360	22.67	2.99	-2.99
1400	23.33	3.03	-3.03
1481	24.68	3.08	-3.08
1540	25.67	3.12	-3.12
1620	27.00	3.16	-3.16
1660	27.67	3.19	-3.19
1860	31.00	3.22	-3.22
1941	32.35	3.25	-3.25

2360	39.33	3.29	-3.29
2580	43.00	3.33	-3.33
2660	44.33	3.36	-3.36
2760	46.00	3.40	-3.40
2820	47.00	3.43	-3.43
2880	48.00	3.47	-3.47
3020	50.33	3.42	-3.42
3100	51.67	3.45	-3.45
3440	57.33	3.41	-3.41
3661	61.02	3.45	-3.45
3821	63.68	3.49	-3.49
3921	65.35	3.52	-3.52
4020	67.00	3.49	-3.49
4120	68.67	3.53	-3.53
4241	70.68	3.57	-3.57
4400	73.33	3.61	-3.61
5781	96.35	3.64	-3.64
5861	97.68	3.68	-3.68
6740	112.33	3.65	-3.65
7061	117.68	3.68	-3.68
7421	123.68	3.71	-3.71
7680	128.00	3.68	-3.68
8041	134.02	3.71	-3.71
9001	150.02	3.75	-3.75
9720	162.00	3.71	-3.71
10041	167.35	3.74	-3.74
10461	174.35	3.78	-3.78
12821	213.68	3.81	-3.81
12980	216.33	3.85	-3.85
13401	223.35	3.88	-3.88
13921	232.02	3.85	-3.85
14120	235.33	3.81	-3.81

DRAWDOWN PLOT FOR OBSERVATION WELL PM-2-0B



COOPER–JACOB DRAWDOWN PLOT FOR PUMPING WELL PM-2-OB



Northern
Engineering and Testing, Inc.
130 Neill Avenue
P.O. Box 4699
Helena, Montana 59601
(406) 443-5210

AQUIFER TEST DATA

WELL OBSERVED _____ (Data Reported on This Form)
WELL TESTED PM-3
TEST DATE 08/18/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT County Lincoln Location: T _____ R _____ Sec. _____ Tract _____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 48 Perforated Zone(s)(ft) 34.9 - 44.9

Desc. of MP _____ Stick-up(ft) _____ SWL below MP(ft) _____ SWL below GS(ft) _____

Aquifer Name _____ Aquifer Description (Lithology, Thickness, Depth to Top) Glacio-fluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) _____

Distance of Observation Well from Pumping Well(ft) _____ Pump hp. & type _____ Pump Depth(ft) _____

Water Quality Sample Taken? yes no Specific Conductance (μmhos/cm @ 25°C) _____ Temp(°C) _____ Time _____

Avg. Discharge(gpm) _____ Test Duration(min) _____ Max WL Change(ft) _____ Transmissivity (gpd/ft) _____

Storativity _____ Hydraulic Conductivity(gpd/ft²) _____ Specific Capacity(gpm/ft of drawdown) _____

REMARKS 0.4 gal slug

Date & hour	Time (sec)	swl (ft)	neg. drawdown (ft)					
16:08:34	—	20.07	—					
:36	2	22.42	2.35					
:39	5	21.62	1.55					
:43	9	21.06	0.99					
:45	11	20.91	0.84					
:48	14	20.77	0.70					
:51	17	20.68	0.61					
:55	21	20.60	0.53					
:57	23	20.56	0.49					
16:09:00	26	20.52	0.45					
:03	29	20.48	0.41					
:07	33	20.44	0.37					
:09	35	20.42	0.35					
:12	38	20.40	0.33					
:15	41	20.38	0.31					
:19	45	20.35	0.28					
:24	50	20.32	0.25					
:28	54	20.30	0.23					
:33	59	20.28	0.21					
:42	68	20.26	0.19					
:46	72	20.24	0.17					
:57	83	20.21	0.14					
16:10:06	92	20.19	0.12					
:22	108	20.17	0.10					

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED _____
(Data Reported On This Form)

WELL TESTED _____

TEST DATE _____

Project _____ Personnel _____

Date & hour	Time	swl (ft)	neg. drawdown (ft)					
:40	126	20.14	0.07					
16:11:07	153	20.12	0.05					
:36	182	20.10	0.03					
16:13:13	279	20.08	0.01					

PM-3 Slug Injection (.4 gal) (Bouwer - Rice)

$r_c = .083$ ft. $A = 2.5$

$r_w = .292$ ft. $B = .3$

$L = 10$ ft. $C = 2.1$

$H = 25.64$ ft.

$L/r_w = 34.25$

D >> H

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w} \right]^{-1} = 2.69$$

D = H

$$\ln \frac{R_e}{r_w} = \left(\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w} \right)^{-1} = 3.25$$

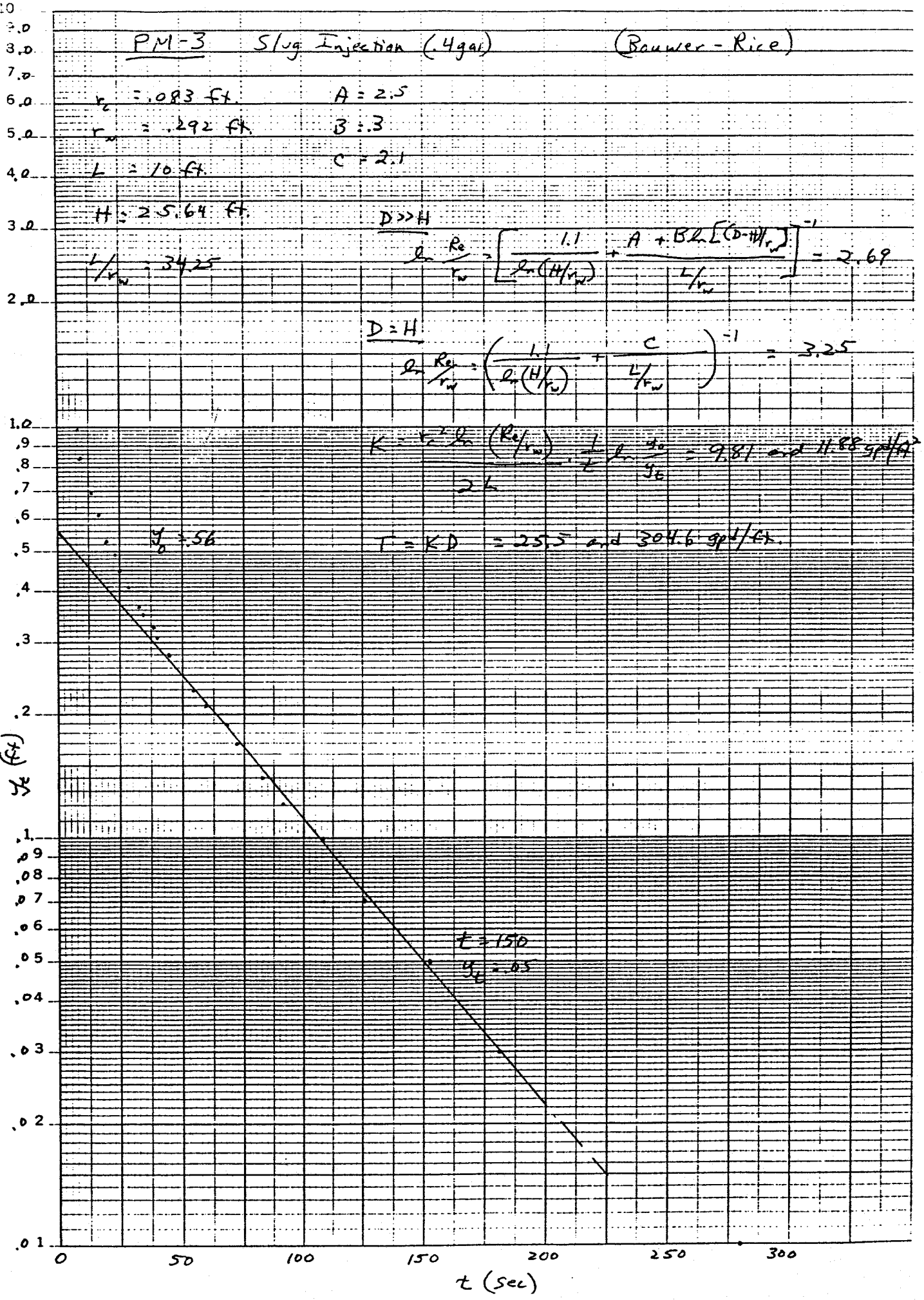
$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_t} = 9.81 \text{ and } 11.88 \text{ gpd/ft}^2$$

$y_0 = .56$

$T = KD = 25.5$ and 304.6 gpd/ft.

$t = 150$

$y_t = .05$



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KEUFFEL & ESSER CO. MADE IN U.S.A.

Northern Engineering and Testing, Inc.
120 Neill Avenue
P.O. Box 4699
Helena, Montana 59601
(406) 443-5270

AQUIFER TEST DATA

WELL OBSERVED (Data Reported on This Form) _____

WELL TESTED PM-5

TEST DATE 8/18/88

Project Montana Silver Venture Personnel Dunlavy, Staley

WELL DESCRIPTION

State MT. County Lincoln Location: T _____ R _____ Sec. _____ Tract _____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 41.5 Perforated Zone(s)(ft) 31.5 – 41.5

Desc. of MP Top of PVC Stick-up(ft) _____ SWL below MP(ft) +5.5 psi SWL below GS(ft) _____

Aquifer Name _____ Aquifer Description (Lithology, Thickness, Depth to Top) Glaciofluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. ~~Pumping~~ Flowing Well Drawdown
2. Observation Well Drawdown
3. ~~Pumping~~ Flowing Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) _____

Distance of Observation Well from Pumping Well(ft) _____ Pump hp. & type Free flow Pump Depth(ft) _____

Water Quality Sample Taken? yes no Specific Conductance (μmhos/cm @ 25°C) _____ Temp(°C) _____ Time _____

Avg. Discharge(gpm) _____ Test Duration(min) _____ Max WL Change(ft) _____ Transmissivity (gpd/ft) _____

Storativity _____ Hydraulic Conductivity(gpd/ft²) _____ Specific Capacity(gpm/ft of drawdown) _____

REMARKS Open valve @ 1425:00, PSI dropped to 0. Δs = 12.7' r_w = .25 ft.

Date & hour	Time (min)	Q (gpm)	s_w/Q (ft)	t/r_w^2				
14:25:10	.17	1.32	9.63	2.72				
:30	.5	.40	31.8	8				
14:26:00	1	.36	35.3	16				
:30	1.5	.33	38.5	24				
14:27:00	2	.33	38.5	32				
14:28:00	3	.32	39.7	48	av. Q	= .37 gpm		
14:29:00	4	.31	41.0	64				
14:30:00	5	.30	42.4	80				
14:32:30	7.5	.30	42.4	120				
14:35:00	10	.28	45.4	160				
14:37:30	12.5	.28	45.4	200				
14:40:00	15	.27	47.1	240				
14:45:00	20	.27	47.1	320				
14:50:00	25	.26	48.9	400				
14:55:00	30	.27	47.1	480				
	Shut-in	@ 1500	hrs.					
Hour	Time(min)	psi	s (ft)					
15:00:10	.17	1.3	3.0					
:20	.33	1.8	4.16					
:30	.50	2.05	4.74					
:40	.66	2.2	5.08					
:50	.92	2.45	5.66					
15:01:00	1.00	2.55	5.89					
:20	1.33	2.90	6.70					

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED _____
(Data Reported On This Form)

WELL TESTED _____

TEST DATE _____

Project _____ Personnel _____

Date & hour	Time (min)	psi	s (ft)					
15:01:40	1.66	3.0	6.93					
15:02:00	2.00	3.1	7.16					
:30	2.5	3.4	7.86					
15:03:00	3.0	3.55	8.20					
:30	3.5	3.7	8.55					
15:04:00	4.0	3.8	8.78					
15:05:00	5.0	4.0	9.24					
15:06:00	6.0	4.1	9.48					
15:07:00	7.0	4.25	9.82					
15:08:00	8.0	4.4	10.17					
15:09:00	9.0	4.45	10.28					
15:10:00	10.0	4.7	10.86					
15:15:00	15.0	4.8	11.09					
15:20:00	20.0	4.9	11.32					
15:25:00	25.0	4.95	11.44					
15:30:00	30.0	5.0	11.56					

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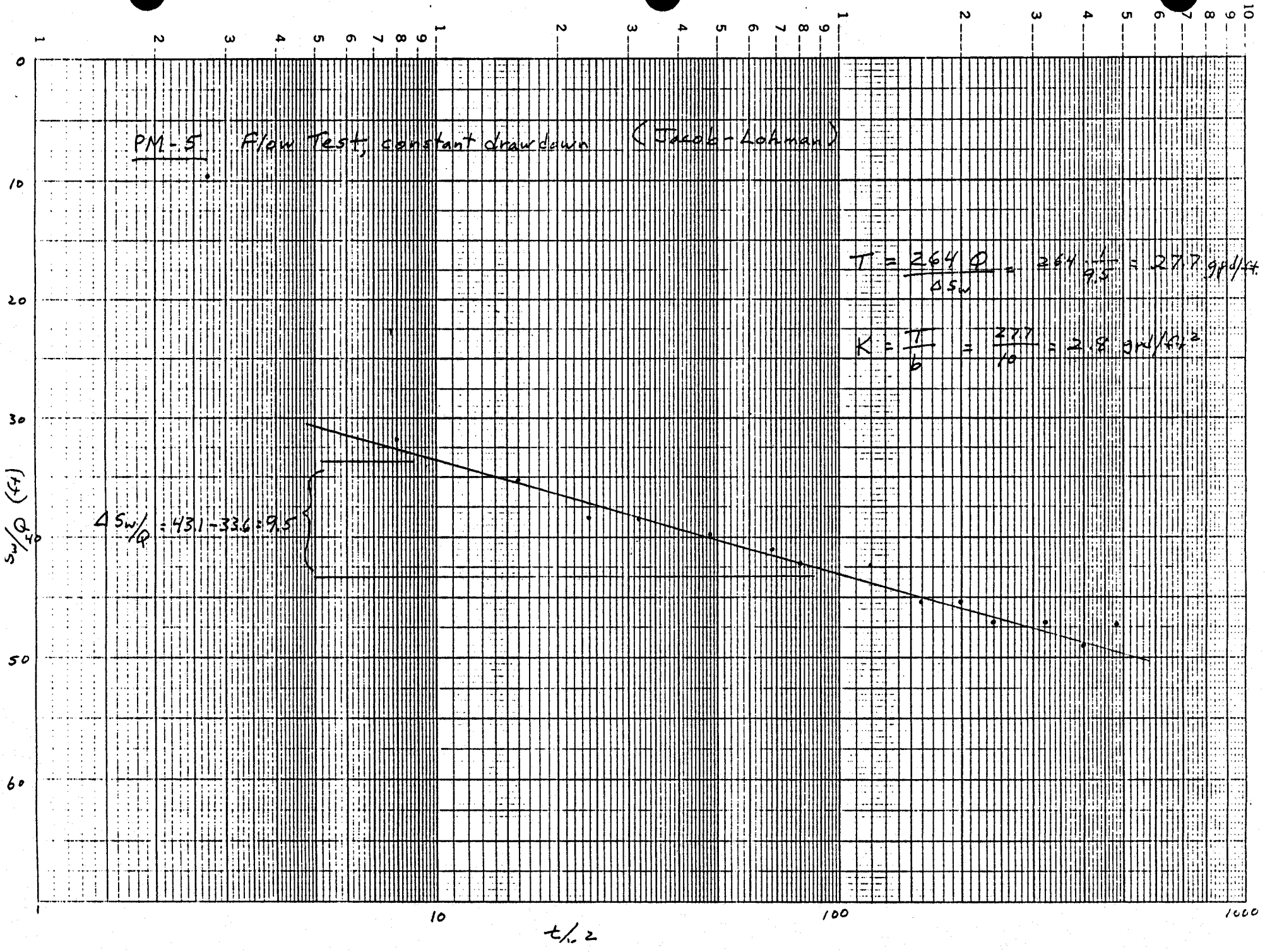
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 5810



K+E SEMI-LOGARITHMIC 3 CYCLES x 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

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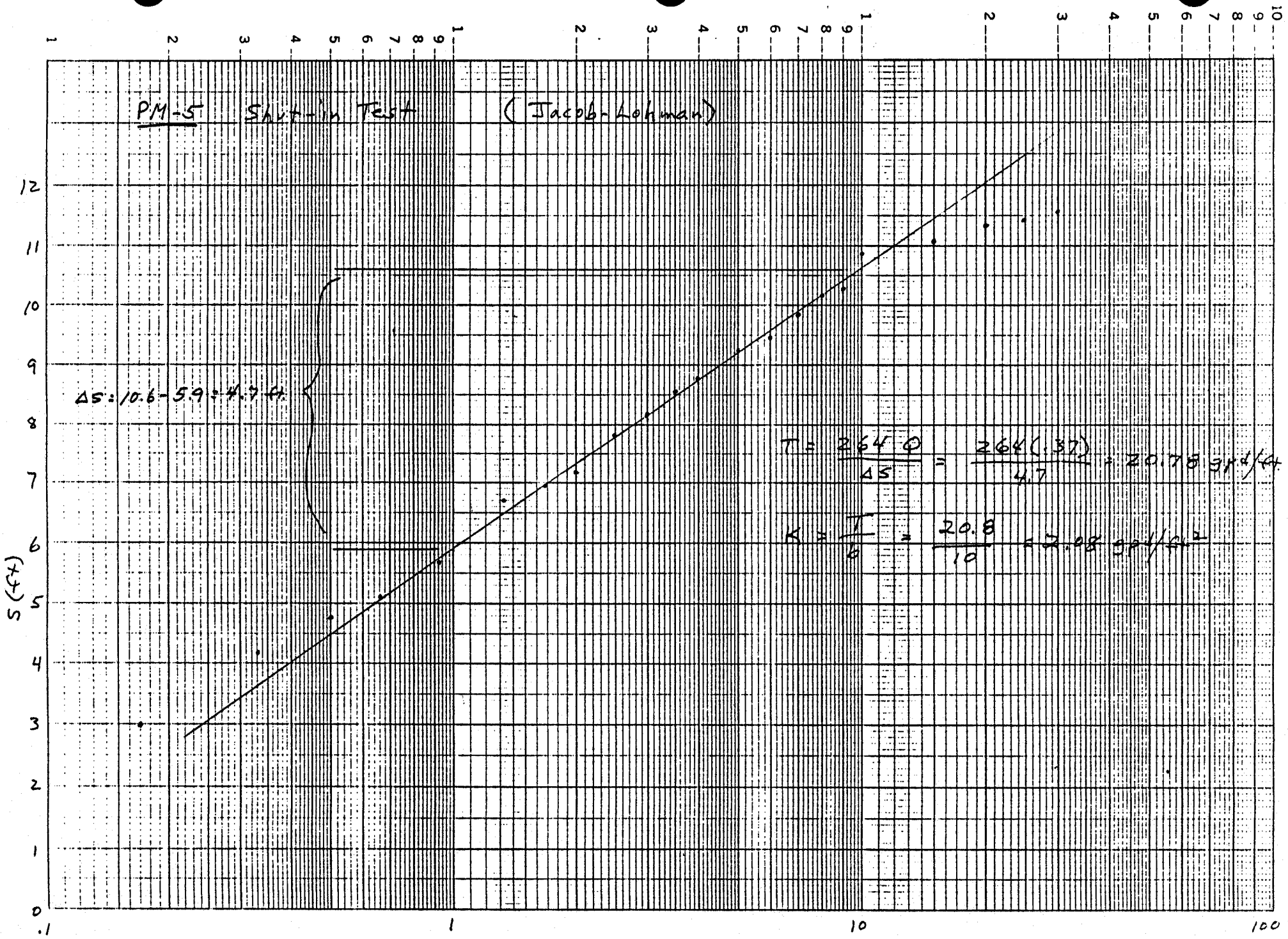


Northern
Engineering and Testing, Inc.
130 Neill Avenue
P.O. Box 4699
Helena, Montana 59604
(406) 443-5210

AQUIFER TEST DATA

WELL OBSERVED _____ (Date Reported on this form)
WELL TESTED PLCM-6 (Shallow)
TEST DATE 08/18/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT County Lincoln Location: T ____ R ____ Sec. ____ Tract ____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 56 Perforated Zone(s)(ft) 8-18

Desc. of MP ____ Stick-up(ft) ____ SWL below MP(ft) ____ SWL below GS(ft) ____

Aquifer Name ____ Aquifer Description (Lithology, Thickness, Depth to Top) fluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ____

Distance of Observation Well from Pumping Well(ft) ____ Pump hp. & type ____ Pump Depth(ft) ____

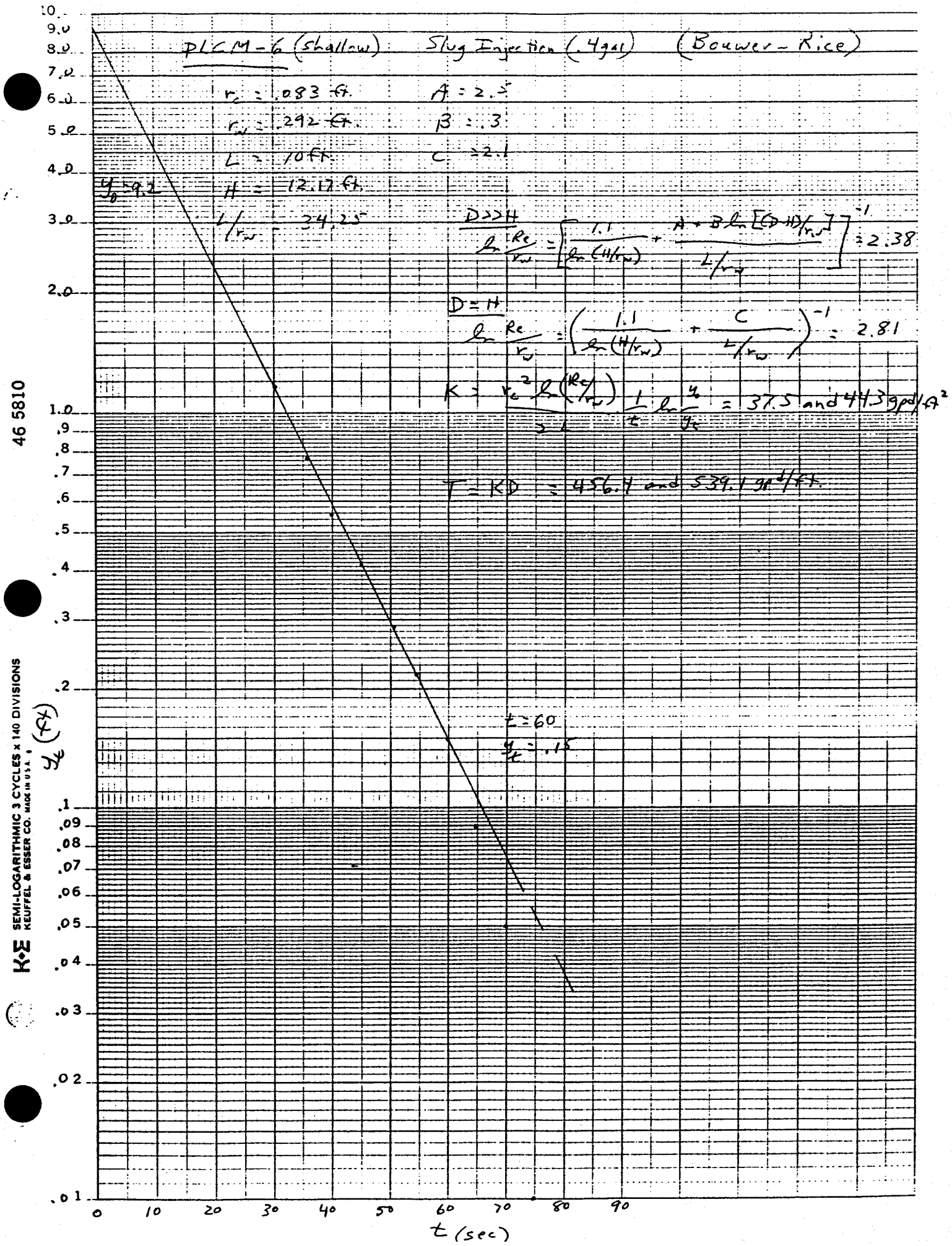
Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ____ Temp(°C) ____ Time ____

Avg. Discharge(gpm) ____ Test Duration(min) ____ Max WL Change(ft) ____ Transmissivity (gpd/ft) ____

Storativity ____ Hydraulic Conductivity(gpd/ft²) ____ Specific Capacity(gpm/ft of drawdown) ____

REMARKS 0.4 gal slug

Date & hour	Time (sec)	swl (ft.)	neg. drawdown (ft)					
10:11:36	—	9.40	—					
10:12:01	25	12.65	3.25					
:06	30	10.57	1.17					
:12	36	10.15	0.75					
:16	40	9.96	0.56					
:21	45	9.82	0.42					
:27	51	9.69	0.29					
:31	55	9.62	0.22					
:36	60	9.55	0.15					
:41	65	9.49	0.09					
:46	70	9.45	0.05					
:51	75	9.41	0.01					
:57	—	9.37	—					
10:13:07	—	9.32	—					
:17	—	9.27	—					



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K+E SEMI-LOGARITHMIC 3 CYCLES x 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

Northern Engineering and Testing, Inc.
120 Neill Avenue
P.O. Box 4699
Helena, Montana 59601
(406) 443-5210

AQUIFER TEST DATA

WELL OBSERVED (Data Reported on this Form) _____
WELL TESTED PLCM-6 (deep)
TEST DATE 8/18/88

Project Montana Silver Venture Personnel Dunlary, Staley

WELL DESCRIPTION

State MT. County Lincoln Location: T _____ R _____ Sec. _____ Tract _____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 56 Perforated Zone(s)(ft) 45.5 - 55.5

Desc. of MP Top of well protector Stick-up(ft) _____ SWL below MP(ft) +2.55 psi SWL below GS(ft) _____

Aquifer Name _____ Aquifer Description (Lithology, Thickness, Depth to Top) Glaciofluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. ~~Pumping~~ Flowing Well Drawdown
2. Observation Well Drawdown
3. ~~Pumping~~ Flowing Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) _____

Distance of Observation Well from Pumping Well(ft) _____ Pump hp. & type Flowing Pump Depth(ft) _____

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) _____ Temp(°C) _____ Time _____

Avg. Discharge(gpm) _____ Test Duration(min) _____ Max WL Change(ft) _____ Transmissivity (gpd/ft) _____

Storativity _____ Hydraulic Conductivity(gpd/ft²) _____ Specific Capacity(gpm/ft of drawdown) _____

REMARKS Open valve @ 10:45:00, psi dropped to .6. Δs = 4.5 ft. r_w = .25 ft.

Date & hour	Time (min)	Q (gpm)	s_w/Q (ft)	t/r_w^2				
10:45:00								
:30	.5	1.76	2.56	8.0				
10:46:00	1	1.06	4.25	16.0	(?)			
:30	1.5	1.76	2.56	24.0				
10:47:00	2.0	1.58	2.85	32.0				
10:48:00	3.0	1.67	2.70	48.0				
10:49:00	4.0	1.60	2.82	64.0	av. Q = 1.54 gpm			
10:50:00	5.0	1.60	2.82	80.0				
10:55:00	10	1.54	2.93	160.0				
11:00:00	15	1.52	2.96	240.0				
11:05:00	20	1.50	3.00	320.0				
11:10:00	25	1.48	3.04	400				
11:15:00	30	1.48	3.04	480				
11:20:00	35	1.50	3.00	560				
	Shut-in	@ 11:25:00						
Hour	Time(min)	psi	s (ft)					
11:25:10	.167	1.3	3.00					
:20	.33	1.45	3.35					
:30	.5	1.55	3.58					
:40	.66	1.65	3.81					
:50	.833	1.75	4.04					
11:26:00	1	1.80	4.16					
:10	1.167	1.80	4.16					
:30	1.5	1.85	4.28					

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED
(Data Reported On This Form)

WELL TESTED

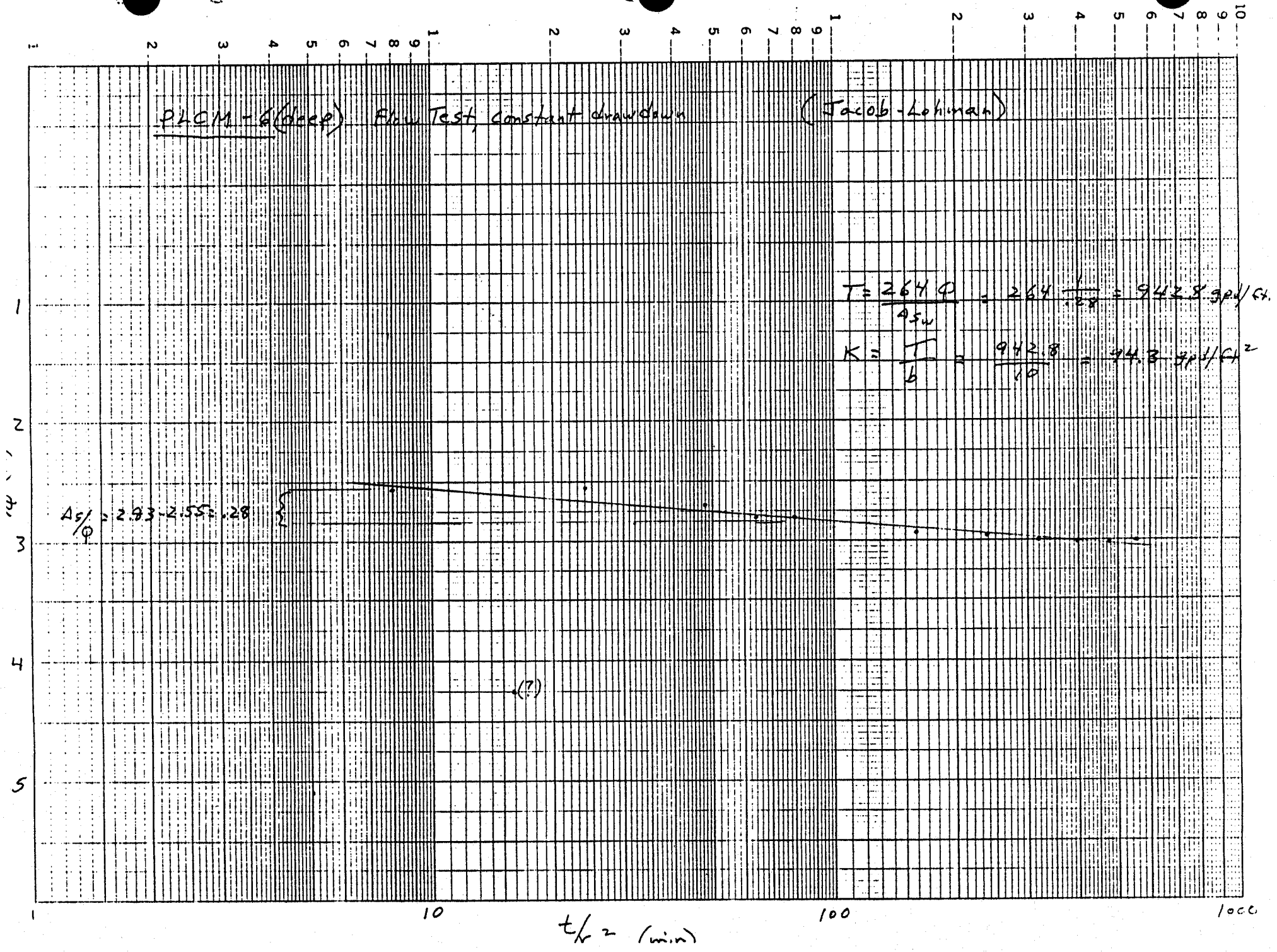
TEST DATE

Project _____ Personnel _____

Date & hour	Time (min)	psi	s (ft)					
11:27:00	2	1.95	4.51					
:30	2.5	1.95	4.51					
11:28:00	3	1.95	4.51					
:30	3.5	2.00	4.62					
11:29:00	4	2.0	4.62					
:30	4.5	2.0	4.62					
11:30:00	5	2.0	4.62					
11:31:00	6	2.0	4.62					
11:32:00	7	2.0	4.62					
11:35:00	10	2.05	4.74					
11:40:00	15	2.1	4.85					
11:50:00	25	2.1	4.85					
12:20:00	55	2.2	5.08					
12:30:00	65	2.4	5.55					
12:43:00	78	2.45	5.66					

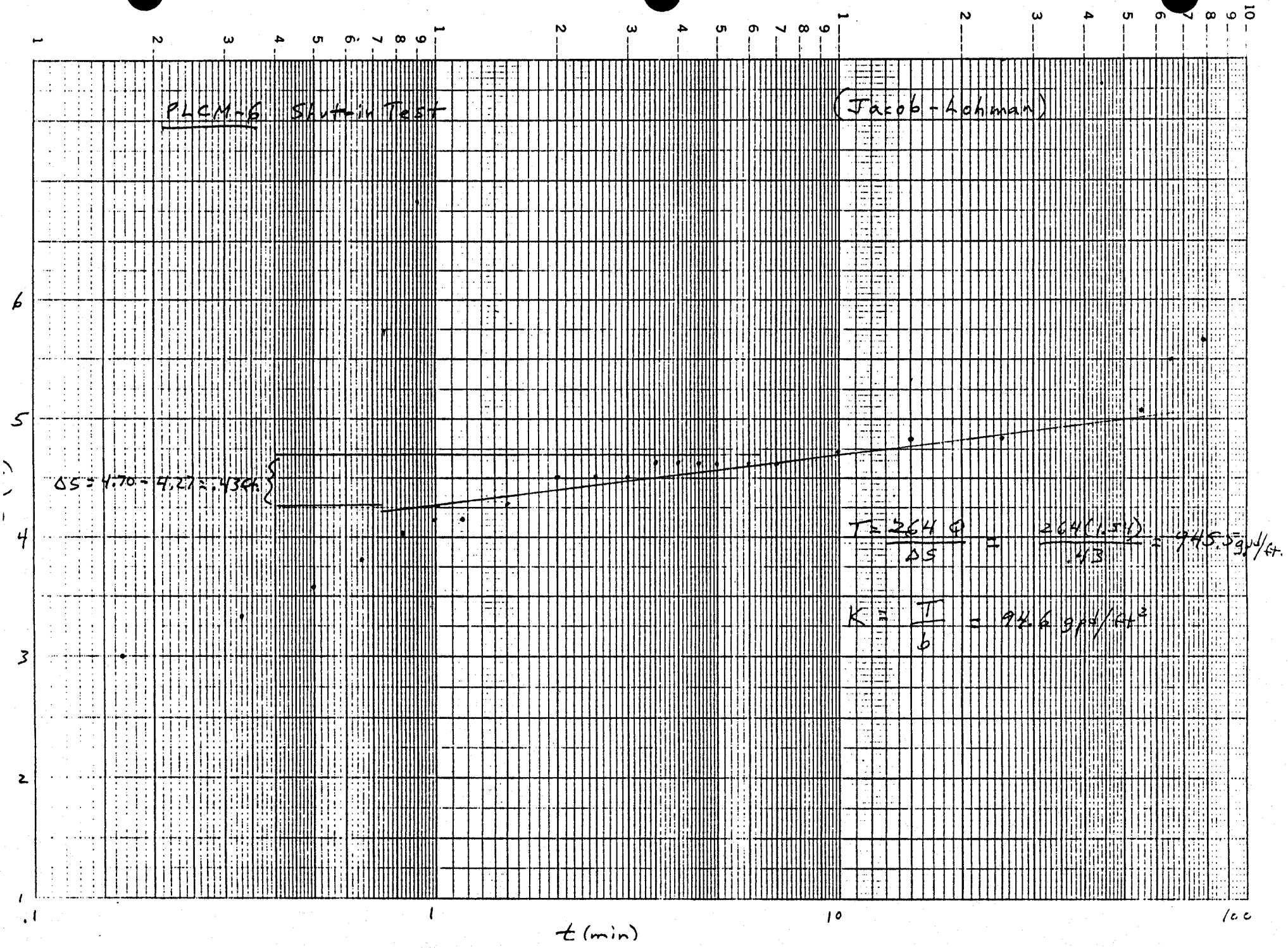
K•E SEMI-LOGARITHMIC 3 CYCLES x 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 5810



K+E SEMI-LOGARITHMIC 3 CYCLES x 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 5810



Northern
Engineering and Testing, Inc.
130 Neill Avenue
P.O. Box 4699
Helena, Montana 59601
(406) 443-5210

AQUIFER TEST DATA

WELL OBSERVED LCTM-8
(Data Reported on This Form)
WELL TESTED LCTM-8
TEST DATE 8/17/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT. County Lincoln Location: T___ R___ Sec. ___ Tract ___

Borehole Diam.(in) 6 Well Diam.(in) 4 Well Depth(ft) 140 Perforated Zone(s)(ft) 45 ft. over 33-93 ft. interval

Desc. of MP ___ Stick-up(ft) ___ SWL below MP(ft) ___ SWL below GS(ft) ___

Aquifer Name ___ Aquifer Description (Lithology, Thickness, Depth to Top) Fluvial channel fill

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ___

Distance of Observation Well from Pumping Well(ft) ___ Pump hp. & type ___ Pump Depth(ft) ___

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ___ Temp(°C) ___ Time ___

Avg. Discharge(gpm) 5.0 Test Duration(min) ___ Max WL Change(ft) ___ Transmissivity (gpd/ft) ___

Storativity ___ Hydraulic Conductivity(gpd/ft^2) ___ Specific Capacity(gpm/ft of drawdown) ___

REMARKS ___

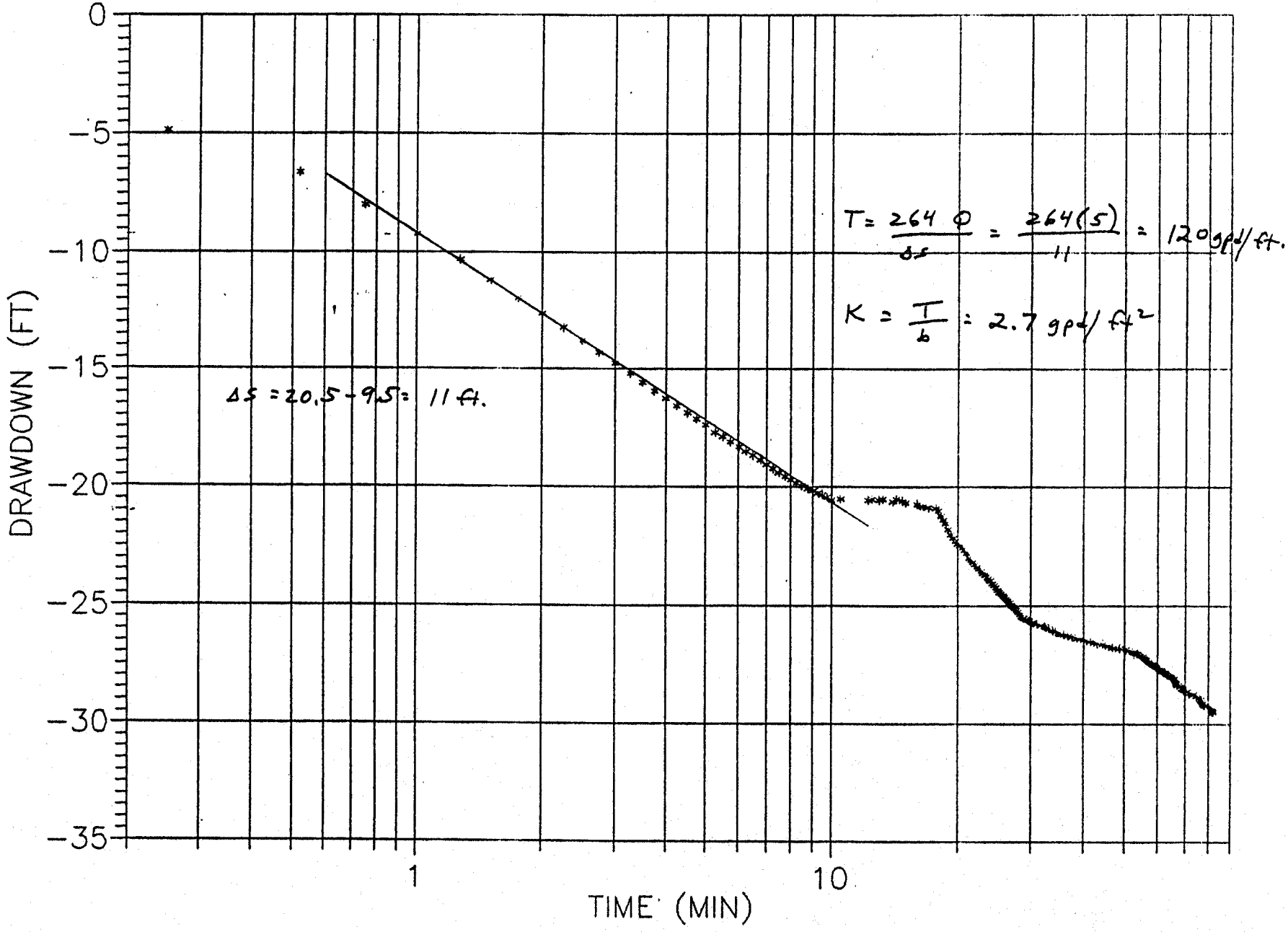
"SECONDS"	"MINUTES"	"DRAWDOWN"	"NEGATIVE DRAWDOWN"
15	.25	4.86	-4.86
31	.52	6.63	-6.63
45	.75	7.99	-7.99
60	1	9.23	-9.23
76	1.27	10.32	-10.32
90	1.5	11.19	-11.19
105	1.75	11.95	-11.95
120	2	12.61	-12.61
135	2.25	13.23	-13.23
150	2.5	13.78	-13.78
165	2.75	14.3	-14.3
180	3	14.76	-14.76
196	3.27	15.21	-15.21
210	3.5	15.58	-15.58
225	3.75	15.94	-15.94
240	4	16.27	-16.27
255	4.25	16.58	-16.58
271	4.52	16.88	-16.88
285	4.75	17.14	-17.14
300	5	17.39	-17.39
316	5.27	17.69	-17.69
330	5.5	17.88	-17.88
345	5.75	18.1	-18.1
361	6.02	18.3	-18.3
375	6.25	18.49	-18.49
390	6.5	18.68	-18.68
406	6.77	18.86	-18.86
420	7	19.05	-19.05
435	7.25	19.22	-19.22
450	7.5	19.38	-19.38
466	7.77	19.54	-19.54
480	8	19.7	-19.7
495	8.25	19.84	-19.84
510	8.5	19.95	-19.95
526	8.77	20.07	-20.07
541	9.02	20.15	-20.15
556	9.27	20.25	-20.25
571	9.52	20.32	-20.32
586	9.77	20.42	-20.42
601	10.02	20.54	-20.54
631	10.52	20.49	-20.49
735	12.25	20.54	-20.54
750	12.5	20.5	-20.5
780	13	20.54	-20.54
795	13.25	20.49	-20.49
840	14	20.59	-20.59
855	14.25	20.5	-20.5
885	14.75	20.56	-20.56
900	15	20.64	-20.64
960	16	20.71	-20.71
975	16.25	20.76	-20.76
991	16.52	20.79	-20.79
1020	17	20.84	-20.84
1065	17.75	20.89	-20.89
1080	18	20.99	-20.99
1095	18.25	21.2	-21.2
1110	18.5	21.36	-21.36
1125	18.75	21.52	-21.52
1140	19	21.75	-21.75

1155	19.25	21.98	-21.98
1170	19.5	22.13	-22.13
1185	19.75	22.26	-22.26
1200	20	22.38	-22.38
1215	20.25	22.46	-22.46
1231	20.52	22.56	-22.56
1246	20.77	22.65	-22.65
1261	21.02	22.79	-22.79
1276	21.27	22.97	-22.97
1291	21.52	23.08	-23.08
1306	21.77	23.16	-23.16
1321	22.02	23.25	-23.25
1336	22.27	23.35	-23.35
1351	22.52	23.45	-23.45
1366	22.77	23.54	-23.54
1380	23	23.63	-23.63
1396	23.27	23.71	-23.71
1411	23.52	23.8	-23.8
1425	23.75	23.87	-23.87
1440	24	23.96	-23.96
1455	24.25	24.06	-24.06
1470	24.5	24.15	-24.15
1485	24.75	24.24	-24.24
1500	25	24.35	-24.35
1515	25.25	24.43	-24.43
1530	25.5	24.51	-24.51
1545	25.75	24.59	-24.59
1560	26	24.65	-24.65
1575	26.25	24.72	-24.72
1590	26.5	24.8	-24.8
1605	26.75	24.88	-24.88
1620	27	24.96	-24.96
1635	27.25	25.03	-25.03
1650	27.5	25.1	-25.1
1665	27.75	25.18	-25.18
1680	28	25.25	-25.25
1695	28.25	25.36	-25.36
1710	28.5	25.45	-25.45
1725	28.75	25.51	-25.51
1755	29.25	25.56	-25.56
1770	29.5	25.59	-25.59
1785	29.75	25.63	-25.63
1816	30.27	25.69	-25.69
1830	30.5	25.72	-25.72
1860	31	25.76	-25.76
1906	31.77	25.82	-25.82
1935	32.25	25.86	-25.86
1951	32.52	25.91	-25.91
1981	33.02	25.96	-25.96
2011	33.52	26.02	-26.02
2026	33.77	26.05	-26.05
2056	34.27	26.1	-26.1
2086	34.77	26.14	-26.14
2116	35.27	26.18	-26.18
2160	36	26.22	-26.22
2206	36.77	26.27	-26.27
2250	37.5	26.31	-26.31
2311	38.52	26.37	-26.37
2355	39.25	26.4	-26.4
2401	40.02	26.44	-26.44

2445	40.75	26.48	-26.48
2490	41.5	26.51	-26.51
2535	42.25	26.55	-26.55
2580	43	26.58	-26.58
2655	44.25	26.62	-26.62
2701	45.02	26.66	-26.66
2746	45.77	26.7	-26.7
2806	46.77	26.74	-26.74
2851	47.52	26.77	-26.77
2926	48.77	26.8	-26.8
3031	50.52	26.85	-26.85
3075	51.25	26.89	-26.89
3135	52.25	26.93	-26.93
3166	52.77	26.96	-26.96
3210	53.5	27	-27
3240	54	27.03	-27.03
3270	54.5	27.08	-27.08
3300	55	27.11	-27.11
3331	55.52	27.16	-27.16
3360	56	27.21	-27.21
3375	56.25	27.24	-27.24
3405	56.75	27.29	-27.29
3435	57.25	27.35	-27.35
3465	57.75	27.4	-27.4
3495	58.25	27.44	-27.44
3525	58.75	27.49	-27.49
3556	59.27	27.52	-27.52
3586	59.77	27.56	-27.56
3616	60.27	27.6	-27.6
3646	60.77	27.66	-27.66
3675	61.25	27.71	-27.71
3705	61.75	27.76	-27.76
3735	62.25	27.8	-27.8
3765	62.75	27.83	-27.83
3795	63.25	27.88	-27.88
3825	63.75	27.92	-27.92
3855	64.25	27.95	-27.95
3885	64.75	27.99	-27.99
3915	65.25	28.02	-28.02
3960	66	28.08	-28.08
3975	66.25	28.14	-28.14
3990	66.5	28.19	-28.19
4005	66.75	28.25	-28.25
4020	67	28.31	-28.31
4035	67.25	28.37	-28.37
4125	68.75	28.41	-28.41
4140	69	28.49	-28.49
4155	69.25	28.52	-28.52
4185	69.75	28.57	-28.57
4290	71.5	28.62	-28.62
4306	71.77	28.7	-28.7
4426	73.77	28.73	-28.73
4485	74.75	28.82	-28.82
4575	76.25	28.87	-28.87
4590	76.5	28.94	-28.94
4605	76.75	28.98	-28.98
4620	77	29.02	-29.02
4635	77.25	29.06	-29.06
4650	77.5	29.1	-29.1
4665	77.75	29.13	-29.13

4680	78	29.17	-29.17
4695	78.25	29.2	-29.2
4830	80.5	29.24	-29.24
4875	81.25	29.33	-29.33
4890	81.5	29.38	-29.38
4905	81.75	29.43	-29.43
4920	82.00	29.48	-29.48

COOPER–JACOB DRAWDOWN PLOT
PUMPING WELL LCTM–8



Northern Engineering and Testing, Inc.
120 Neill Avenue
P.O. Box 4699
Helena, Montana 59601
(406) 442-5270

AQUIFER TEST DATA

WELL OBSERVED _____ (Data Reported on This Form)
WELL TESTED LCM-9
TEST DATE 08/19/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT. County Lincoln Location: T _____ R _____ Sec. _____ Tract _____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 72 Perforated Zone(s)(ft) 57-67

Desc. of MP _____ Stick-up(ft) _____ SWL below MP(ft) _____ SWL below GS(ft) _____

Aquifer Name _____ Aquifer Description (Lithology, Thickness, Depth to Top) Glaciofluvial gravels

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) _____

Distance of Observation Well from Pumping Well(ft) _____ Pump hp. & type _____ Pump Depth(ft) _____

Water Quality Sample Taken? yes no Specific Conductance (μmhos/cm @ 25°C) _____ Temp(°C) _____ Time _____

Avg. Discharge(gpm) _____ Test Duration(min) _____ Max WL Change(ft) _____ Transmissivity (gpd/ft) _____

Storativity _____ Hydraulic Conductivity(gpd/ft²) _____ Specific Capacity(gpm/ft of drawdown) _____

REMARKS 0.4 gal slug

Date & hour	Time (sec)	swl (ft)	neg. drawdown (ft)					
09:59:16	—	21.32	—					
10:00:05	49	25.35	4.03					
:07	51	25.43	4.11					
:14	58	25.38	4.06					
:19	63	25.36	4.04					
:22	66	25.34	4.02					
:26	70	25.31	3.99					
:31	75	25.28	3.96					
:35	79	25.25	3.93					
:40	84	25.22	3.90					
:47	91	25.18	3.86					
:52	96	25.15	3.83					
:59	103	25.11	3.79					
10:01:04	108	25.09	3.77					
:08	112	25.06	3.74					
:13	117	25.03	3.71					
:17	121	25.00	3.68					
:22	126	24.97	3.65					
:26	130	24.95	3.63					
:31	135	24.92	3.60					
:38	142	24.88	3.56					
:43	147	24.85	3.53					
:47	151	24.83	3.51					
:52	156	24.81	3.49					

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED
(Data Reported On This Form)

WELL TESTED

TEST DATE

Project _____ Personnel _____

Date & hour	Time (sec)	SWL (ft)	neg drawdown (ft)					
:59	163	24.77	3.45					
10:02:04	168	24.72	3.40					
:08	172	24.68	3.36					
:10	174	24.66	3.34					
:13	177	24.63	3.31					
:16	180	24.60	3.28					
:19	183	24.58	3.26					
:23	187	24.53	3.21					
:28	192	24.50	3.18					
:31	195	24.48	3.16					
:35	199	24.43	3.11					
:40	204	24.40	3.08					
:43	207	24.38	3.06					
:47	211	24.35	3.03					
:50	214	24.32	3.00					
:55	219	24.29	2.97					
:59	223	24.26	2.94					
10:03:04	228	24.23	2.91					
:11	235	24.18	2.86					
:16	240	24.14	2.82					
:20	244	24.11	2.79					
:25	249	24.09	2.77					
:32	256	24.04	2.72					
:37	261	24.00	2.68					
:41	265	23.98	2.66					

LCM-9 Slug Injection (.4 gal) (Bouwer-Rice)

$r_c = .083$ ft. $A = 2.5$

$r_w = .292$ ft. $B = .3$

$L = 10$ ft. $C = 2.1$

$H = 55.72$ ft.

$L/r_w = 34.25$ ft.

D >> H

$$\ln R_e/r_w = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B\ln[(D-H)/r_w]}{L/r_w}\right]^{-1} = 2.98$$

D = H

$$\ln R_e/r_w = \left(\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right)^{-1} = 3.69$$

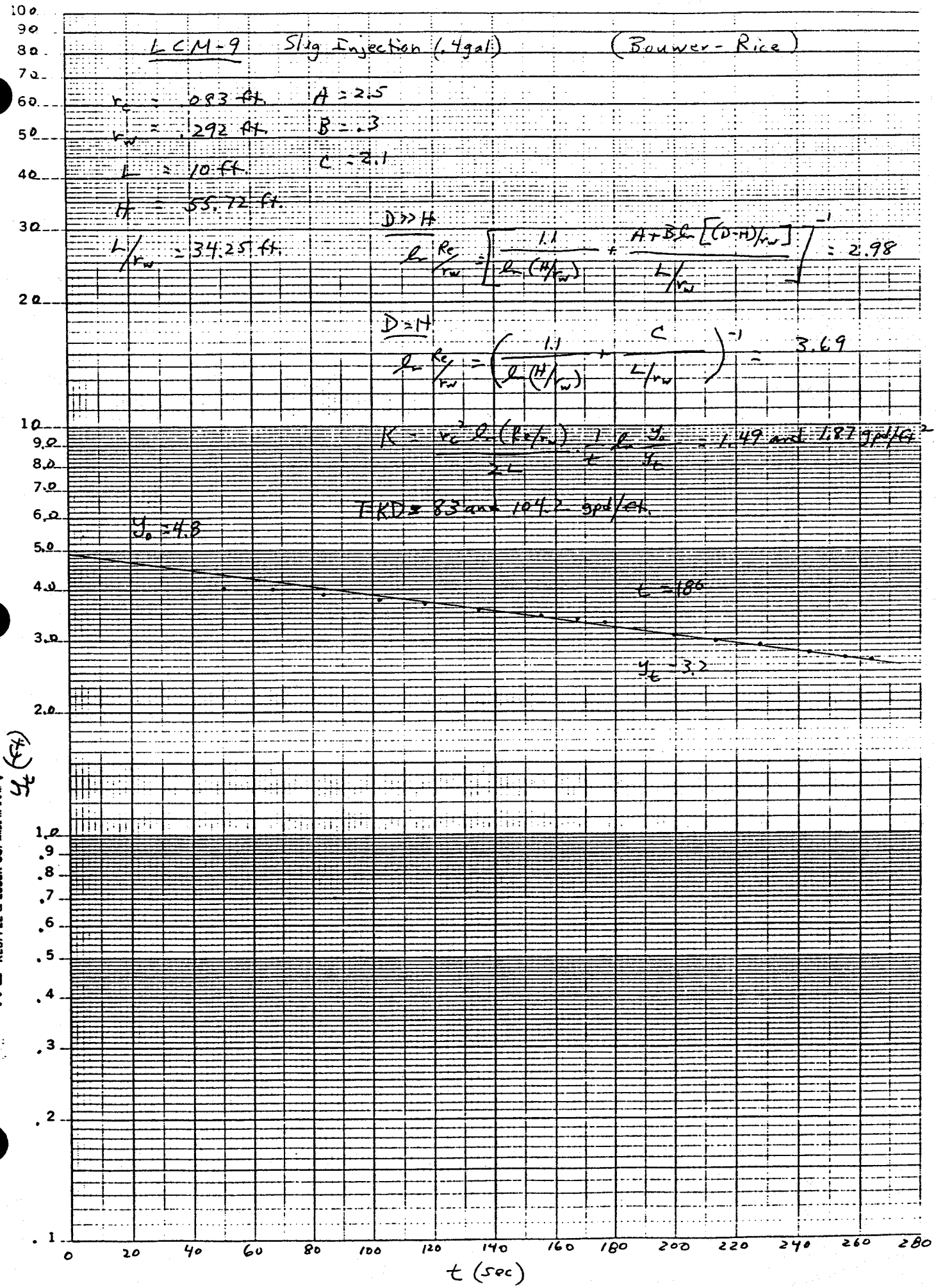
$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_t} = 1.49 \text{ and } 1.87 \text{ gpd/ft}^2$$

T = KD = 83 and 104.2 gpd/ft.

$y_0 = 4.8$

$t = 180$

$y_t = 3.2$



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P.O. Box 4699
Helena, Montana 59601
(406) 443-5210

AQUIFER TEST DATA

WELL OBSERVED (Data Reported on This Form) _____
WELL TESTED LCM-10
TEST DATE 08/19/88

Project Montana Silver Venture Personnel Dunlavy

WELL DESCRIPTION

State MT. County Lincoln Location: T _____ R _____ Sec. _____ Tract _____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 40 Perforated Zone(s)(ft) 25-40

Desc. of MP _____ Stick-up(ft) _____ SWL below MP(ft) _____ SWL below GS(ft) _____

Aquifer Name _____ Aquifer Description (Lithology, Thickness, Depth to Top) Colluvium

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) _____

Distance of Observation Well from Pumping Well(ft) _____ Pump hp. & type _____ Pump Depth(ft) _____

Water Quality Sample Taken? yes no Specific Conductance (μmhos/cm @ 25°C) _____ Temp(°C) _____ Time _____

Avg. Discharge(gpm) _____ Test Duration(min) _____ Max WL Change(ft) _____ Transmissivity (gpd/ft) _____

Storativity _____ Hydraulic Conductivity(gpd/ft²) _____ Specific Capacity(gpm/ft of drawdown) _____

REMARKS 0.4 gal slug

Date & hour	Time (min)	swl (ft)	neg drawdown (ft)					
08:56:19	—	18.26	—					
08:57:04	.75	22.41	4.15					
:08	.82	22.16	3.90					
:11	.87	22.14	3.88					
:29	1.17	22.11	3.85					
:47	1.47	22.08	3.82					
08:58:07	1.80	22.06	3.80					
:14	1.92	22.03	3.77					
:49	2.50	22.01	3.75					
08:59:26	3.12	21.99	3.73					
:53	3.57	21.97	3.71					
09:00:43	4.40	21.94	3.68					
09:01:22	5.05	21.92	3.66					
09:02:05	5.77	21.90	3.64					
09:02:53	6.57	21.88	3.62					
09:03:32	7.22	21.86	3.60					
09:04:29	8.17	21.84	3.58					
09:05:16	8.95	21.82	3.56					
09:06:07	9.80	21.80	3.54					
09:06:56	10.62	21.78	3.52					
09:07:35	11.27	21.75	3.49					
09:08:05	11.77	21.73	3.47					
09:09:05	12.77	21.71	3.45					
09:09:07	12.80	21.73	3.47					

AQUIFER TEST DATA
(Cont.)

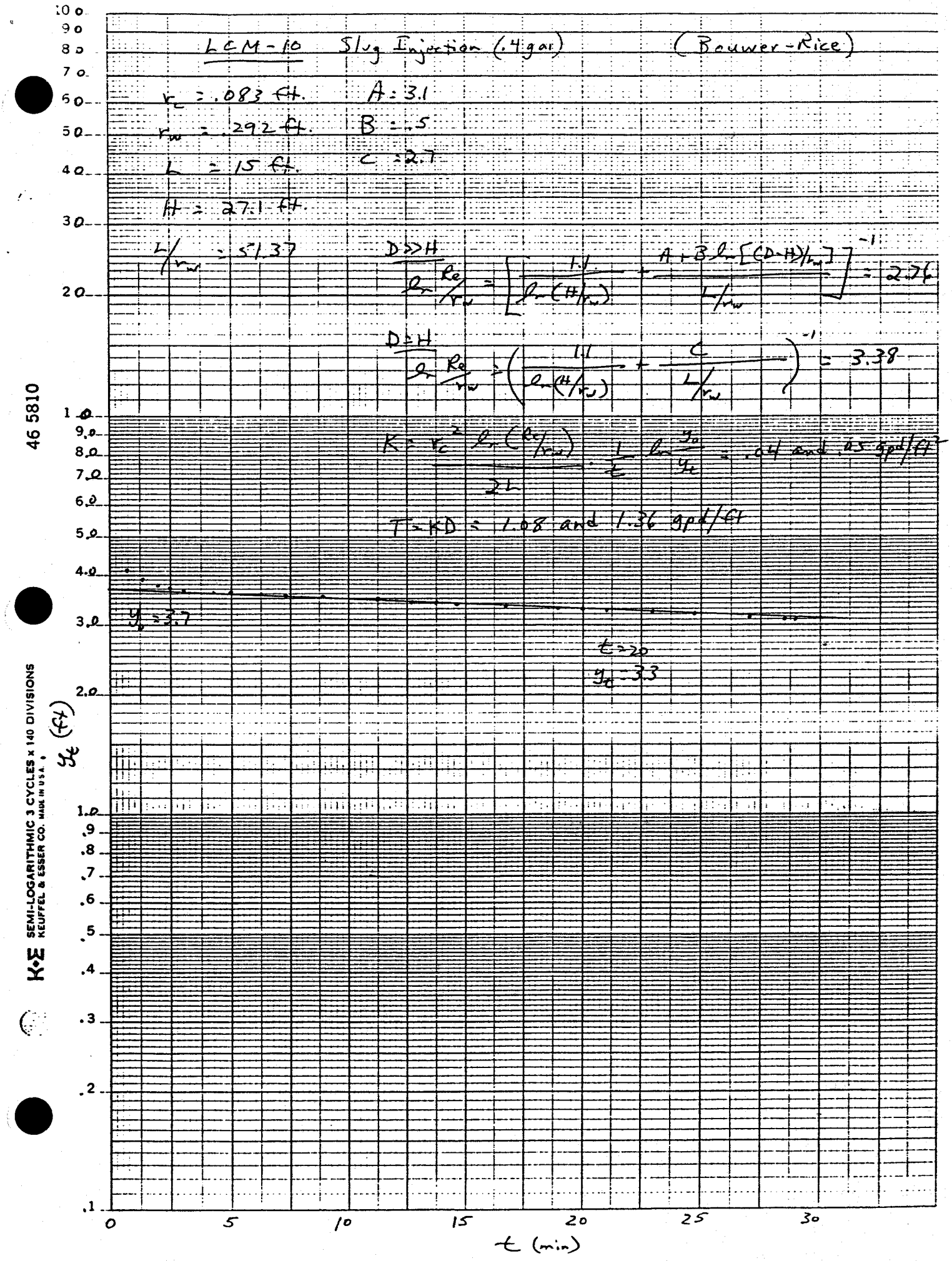
WELL OBSERVED _____
(Data Reported On This Form)

WELL TESTED _____

TEST DATE _____

Project _____ Personnel _____

Date & hour	Time (min)	swl (ft)	neg drawdown (ft)					
09:09:11	12.87	21.71	3.45					
09:10:05	13.77	21.68	3.42					
:07	13.80	21.70	3.44					
:11	13.87	21.68	3.42					
:13	13.90	21.70	3.44					
:17	13.97	21.68	3.42					
09:11:05	14.77	21.66	3.40					
:59	15.67	21.64	3.38					
09:13:08	16.82	21.62	3.36					
:59	17.67	21.60	3.34					
09:15:23	19.07	21.58	3.32					
:25	19.10	21.61	3.35					
:37	19.30	21.59	3.33					
09:16:22	20.05	21.56	3.30					
09:17:11	20.87	21.54	3.28					
:13	20.90	21.57	3.31					
:16	20.95	21.55	3.29					
:59	21.67	21.53	3.27					
09:19:19	23.00	21.51	3.25					
09:20:22	24.05	21.49	3.23					
09:21:02	24.72	21.47	3.21					
09:22:22	26.05	21.44	3.18					
09:23:17	26.97	21.42	3.16					
09:24:47	28.47	21.39	3.13					
09:25:02	28.72	21.42	3.16					
:10	28.85	21.39	3.13					


LCM-10 Slug Injection (.4 gal) (Bouwer-Rice)
r_c = .083 ft. A = 3.1
r_w = .292 ft. B = .5
L = 15 ft. C = 2.7
H = 27.1 ft.
L/r_w = 51.37
D >> H
$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w}\right]^{-1} = 2.76$
D = H
$\ln \frac{R_e}{r_w} = \left(\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right)^{-1} = 3.38$
$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_t}$ = .04 and .05 gpd/ft²
T = KD = 1.08 and 1.36 gpd/ft
y_0 = 3.7
t = 20
y_t = 3.3
y_t (ft)
t (min)
0
5
10
15
20
25
30
100
90
80
70
60
50
40
30
20
10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
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AQUIFER TEST DATA

WELL OBSERVED (Data Reported on This Form) _____
WELL TESTED LCM-11
TEST DATE 08/15/88

Project Montana Silver Venture Personnel Dunlary

WELL DESCRIPTION

State MT. County Lincoln Location: T _____ R _____ Sec. _____ Tract _____

Borehole Diam.(in) 6 Well Diam.(in) 2 Well Depth(ft) 62.5 Perforated Zone(s)(ft) 57-62

Desc. of MP _____ Stick-up(ft) _____ SWL below MP(ft) _____ SWL below GS(ft) _____

Aquifer Name _____ Aquifer Description (Lithology, Thickness, Depth to Top) _____

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) _____

Distance of Observation Well from Pumping Well(ft) _____ Pump hp. & type _____ Pump Depth(ft) _____

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) _____ Temp(°C) _____ Time _____

Avg. Discharge(gpm) _____ Test Duration(min) _____ Max WL Change(ft) _____ Transmissivity (gpd/ft) _____

Storativity _____ Hydraulic Conductivity(gpd/ft²) _____ Specific Capacity(gpm/ft of drawdown) _____

REMARKS 0.4 gal slug

Date & hour	Time (min)	SWL (ft.)	neg. drawdown (ft.)					
18:17:24	0.00	17.44	—					
18:18:20	0.93	21.66	4.22					
:24	1.00	21.68	4.24					
:55	1.52	21.66	4.22					
18:19:19	1.92	21.64	4.20					
:34	2.17	21.62	4.18					
18:20:00	2.60	21.59	4.15					
:29	3.08	21.56	4.12					
:59	3.58	21.54	4.10					
18:21:14	3.83	21.51	4.07					
:44	4.33	21.49	4.05					
18:22:19	4.92	21.47	4.03					
:44	5.33	21.44	4.00					
18:23:04	5.67	21.42	3.98					
:39	6.25	21.39	3.95					
18:24:04	6.67	21.37	3.93					
:24	7.00	21.35	3.91					
:49	7.42	21.32	3.88					
18:25:09	7.75	21.30	3.86					
:44	8.33	21.26	3.82					
18:25:59	8.58	21.24	3.80					
18:26:10	8.77	21.22	3.78					
:25	9.02	21.19	3.75					
:40	9.27	21.17	3.73					

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED
(Data Reported On This Form)

WELL TESTED

TEST DATE

Project _____ Personnel _____

Date & hour	Time (min)	SWL (ft)	neg. drawdown (ft.)					
:55	9.52	21.15	3.71					
18:27:10	9.77	21.12	3.68					
:25	10.02	21.09	3.65					
:40	10.27	21.07	3.63					
:55	10.52	21.04	3.60					
18:28:14	10.93	21.02	3.58					
:35	11.18	20.99	3.55					
:54	11.50	20.96	3.52					
18:29:05	11.68	20.94	3.50					
:24	12.00	20.92	3.48					
:44	12.33	20.90	3.46					
:59	12.58	20.88	3.44					
18:30:20	12.93	20.86	3.42					
:40	13.27	20.83	3.39					
:59	13.58	20.81	3.37					
18:31:20	13.93	20.79	3.35					
:39	14.25	20.77	3.33					
:54	14.50	20.75	3.31					
18:32:15	14.85	20.73	3.29					
:35	15.18	20.71	3.27					
:54	15.50	20.69	3.25					
18:33:14	15.83	20.67	3.23					
:25	16.02	20.65	3.21					
:54	16.50	20.63	3.19					
18:34:15	16.85	20.60	3.16					
:40	17.27	20.58	3.14					

LCM-11 Slug Injection (.4 gal) (Bouwer - Rice)

$r_c = .083$ ft. $A = 2$

$r_w = .292$ ft. $B = .3$

$L = 5$ ft. $C = 1.5$

$H = 48.7$ ft.

$L/r_w = 17.12$

$D \gg H$

$$\ln R_e/r_w = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B\ln[(D-H)/r_w]}{L/r_w}\right]^{-1} = 2.29$$

$D = H$

$$\ln R_e/r_w = \left(\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right)^{-1} = 3.30$$

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_t} = .39 \text{ and } .58 \text{ gpd/ft}^2$$

$T = KD = 18.99$ and 28.25 gpd/ft.

$y_0 = 4.6$

$t = 12$

$y_t = 3.5$

y_t (ft)

t (min)

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Chen-Northern, Inc.

APPENDIX J

APPENDICES

J1 AND J2

APPENDIX J1

GROUNDWATER DATABASE

COMPARABILITY

As stated in the discussion presented in Appendix G4, comparability is assessed to insure data developed during the investigation are comparable to existing data. Chen-Northern has collected the only known groundwater quality data in the Montana Project study area, and therefore, no comparisons can be made.

COMPLETENESS

Completeness was assessed by comparing the number of valid samples to the number of samples collected and to the number of samples planned. Valid samples are those which have not exceeded holding times and were collected by approved methods.

Table J-1 presents completeness data for four groundwater sampling episodes. As proposed, the 80% completeness criterion was met for the four quarterly sampling events.

TABLE J-1

GROUNDWATER COMPLETENESS SUMMARY FOR SAMPLES
COLLECTED DURING AUGUST AND OCTOBER, 1988; JANUARY AND MARCH, 1989

	NATURAL SAMPLES	FIELD REPLICATES	CROSS-CONTAMINATION BLANK	BOTTLE BLANK	BLIND FIELD STANDARDS	TOTAL
Number of samples proposed	40	4	4	4	4	56
Number of samples collected	37	4	4	4	4	53
Percent valid samples	100	100	100	100	100	100
Percent completeness	93	100	100	100	100	98.6

Notes:

The springs SP-4 and SP-5 have been excluded from the winter quarter sampling program. Artesian wells were frozen during January, 1989 and could not be sampled.

Revised -- JUNE 23, 1989

REPRESENTATIVENESS

As discussed in Appendix G4, representativeness is the detection of bias due to contamination of bottle blanks and/or cross-contamination blanks which have been analyzed with natural samples.

In groundwater sample blanks, contamination was present in various parameters, including cadmium, mercury, zinc, nitrate + nitrite as N, and fluoride. Suspect data are flagged in accordance with the method described in Appendix G4, and data will be flagged with a "A" if the detected value in the natural sample is equal to or less than 1.5 times the highest level in the associated blank.

ACCURACY

As stated in the discussion presented in Appendix G-4, a laboratory accuracy statement was prepared using blind field standards as quality control samples to assess laboratory accuracy. Blind field standards used in this investigation are certified standards prepared by the U.S. Environmental Protection Agency. Blind field samples were submitted into the groundwater sample train at a frequency of one sample per sampling episode. Quantitative methods used to determine accuracy are presented in Appendix G-4.

The groundwater accuracy statement presented in Table J-2, contains the total number of standards submitted for analysis, average percent recovery, maximum uncertainty, and completeness for each parameter. A target of an 80% confidence level with +/- 20% deviation was met for all parameters.

TABLE 3 NORANDA MONTANA PROJECT GROUNDWATER DATA VALIDATION STATEMENTS

05/24/89 16:38:39

	Parameter	ACCURACY # Samples	ACCURACY Accuracy (Average % Recovered)	ACCURACY Maximum Uncertainty (+/- %)	ACCURACY Completeness (%)	PRECISION Precision (%)	PRECISION # Samples	PRECISION Maximum Uncertainty (+/- %)	PRECISION Completeness (%)
1	Alkalinity, total	4	98.46	2.2	100.0	0.00	4	4.3652	100
2	Aluminum	3	87.14	9.0	75.0	0.00	4	0.0000	100
3	Arsenic	3	92.87	9.9	75.0	0.00	4	0.0000	100
4	Cadmium	3	107.42	21.7	75.0	-46.67	4	134.5296	100
5	Calcium	4	97.48	13.7	100.0	4.84	4	15.2772	100
6	Chloride	4	93.96	2.1	100.0	0.00	4	0.0000	100
7	Chromium	3	104.68	14.5	75.0	0.00	4	0.0000	100
8	Copper	3	93.05	2.9	75.0	0.00	4	0.0000	100
9	Fluoride	4	88.49	9.7	100.0	5.45	4	43.0596	100
10	Iron	3	105.03	15.1	75.0	0.00	4	0.0000	100
11	Lead	3	125.20	36.7	75.0	0.00	4	0.0000	100
12	Magnesium	4	88.53	8.6	100.0	3.85	4	15.0769	100
13	Manganese	3	104.29	5.7	75.0	0.00	4	0.0000	100
14	Mercury	3	102.57	68.6	75.0	-10.00	4	39.2000	100
15	Molybdenum	0	(1)	(1)	---	0.00	4	0.0000	100
16	Nitrate	3	92.85	14.3	75.0	10.44	4	42.3711	100
17	Potassium	4	90.00	9.8	100.0	0.00	4	0.0000	100
18	Silver	0	(1)	(1)	---	0.00	4	0.0000	100
19	Sodium	4	102.62	9.5	100.0	52.22	4	136.2809	100
20	Sulfate	4	72.51	35.7	100.0	21.43	4	84.0000	100
21	Total Dissolved Solids	4	101.50	8.2	100.0	1.37	4	17.4255	100
22	Zinc	3	106.35	5.4	75.0	0.00	4	0.0000	100

NOTES: 1) The blind field standard was not formulated for this parameter.
2) All values were below the detection level of the instrument.

Revised -- JUNE 23, 1989

PRECISION

A precision statement was developed using field duplicates collected for each parameter during groundwater sampling episodes. Again, due to the small size of the data set, groundwater data were evaluated for precision using qualitative techniques.

As discussed in the QA/QC program (Appendix C p.12) ranges of duplicate values are determined using laboratory acceptance criteria. Duplicate values outside of the range for the August, 1988 sampling were calcium, sodium, and cadmium. The October, 1988 duplicate values were all within appropriate laboratory acceptance criteria, the exception of cadmium.

APPENDIX J2

GROUNDWATER DATA VALIDATION

NORANDA MONTANA PROJECT GROUNDWATER DATA 05/24/89

FIELD MEASUREMENTS:

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Static Water Level (ft)	Discharge (CFS)	Water Temperature (C)	Field Eh (mV)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
BB -100	08-19-88	1045	BB	93908	GRAB	--	--	--	--	--	6.4	--	2
BFSGW-001	08-11-88	--	BFS	93910	GRAB	--	--	--	--	--	7.5	--	269
CC -100	08-19-88	1100	CCB	93909	GRAB	--	--	--	--	--	6.3	--	2
LCM -009	08-19-88	0930	N	93907	GRAB	-12.90	--	10.0	+240	7.2	7.2	202	208
LCM -010	08-16-88	1630	N	93897	GRAB	-16.00	--	9.0	+230	6.9	7.4	154	156
LCM -011	08-15-88	1730	N	93896	GRAB	-16.52	--	11.0	+170	9.0	9.0	240	244
LCTM -008	08-17-88	1620	N	93899	GRAB	-14.90	--	11.0	+220	7.1	7.2	186	193
PLCM -6DP	08-18-88	1315	D	93902	GRAB	+2.55	--	8.0	--	7.2	7.8	170	179
PLCM -6DP	08-18-88	1300	N	93901	GRAB	+2.55	--	8.0	+260	7.1	7.8	180	177
PLCM -6SH	08-18-88	1245	N	93900	GRAB	-9.88	--	8.0	+180	8.9	8.7	196	208
PM -002	08-16-88	1840	N	93898	GRAB	-17.55	--	10.0	+250	6.2	7.1	124	124
PM -003	08-18-88	1630	N	93904	GRAB	-16.31	--	9.0	+260	6.8	7.2	170	179
PM -005	08-18-88	1545	N	93903	GRAB	+5.50	--	11.0	+245	7.5	7.7	335	349
SP -004	08-18-88	1200	N	93906	GRAB	--	0.02	7.0	+290	7.4	7.5	24	33
SP -005	08-16-88	1000	N	93905	GRAB	--	0.01	8.5	+280	7.1	7.6	31	25

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample, BFS - blind field standard.
2) Sampling Method: GRAB - grab sample, see SOP-18.
3) Static water level given in feet below top of casing.
4) "--" indicates that data was not collected.

NORANDA MONTANA PROJECT GROUNDWATER DATA 05/24/89 Run 7

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
BB -100	08-19-88	BB	0.1U	0.005U	0.001	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
BFSGW-001	08-11-88	BFS	0.5	0.10	0.021	0.09	0.097	0.09	0.104	0.10	0.0059	0.05U	0.001U	0.10
CC -100	08-19-88	CCB	0.1U	0.005U	0.001	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
LCM -009	08-19-88	N	0.1U	0.005U	0.003BCR	0.02U	0.02U	0.05U	0.01U	0.76	0.0002U	0.05U	0.001	0.21
LCM -010	08-16-88	N	0.1U	0.005U	0.001BCRZ	0.02U	0.02U	0.05U	0.01U	0.33	0.0002U	0.05U	0.001U	0.02U
LCM -011	08-15-88	N	0.1U	0.005U	0.001UBCRZ	0.02U	0.02U	0.05U	0.01U	0.81	0.0002U	0.05U	0.001U	0.02U
LCTM -008	08-17-88	N	0.1U	0.005U	0.006BCR	0.02U	0.02U	0.05U	0.01U	0.14	0.0002U	0.05U	0.001U	0.20
PLCM -6DP	08-18-88	D	0.1U	0.005U	0.004BCR	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
PLCM -6DP	08-18-88	N	0.1U	0.005U	0.001BCRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
PLCM -6SH	08-18-88	N	0.1U	0.005	0.002BCR	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
PM -002	08-16-88	N	0.1U	0.005U	0.002BCR	0.02U	0.03	0.05U	0.01U	0.03	0.0002U	0.05U	0.001U	0.23
PM -003	08-18-88	N	0.1U	0.005U	0.002BCR	0.02U	0.02U	0.05U	0.01U	0.02	0.0002U	0.05U	0.001U	0.02
PM -005	08-18-88	N	0.1U	0.005U	0.001BCRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001	0.02U
SP -004	08-18-88	N	0.1U	0.005U	0.001UBCRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
SP -005	08-16-88	N	0.1U	0.005U	0.001BCRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not usable for statistics.

FIELD MEASUREMENTS:

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Static Water Level (ft)	Discharge (CFS)	Water Temperature (C)	Field Eh (mV)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
BB -100	10-21-88	1445	BB	94622	GRAB	--	--	--	--	--	6.6	--	6
BFSGW-100	10-24-88	--	BFS	94630	GRAB	--	--	--	--	--	7.7	--	265
CC -100	10-22-88	1345	CCB	94625	GRAB	--	--	10.0	+220	6.1	6.4	0	5
LCM -009	10-21-88	1545	N	94623	GRAB	-14.04	--	9.5	+90	7.1	7.2	184	196
LCM -010	10-22-88	1615	N	94617	GRAB	-16.33	--	6.5	+170	7.6	7.6	150	154
LCM -011	10-22-88	1720	N	94627	GRAB	-15.55	--	7.0	+170	8.4	8.5	173	189
LCTM -008	10-22-88	--			--	--	--	--	--	--	--	--	--
PLCM -6DP	10-21-88	1150	N	94619	GRAB	+2.50	--	6.5	+230	7.3	7.8	168	176
PLCM -6DP	10-21-88	1210	D	94620	GRAB	+5.8	--	6.5	+246	7.3	7.8	162	178
PLCM -6SH	10-21-88	1350	N	94618	GRAB	-10.00	--	9.0	+68	8.1	8.1	161	198
PM -002	10-22-88	1500	N	94626	GRAB	-17.70	--	9.0	+200	6.6	7.3	109	116
PM -003	10-22-88	1315	N	94624	GRAB	-16.60	--	9.0	+240	6.6	7.0	174	180
PM -005	10-21-88	1450	N	94621	GRAB	+12.7	--	9.0	+72	7.6	7.8	319	346
SP -004	10-18-88	1145	N	94628	GRAB	--	0.044	7.0	--	6.8	7.4	27	27
SP -005	10-20-88	1220	N	94629	GRAB	--	0.05	--	--	7.5	7.4	18	26

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample, BFS - blind field standard.
2) Sampling Method: GRAB - grab sample, see SOP-18.
3) Static water level given in feet below top of casing.
4) "--" indicates that data was not collected.

NORANDA MONTANA PROJECT GROUNDWATER DATA

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Holyb-denum	Total Recov. Silver	Total Recov. Zinc
BB -100	10-21-88	BB	0.1U	0.005U	0.001	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
BFSGW-100	10-24-88	BFS	0.44	0.096	0.024	0.10	0.09	0.11	0.100	0.11	0.0049	0.05U	0.001U	0.11
CC -100	10-22-88	CCB	0.1U	0.005U	0.001U	0.02U	0.02U	0.05U	0.01U	0.02U	0.0004	0.05U	0.001U	0.02
LCM -009	10-21-88	N	0.8	0.005U	0.002BR	0.02U	0.02U	0.55	0.01U	0.13	0.0002CZ	0.05U	0.001U	0.02UCZ
LCM -010	10-22-88	N	0.1U	0.005U	0.001BRZ	0.02U	0.02U	0.07	0.01U	1.09	0.0003CZ	0.05U	0.001U	0.02UCZ
LCM -011	10-22-88	N	0.01U	0.005U	0.001UBRZ	0.02U	0.02U	0.05U	0.01U	0.02	0.0002UCZ	0.05U	0.001U	0.02UCZ
LCTM -008	10-22-88													
PLCM -6DP	10-21-88	N	0.1U	0.005U	0.001UBRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002CZ	0.05U	0.001U	0.02UCZ
PLCM -6DP	10-21-88	D	0.1U	0.005U	0.002BR	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002CZ	0.05U	0.001U	0.02UCZ
PLCM -6SH	10-21-88	N	0.2	0.005U	0.002UBR	0.02U	0.02U	0.14	0.01U	0.02U	0.0003CZ	0.05U	0.001U	0.02UCZ
PM -002	10-22-88	N	0.1U	0.005U	0.002BR	0.02U	0.02U	0.05U	0.01U	0.11	0.0002UCZ	0.05U	0.001	0.02UCZ
PM -003	10-22-88	N	0.1U	0.005U	0.002BR	0.02U	0.02U	0.07	0.01U	0.02U	0.0004UCZ	0.05U	0.001U	0.02UCZ
PM -005	10-21-88	N	0.1U	0.005U	0.001BRZ	0.03	0.02U	0.05U	0.01U	0.03	0.0002CZ	0.05U	0.001U	0.03C
SP -004	10-18-88	N	0.1U	0.005U	0.001BRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002UCZ	0.05	0.001U	0.02UCZ
SP -005	10-20-88	N	0.1U	0.005U	0.001BRZ	0.02U	0.02U	0.05U	0.01U	0.02U	0.0002UCZ	0.05U	0.001U	0.02UCZ

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not usable for statistics.

NORANDA MONTANA PROJECT GROUNDWATER DATA 05/24/89

FIELD MEASUREMENTS:

STATION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE	LAB NUMBER	SAMPLING METHOD	Static Water Level (ft)	Discharge (CFS)	Water Temperature (C)	Field Eh (mV)	Field pH	Lab pH	Specific Conductance (umhos/cm) Field	Lab
BB -100	1-26-89	2000	BB	95670	GRAB	--	--	19.0	--	4.8	4.0	10	7
BFSGW-100	12-2-88	0930	BFS	95675	GRAB	--	--	--	--	--	6.4	--	272
CC -100	1-26-89	2100	CCB	95677	GRAB	--	--	19.0	--	4.9	4.6	10	8
LCH -009	1-26-89	1330	N	95667	GRAB	-11.60	--	8.0	--	7.0	6.3	154	186
LCH -010	1-26-89	1630	N	95673	GRAB	-8.6	--	6.0	--	7.5	6.9	154	181
LCH -011	1-26-89	1445	N	95674	GRAB	-7.4	--	9.0	--	8.1	7.4	98	120
LCTH -008	1-26-89	0930	N	95676	GRAB	-12.90	--	8.0	--	7.2	6.7	156	179
PLCH -6DP	--	--		--	--	--	--	--	--	--	--	--	--
PLCH -6SH	1-25-89	1030	N	95669	GRAB	-6.2	--	8.0	--	7.9	7.2	161	188
PM -002	1-25-89	1400	N	95671	GRAB	-15.85	--	8.0	--	7.1	6.3	98	113
PM -002	1-25-89	1445	D	95668	GRAB	-15.85	--	9.0	--	7.1	6.3	98	115
PM -003	1-25-89	0900	N	95672	GRAB	-16.70	--	9.0	--	7.0	6.3	149	174
PM -005	--	--		--	--	--	--	--	--	--	--	--	--
SP -004	--	--		--	--	--	--	--	--	--	--	--	--
SP -005	--	--		--	--	--	--	--	--	--	--	--	--

NOTES: 1) Sample Type: BB - bottle blank, CCB - cross-contamination blank, D - duplicate sample, N - natural sample, BFS - blind field standard.
2) Sampling Method: GRAB - grab sample, see SOP-18.
3) Static water level given in feet below top of casing.
4) "--" indicates that data was not collected.

TRACE METALS:

STATION	SAMPLE DATE	SAMPLE TYPE	Total Recov. Aluminum	Total Recov. Arsenic	Total Recov. Cadmium	Total Recov. Chromium	Total Recov. Copper	Total Recov. Iron	Total Recov. Lead	Total Recov. Manganese	Total Recov. Mercury	Total Recov. Molyb-denum	Total Recov. Silver	Total Recov. Zinc
BB -100	1-26-89	BB	--	--	--	--	--	--	--	--	--	--	--	--
BFSGW-100	12-2-88	BFS	0.4	0.080	0.032	0.12	0.092	0.12	0.17	0.10	0.0044	0.05U	0.001U	0.11
CC -100	1-26-89	CCB	0.1U	0.005U	0.001	0.02U	0.01U	0.05U	0.01U	0.02U	0.0002U	0.05U	0.001U	0.02U
LCH -009	1-26-89	N	0.1U	0.005U	0.001ACZ	0.02U	0.01U	0.05U	0.01UAZ	0.02U	0.0002U	0.05U	0.001U	0.02U
LCH -010	1-26-89	N	0.1U	0.005U	0.001ACZ	0.02U	0.01U	0.05U	0.01UAZ	0.71	0.0002U	0.05U	0.001U	0.02U
LCH -011	1-26-89	N	0.1U	0.005U	0.001UACZ	0.02U	0.01U	0.05U	0.01UAZ	0.02U	0.0002U	0.05U	0.001U	0.02U
LCTH -008	1-26-89	N	0.1U	0.005U	0.004ACZ	0.02U	0.01U	0.05U	0.01UAZ	0.14	0.0002U	0.05U	0.001U	0.02U
PLCH -6DP	--													
PLCH -6SH	1-25-89	N	0.1U	0.005U	0.001ACZ	0.02U	0.01U	0.05U	0.01UAZ	0.02U	0.0002U	0.05U	0.001U	0.02U
PH -002	1-25-89	N	0.1U	0.005U	0.002ACZ	0.02U	0.01U	0.05U	0.01UAZ	0.04	0.0002U	0.05U	0.001U	0.02U
PH -002	1-25-89	D	0.1U	0.005U	0.002UACZ	0.02U	0.01U	0.05U	0.01UAZ	0.04	0.0003	0.05U	0.001U	0.02U
PH -003	1-25-89	N	0.1U	0.005U	0.001ACZ	0.02U	0.01U	0.05U	0.01UAZ	0.02U	0.0002U	0.05U	0.001U	0.02U
PH -005	--													
SP -004	--													
SP -005	--													

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - values are given in mg/L unless otherwise noted.
R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not usable for statistics.

STATION	SAMPLE DATE	SAMPLE TYPE	Total Hardness as CaCO3 **	Calcium	Magnesium	Sodium	Potassium	Total as CaCO3	Bicarbonate as HCO3	Carbonate as CO3	Sulfate	Chloride	Fluoride	Nitrate & Nitrite as N	Total Dissolved Solids
			<---------- COMMON IONS ----------					<----- ALKALINITY ----->					OTHERS:		
BB -100	3-30-89	BB	0	1U	1U	1U	1U	2	2	0	1U	1U	0.05U	0.02	1U
BFSGW-100	4-3-89	BFS	146	45	8	52	8	33	40	0	94	77	1.18	0	318
CCB -100	3-30-89	CCB	0	1U	1U	1U	1U	1	1	0	1	1U	0.05U	0.03	1U
LCM -009	3-28-89	N	69	16	7	5ARZ	1U	80	98	0	3C	1U	0.10	0.08BC	91
LCM -010	3-28-89	N	73	21	5	10ARZ	14	88	107	0	18C	2	0.23	0.08BC	133
LCM -011	3-28-89	N	69	21	4	1ARZ	1U	65	79	0	5C	3	0.05U	0.02BCZ	88
LCTM -008	3-28-29	N	81	19	8	6ARZ	1U	91	111	0	2C	1U	0.07	0.06BC	106
PLCM -6DP	3-29-89	N	98	26	8	4ARZ	1U	91	111	0	3C	1U	0.05U	0.04BCZ	100
PLCM -6DH	3-29-89	N	126	19	19	5ARZ	10	127	155	0	7C	2	0.05U	0.04BCZ	78
PM -002	3-29-89	N	44	11	4	5ARZ	1U	37	45	0	4C	1U	0.05U	2.60BC	45
PM -003	3-29-89	N	81	19	8	7ARZ	1U	81	99	0	5C	1U	0.05U	0.11BC	87
PM -005	3-29-89	N	212	47	23	4UARZ	1U	193	236	0	5C	1	0.05U	0.06BC	188
PM -005	3-29-89	D	215	48	23	1UARZ	1U	187	228	0	2C	1U	0.05U	0.07BC	189
SP -004	--														
SP -005	--														

NOTE: A - blind field standard outside advisory range.
B - bottle blank equal to or above detection limit.
C - cross-contamination blank equal to or above detection limit.
* - All values are given in mg/L unless otherwise noted.

R - field duplicates outside expected range.
U - value less than detection limit.
Z - value not usable for statistics.
** - Hardness is a calculated value.

APPENDIX J3

GROUNDWATER

STATISTICAL SUMMARY

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: PM -002

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.1000	< 0.1000	0.0000	4
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	4
3	Cadmium	0.0020	0.0040	0.0025	0.0010	4
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	4
5	Copper	< 0.0100	0.0300	< 0.0175	0.0043	4
6	Iron	< 0.0500	0.0500	< 0.0500	0.0000	4
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	4
8	Manganese	0.0300	0.1100	0.0525	0.0386	4
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	4
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	4
11	Silver	< 0.0010	0.0010	< 0.0013	0.0004	4
12	Zinc	< 0.0200	0.2300	< 0.0900	0.0990	3
13	Total Dissolved Solids	57.0000	73.0000	66.2500	6.9940	4
14	Nitrate/Nitrite as N	0.1000	2.6000	1.0450	1.1190	4
15	Sulfate	1.0000	11.0000	4.7500	4.3493	4
16	Total Hardness as CaCO3	40.0000	54.0000	46.2500	5.9090	4
17	Calcium	11.0000	15.0000	12.2500	1.8930	4
18	Magnesium	4.0000	4.0000	4.0000	0.0000	4
19	Sodium	5.0000	6.0000	5.3333	0.5774	3
20	Potassium	< 1.0000	3.0000	< 1.7500	0.3536	4
21	Total Alkalinity as CaCO3	37.0000	58.0000	51.2500	9.9121	4
22	Bicarbonate as HCO3	45.0000	71.0000	62.5000	12.2610	4
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	4
24	Chloride	< 1.0000	1.0000	< 1.0000	0.0000	4
25	Fluoride	< 0.0500	0.0900	< 0.0633	0.0189	3
26	Field Eh (mV)	200.0000	320.0000	256.6667	60.2771	3
27	Field pH (s.u.)	6.2000	7.1000	6.7250	0.4113	4
28	Field Specific Conductance (umhos/cm)	84.0000	124.000	103.7500	16.9386	4
29	Lab pH	6.2000	7.3000	6.7250	0.5560	4
30	Lab Specific Conductance-umhos/cm	90.0000	124.000	110.7500	14.5917	4
31	Temperature-deg. C	7.0000	10.0000	8.5000	1.2910	4

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: PM -003

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.2000	< 0.1250	0.0000	4
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	4
3	Cadmium	0.0020	0.0020	0.0020	0.0000	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	4
5	Copper	< 0.0100	< 0.0200	< 0.0150	0.0058	4
6	Iron	< 0.0500	0.1700	< 0.0850	0.0354	4
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	4
8	Manganese	< 0.0200	0.0200	< 0.0200	0.0000	4
9	Mercury	< 0.0002	< 0.0004	< 0.0003	0.0001	4
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	4
11	Silver	< 0.0010	< 0.0020	< 0.0013	0.0005	4
12	Zinc	< 0.0200	0.0200	< 0.0200	0.0000	4
13	Total Dissolved Solids	87.0000	122.0000	103.5000	14.4799	4
14	Nitrate/Nitrite as N	0.1100	3.5900	1.2375	1.6337	4
15	Sulfate	1.0000	5.0000	3.2500	2.0616	4
16	Total Hardness as CaCO3	77.0000	87.0000	81.5000	4.1231	4
17	Calcium	16.0000	20.0000	18.5000	1.7321	4
18	Magnesium	8.0000	9.0000	8.5000	0.5774	4
19	Sodium	6.0000	7.0000	6.6667	0.5774	3
20	Potassium	< 1.0000	4.0000	< 2.2500	0.8660	4
21	Total Alkalinity as CaCO3	78.0000	88.0000	81.7500	4.3493	4
22	Bicarbonate as HCO3	95.0000	107.0000	99.7500	5.1235	4
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	4
24	Chloride	< 1.0000	1.0000	< 1.0000	0.0000	4
25	Fluoride	< 0.0500	0.1000	< 0.0625	0.0177	4
26	Field Eh (mV)	240.0000	300.0000	266.6667	30.5505	3
27	Field pH (s.u.)	6.6000	7.3000	6.9250	0.2986	4
28	Field Specific Conductance (umhos/cm)	143.0000	174.000	159.0000	15.2971	4
29	Lab pH	6.3000	7.2000	6.7500	0.4203	4
30	Lab Specific Conductance-umhos/cm	166.0000	180.000	174.7500	6.3966	4
31	Temperature-deg. C	7.0000	9.0000	8.5000	1.0000	4

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: PM -005

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	3
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	3
3	Cadmium	0.0010	0.0010	0.0010	0.0000	1
4	Chromium	< 0.0200	0.0300	< 0.0267	0.0000	3
5	Copper	< 0.0100	< 0.0200	< 0.0167	0.0058	3
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	3
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	3
8	Manganese	< 0.0200	0.0300	< 0.0267	0.0000	3
9	Mercury	< 0.0002	0.0002	< 0.0002	0.0000	3
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	3
11	Silver	< 0.0010	0.0010	< 0.0013	0.0005	3
12	Zinc	< 0.0200	0.0300	< 0.0233	0.0000	3
13	Total Dissolved Solids	175.0000	191.0000	184.6667	8.5049	3
14	Nitrate/Nitrite as N	0.0300	0.2600	0.1167	0.1250	3
15	Sulfate	1.0000	5.0000	2.3333	2.3094	3
16	Total Hardness as CaCO3	181.0000	212.0000	195.0000	15.7162	3
17	Calcium	41.0000	47.0000	43.3333	3.2146	3
18	Magnesium	19.0000	23.0000	21.0000	2.0000	3
19	Sodium	2.0000	3.0000	2.5000	0.7071	2
20	Potassium	< 1.0000	2.0000	< 1.3333	0.0000	3
21	Total Alkalinity as CaCO3	191.0000	198.0000	194.0000	3.6056	3
22	Bicarbonate as HCO3	233.0000	242.0000	237.0000	4.5826	3
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	3
24	Chloride	< 1.0000	1.0000	< 1.0000	0.0000	3
25	Fluoride	< 0.0500	0.1000	< 0.0667	0.0000	3
26	Field Eh (mV)	72.0000	280.0000	199.0000	111.3688	3
27	Field pH (s.u.)	7.5000	7.6000	7.5667	0.0577	3
28	Field Specific Conductance (umhos/cm)	283.0000	335.000	312.3333	26.6333	3
29	Lab pH	7.3000	7.8000	7.6000	0.2646	3
30	Lab Specific Conductance-umhos/cm	338.0000	349.000	344.3333	5.6862	3
31	Temperature-deg. C	7.5000	11.0000	9.1667	1.7559	3

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: PLCM -6DP

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	3
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	3
3	Cadmium	< 0.0010	0.0010	< 0.0010	0.0000	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	3
5	Copper	< 0.0100	< 0.0200	< 0.0167	0.0058	3
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	3
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	3
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	3
9	Mercury	< 0.0002	0.0002	< 0.0002	0.0000	3
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	3
11	Silver	< 0.0010	< 0.0020	< 0.0013	0.0006	3
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	3
13	Total Dissolved Solids	100.0000	102.0000	101.0000	1.0000	3
14	Nitrate/Nitrite as N	0.0400	0.0400	0.0400	0.0000	2
15	Sulfate	< 1.0000	3.0000	< 1.6667	0.9428	3
16	Total Hardness as CaCO3	92.0000	98.0000	94.3333	3.2146	3
17	Calcium	24.0000	26.0000	25.0000	1.0000	3
18	Magnesium	7.0000	8.0000	7.6667	0.5774	3
19	Sodium	2.0000	4.0000	3.0000	1.4142	2
20	Potassium	< 1.0000	1.0000	< 1.0000	0.0000	3
21	Total Alkalinity as CaCO3	91.0000	94.0000	92.3333	1.5275	3
22	Bicarbonate as HCO3	111.0000	115.0000	112.6667	2.0817	3
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	3
24	Chloride	< 1.0000	1.0000	< 1.0000	0.0000	3
25	Fluoride	< 0.0500	0.0900	< 0.0700	0.0000	2
26	Field Eh (mV)	230.0000	295.0000	261.6667	32.5320	3
27	Field pH (s.u.)	7.1000	7.9000	7.4333	0.4163	3
28	Field Specific Conductance (umhos/cm)	148.0000	180.000	165.3333	16.1658	3
29	Lab pH	7.3000	7.8000	7.6333	0.2887	3
30	Lab Specific Conductance-umhos/cm	176.0000	191.000	181.3333	8.3865	3
31	Temperature-deg. C	6.5000	8.0000	7.1667	0.7638	3

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: PLCM -6SH

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	1.0000	< 0.3500	0.2828	4
2	Arsenic	< 0.0050	0.0050	< 0.0050	0.0000	4
3	Cadmium	< 0.0020	0.0020	< 0.0020	0.0000	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	4
5	Copper	< 0.0100	< 0.0200	< 0.0150	0.0058	4
6	Iron	< 0.0500	0.9200	< 0.2900	0.2758	4
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	4
8	Manganese	< 0.0200	0.0300	< 0.0225	0.0000	4
9	Mercury	< 0.0002	0.0003	< 0.0002	0.0000	4
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	4
11	Silver	< 0.0010	< 0.0020	< 0.0013	0.0005	4
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	4
13	Total Dissolved Solids	78.0000	145.0000	111.0000	27.3861	4
14	Nitrate/Nitrite as N	0.1200	0.5700	0.2800	0.2516	3
15	Sulfate	1.0000	7.0000	3.3333	3.2146	3
16	Total Hardness as CaCO3	86.0000	126.0000	106.5000	19.0526	4
17	Calcium	18.0000	31.0000	22.2500	5.9652	4
18	Magnesium	8.0000	19.0000	12.2500	4.7871	4
19	Sodium	< 1.0000	8.0000	< 4.6667	1.4142	3
20	Potassium	1.0000	10.0000	5.5000	4.6547	4
21	Total Alkalinity as CaCO3	90.0000	127.0000	111.2500	16.7606	4
22	Bicarbonate as HCO3	110.0000	155.0000	130.7500	18.4820	4
23	Carbonate as CaCO3	0.0000	10.0000	2.5000	5.0000	4
24	Chloride	< 1.0000	2.0000	< 1.2500	0.4330	4
25	Fluoride	< 0.0500	0.1400	< 0.0875	0.0106	4
26	Field Eh (mV)	68.0000	295.0000	181.0000	113.5033	3
27	Field pH (s.u.)	7.7000	8.9000	8.1500	0.5260	4
28	Field Specific Conductance (umhos/cm)	107.0000	196.000	156.2500	36.7457	4
29	Lab pH	7.2000	8.7000	7.8000	0.7348	4
30	Lab Specific Conductance-umhos/cm	135.0000	208.000	182.2500	32.5410	4
31	Temperature-deg. C	5.0000	9.0000	7.5000	1.7321	4

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: LCTM -008

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	3
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	3
3	Cadmium	0.0060	0.0060	0.0060	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	3
5	Copper	< 0.0100	< 0.0200	< 0.0133	0.0058	3
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	3
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	3
8	Manganese	0.0900	0.1400	0.1233	0.0289	3
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	3
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	3
11	Silver	< 0.0010	< 0.0020	< 0.0013	0.0006	3
12	Zinc	< 0.0200	0.2000	< 0.0800	0.0000	3
13	Total Dissolved Solids	104.0000	108.0000	106.0000	2.0000	3
14	Nitrate/Nitrite as N	0.0600	0.8700	0.3300	0.4677	3
15	Sulfate	2.0000	4.0000	3.0000	1.0000	3
16	Total Hardness as CaCO3	75.0000	95.0000	83.6667	10.2632	3
17	Calcium	15.0000	23.0000	19.0000	4.0000	3
18	Magnesium	8.0000	9.0000	8.6667	0.5774	3
19	Sodium	5.0000	7.0000	6.0000	1.4142	2
20	Potassium	< 1.0000	2.0000	< 1.3333	0.0000	3
21	Total Alkalinity as CaCO3	91.0000	96.0000	93.0000	2.6458	3
22	Bicarbonate as HCO3	111.0000	117.0000	113.3333	3.2146	3
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	3
24	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	3
25	Fluoride	0.0700	0.1200	0.0933	0.0252	3
26	Field Eh (mV)	210.0000	220.0000	215.0000	7.0711	2
27	Field pH (s.u.)	7.1000	7.2000	7.1667	0.0577	3
28	Field Specific Conductance (umhos/cm)	153.0000	186.000	165.0000	18.2483	3
29	Lab pH	6.6000	7.2000	6.8333	0.3215	3
30	Lab Specific Conductance-umhos/cm	179.0000	194.000	188.6667	8.3865	3
31	Temperature-deg. C	6.5000	11.0000	8.5000	2.2913	3

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: LCM -009

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.8000	< 0.2750	0.0000	4
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	4
3	Cadmium	0.0020	0.0030	0.0025	0.0007	2
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	4
5	Copper	< 0.0100	< 0.0200	< 0.0150	0.0058	4
6	Iron	< 0.0500	0.5500	< 0.1750	0.0000	4
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	4
8	Manganese	< 0.0200	0.7600	< 0.2325	0.2227	4
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	3
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	4
11	Silver	< 0.0010	0.0010	< 0.0013	0.0004	4
12	Zinc	< 0.0200	0.2100	< 0.0675	0.0000	4
13	Total Dissolved Solids	91.0000	115.0000	104.5000	11.0905	4
14	Nitrate/Nitrite as N	0.0800	1.3800	0.5475	0.6166	4
15	Sulfate	2.0000	3.0000	2.5000	0.5774	4
16	Total Hardness as CaCO3	69.0000	110.0000	86.7500	17.1148	4
17	Calcium	16.0000	29.0000	21.0000	5.7155	4
18	Magnesium	7.0000	9.0000	8.2500	0.9574	4
19	Sodium	4.0000	8.0000	6.3333	2.0817	3
20	Potassium	< 1.0000	2.0000	< 1.5000	0.0000	4
21	Total Alkalinity as CaCO3	80.0000	108.0000	92.5000	11.8181	4
22	Bicarbonate as HCO3	98.0000	132.0000	113.0000	14.4453	4
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	4
24	Chloride	< 1.0000	2.0000	< 1.5000	0.0000	4
25	Fluoride	0.1000	0.1500	0.1333	0.0289	3
26	Field Eh (mV)	90.0000	310.0000	213.3333	112.3981	3
27	Field pH (s.u.)	7.0000	7.3000	7.1500	0.1291	4
28	Field Specific Conductance (umhos/cm)	154.0000	202.000	175.5000	21.7486	4
29	Lab pH	6.3000	7.2000	6.7750	0.4924	4
30	Lab Specific Conductance-umhos/cm	174.0000	208.000	191.0000	14.4684	4
31	Temperature-deg. C	8.0000	10.0000	8.8750	1.0308	4

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: LCM -010

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	0.1000	< 0.1000	0.0000	4
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	4
3	Cadmium	0.0010	0.0010	0.0010	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	4
5	Copper	< 0.0100	< 0.0200	< 0.0150	0.0058	4
6	Iron	< 0.0500	0.0700	< 0.0575	0.0035	4
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	4
8	Manganese	0.3300	1.0900	0.7500	0.3204	4
9	Mercury	< 0.0002	0.0003	< 0.0002	0.0000	4
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	4
11	Silver	< 0.0010	< 0.0020	< 0.0013	0.0005	4
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	4
13	Total Dissolved Solids	94.0000	133.0000	108.7500	17.1537	4
14	Nitrate/Nitrite as N	0.0600	0.3200	0.1425	0.1201	4
15	Sulfate	3.0000	18.0000	9.5000	6.5574	4
16	Total Hardness as CaCO3	47.0000	93.0000	67.5000	20.0915	4
17	Calcium	12.0000	21.0000	15.7500	3.8622	4
18	Magnesium	4.0000	14.0000	6.7500	4.8563	4
19	Sodium	9.0000	12.0000	10.3333	1.5275	3
20	Potassium	5.0000	17.0000	10.7500	5.6789	4
21	Total Alkalinity as CaCO3	78.0000	88.0000	81.2500	4.7170	4
22	Bicarbonate as HCO3	95.0000	107.0000	99.0000	5.6569	4
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	4
24	Chloride	2.0000	5.0000	2.7500	1.5000	4
25	Fluoride	0.1100	0.2300	0.1725	0.0568	4
26	Field Eh (mV)	170.0000	300.0000	233.3333	65.0641	3
27	Field pH (s.u.)	6.9000	7.7000	7.4250	0.3594	4
28	Field Specific Conductance (umhos/cm)	150.0000	168.000	156.5000	7.8951	4
29	Lab pH	6.9000	7.6000	7.2500	0.3109	4
30	Lab Specific Conductance-umhos/cm	154.0000	196.000	171.7500	20.3039	4
31	Temperature-deg. C	5.0000	9.0000	6.6250	1.7017	4

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: LCM -011

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.0100	1.6000	< 0.4525	0.0390	4
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	4
3	Cadmium	< 0.0010	< 0.0010	< 0.0010	0.0000	3
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	4
5	Copper	< 0.0100	< 0.0200	< 0.0150	0.0058	4
6	Iron	< 0.0500	0.8600	< 0.2525	0.0000	4
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	4
8	Manganese	< 0.0200	0.8100	< 0.2175	0.3421	4
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	4
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	4
11	Silver	< 0.0010	< 0.0020	< 0.0013	0.0005	4
12	Zinc	< 0.0200	0.0200	< 0.0200	0.0000	4
13	Total Dissolved Solids	64.0000	148.0000	100.0000	35.3270	4
14	Nitrate/Nitrite as N	0.0500	0.5800	0.3167	0.2650	3
15	Sulfate	5.0000	11.0000	7.6667	3.0551	3
16	Total Hardness as CaCO3	49.0000	137.0000	83.0000	37.8770	4
17	Calcium	13.0000	30.0000	20.7500	7.0415	4
18	Magnesium	4.0000	15.0000	7.5000	5.1962	4
19	Sodium	4.0000	48.0000	21.0000	23.6432	3
20	Potassium	< 1.0000	3.0000	< 2.2500	0.4330	4
21	Total Alkalinity as CaCO3	54.0000	203.0000	105.7500	67.8694	4
22	Bicarbonate as HCO3	66.0000	197.0000	116.2500	59.1009	4
23	Carbonate as CaCO3	0.0000	25.0000	6.2500	12.5000	4
24	Chloride	< 1.0000	4.0000	< 2.5000	0.7500	4
25	Fluoride	< 0.0500	0.1900	< 0.1200	0.0303	4
26	Field Eh (mV)	170.0000	290.0000	210.0000	69.2820	3
27	Field pH (s.u.)	8.1000	9.0000	8.4750	0.3775	4
28	Field Specific Conductance (umhos/cm)	96.0000	240.000	151.7500	68.8882	4
29	Lab pH	7.4000	9.0000	8.1500	0.7326	4
30	Lab Specific Conductance-umhos/cm	120.0000	244.000	168.7500	59.5392	4
31	Temperature-deg. C	6.0000	11.0000	8.2500	2.2174	4

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

Station: SP -004

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	2
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	2
3	Cadmium	< 0.0010	< 0.0010	< 0.0010	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	2
5	Copper	< 0.0200	< 0.0200	< 0.0200	0.0000	2
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	2
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	2
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	2
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	1
10	Molybdenum	< 0.0500	0.0500	< 0.0500	0.0000	2
11	Silver	< 0.0010	< 0.0010	< 0.0010	0.0000	2
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	1
13	Total Dissolved Solids	15.0000	25.0000	20.0000	7.0711	2
14	Nitrate/Nitrite as N	0.0200	0.0300	0.0250	0.0071	2
15	Sulfate	< 1.0000	2.0000	< 1.5000	0.0000	2
16	Total Hardness as CaCO3	< 5.0000	< 5.0000	< 5.0000	0.0000	2
17	Calcium	2.0000	2.0000	2.0000	0.0000	2
18	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	2
19	Sodium	1.0000	2.0000	1.5000	0.7071	2
20	Potassium	< 1.0000	1.0000	< 1.0000	0.0000	2
21	Total Alkalinity as CaCO3	11.0000	15.0000	13.0000	2.8284	2
22	Bicarbonate as HCO3	13.0000	18.0000	15.5000	3.5355	2
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	2
24	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	2
25	Fluoride	(2)	(2)	(2)	(2)	0
26	Field Eh (mV)	290.0000	290.0000	290.0000	0.0000	1
27	Field pH (s.u.)	6.8000	7.4000	7.1000	0.4243	2
28	Field Specific Conductance (umhos/cm)	24.0000	27.000	25.5000	2.1213	2
29	Lab pH	7.4000	7.5000	7.4500	0.0707	2
30	Lab Specific Conductance-umhos/cm	27.0000	33.000	30.0000	4.2426	2
31	Temperature-deg. C	7.0000	7.0000	7.0000	0.0000	2

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

Noranda Montana Project Groundwater Quality Analysis - April 1988-April 1989

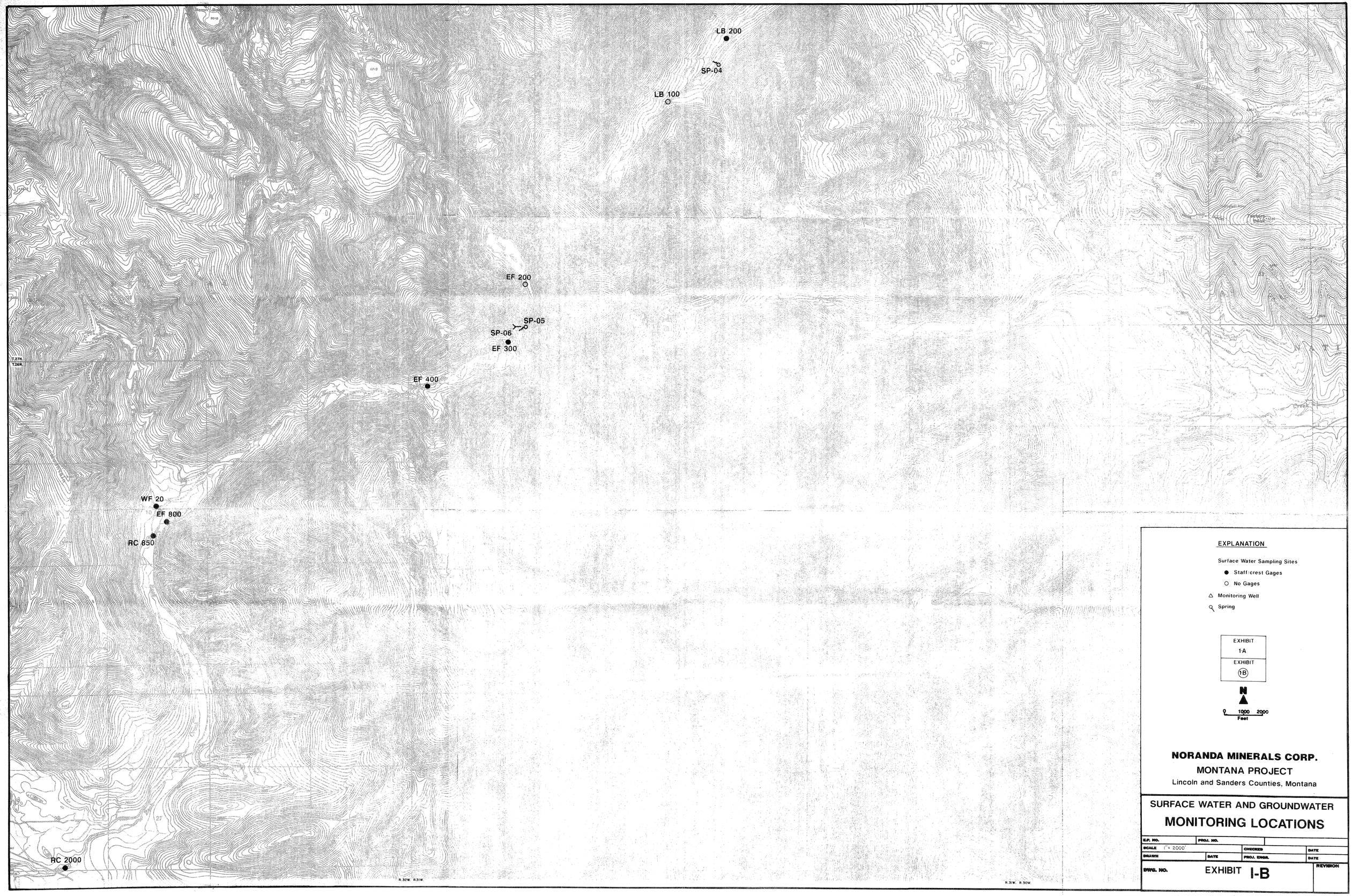
Station: SP -005

	PARAMETER	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	NUMBER OF SAMPLES
1	Aluminum	< 0.1000	< 0.1000	< 0.1000	0.0000	2
2	Arsenic	< 0.0050	< 0.0050	< 0.0050	0.0000	2
3	Cadmium	0.0010	0.0010	0.0010	0.0000	1
4	Chromium	< 0.0200	< 0.0200	< 0.0200	0.0000	2
5	Copper	< 0.0200	< 0.0200	< 0.0200	0.0000	2
6	Iron	< 0.0500	< 0.0500	< 0.0500	0.0000	2
7	Lead	< 0.0100	< 0.0100	< 0.0100	0.0000	2
8	Manganese	< 0.0200	< 0.0200	< 0.0200	0.0000	2
9	Mercury	< 0.0002	< 0.0002	< 0.0002	0.0000	1
10	Molybdenum	< 0.0500	< 0.0500	< 0.0500	0.0000	2
11	Silver	< 0.0010	< 0.0010	< 0.0010	0.0000	2
12	Zinc	< 0.0200	< 0.0200	< 0.0200	0.0000	1
13	Total Dissolved Solids	6.0000	12.0000	9.0000	4.2426	2
14	Nitrate/Nitrite as N	0.0800	0.1100	0.0950	0.0212	2
15	Sulfate	1.0000	2.0000	1.5000	0.7071	2
16	Total Hardness as CaCO3	< 3.0000	8.0000	< 5.5000	0.0000	2
17	Calcium	1.0000	3.0000	2.0000	1.4142	2
18	Magnesium	< 1.0000	< 1.0000	< 1.0000	0.0000	2
19	Sodium	1.0000	1.0000	1.0000	0.0000	2
20	Potassium	< 1.0000	1.0000	< 1.0000	0.0000	2
21	Total Alkalinity as CaCO3	10.0000	13.0000	11.5000	2.1213	2
22	Bicarbonate as HCO3	12.0000	16.0000	14.0000	2.8284	2
23	Carbonate as CaCO3	0.0000	0.0000	0.0000	0.0000	2
24	Chloride	< 1.0000	< 1.0000	< 1.0000	0.0000	2
25	Fluoride	(2)	(2)	(2)	(2)	0
26	Field Eh (mV)	280.0000	280.0000	280.0000	0.0000	1
27	Field pH (s.u.)	7.1000	7.5000	7.3000	0.2828	2
28	Field Specific Conductance (umhos/cm)	18.0000	31.000	24.5000	9.1924	2
29	Lab pH	7.4000	7.6000	7.5000	0.1414	2
30	Lab Specific Conductance-umhos/cm	25.0000	26.000	25.5000	0.7071	2
31	Temperature-deg. C	8.5000	8.5000	8.5000	0.0000	1

NOTES: 1) All quantities are in mg/L unless otherwise noted.
2) No valid sample data was found for this site.

EXHIBIT I

Chen-Northern, Inc.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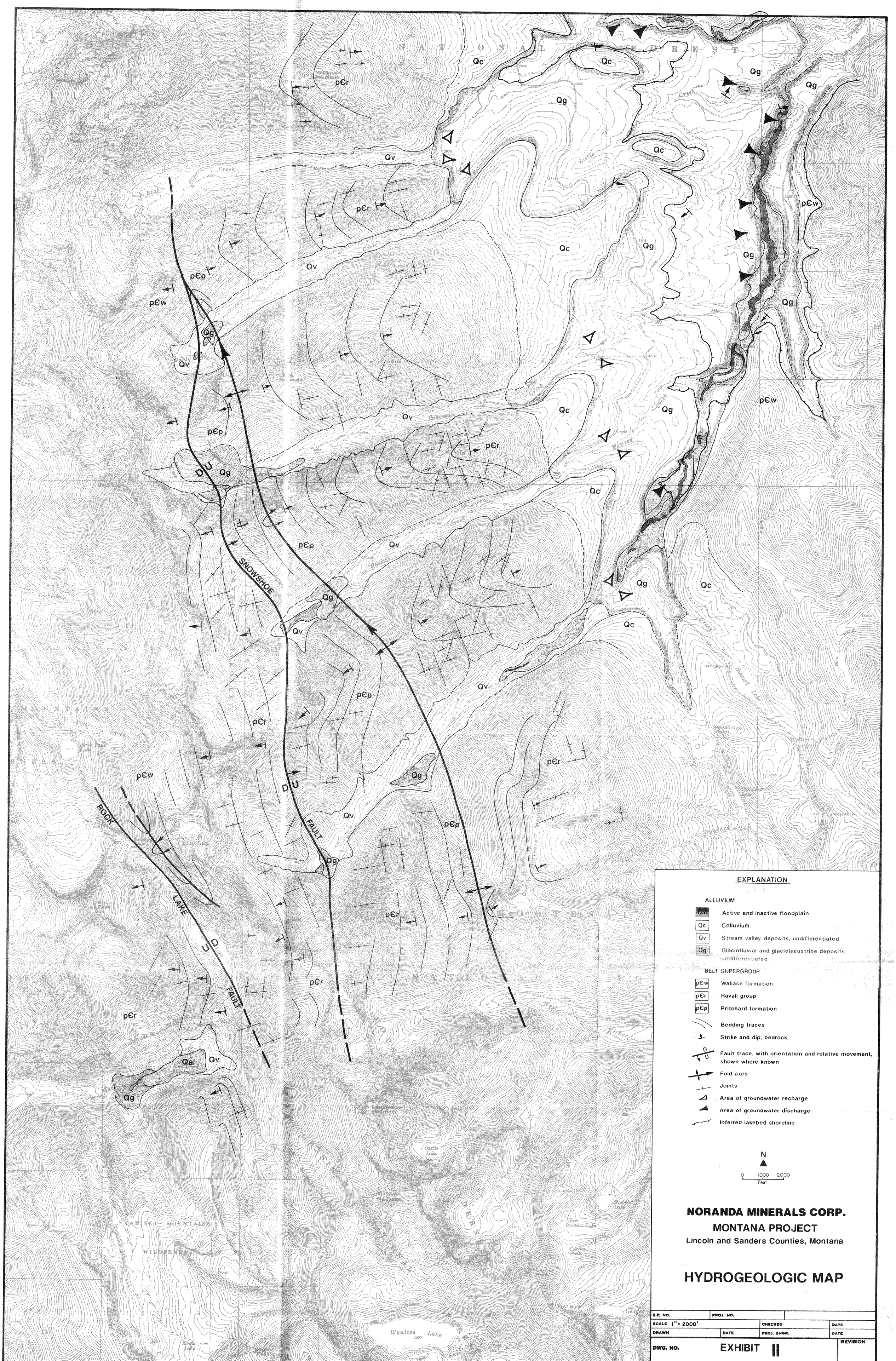
LB 100
EF 200
SP-05
SP-06
EF 300
EF 400
WF 20
EF 800
RC 850
RC 2000
EXPLANATION
Surface Water Sampling Sites
Staff/crest Gages
No Gages
Monitoring Well
Spring
EXHIBIT
1A
EXHIBIT
1B
N
0 1000 2000
Feet
NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana
SURFACE WATER AND GROUNDWATER
MONITORING LOCATIONS
E.P. NO.
PROJ. NO.
SCALE 1" = 2000'
CHECKED
DATE
DRAWN
DATE
PROJ. ENGR.
DATE
DWG. NO.
EXHIBIT I-B
REVISION

EXHIBIT II

Chen-Northern, Inc.



EXPLANATION

ALLUVIUM

- Qal — Active and inactive floodplain
- Qc — Colluvium
- Qv — Stream valley deposits, undifferentiated
- Qg — Glaciofluvial and glaciolacustrine deposits, undifferentiated

BELT SUPERGROUP

- pЄw — Wallace formation
- pЄr — Ravali group
- pЄp — Pritchard formation

- Bedding traces
- Strike and dip, bedrock
- Fault trace, with orientation and relative movement, shown where known
- Fold axes
- Joints
- Area of groundwater recharge
- Area of groundwater discharge
- Inferred lakebed shoreline

N

0 1000 2000
Feet

NORANDA MINERALS CORP.

MONTANA PROJECT

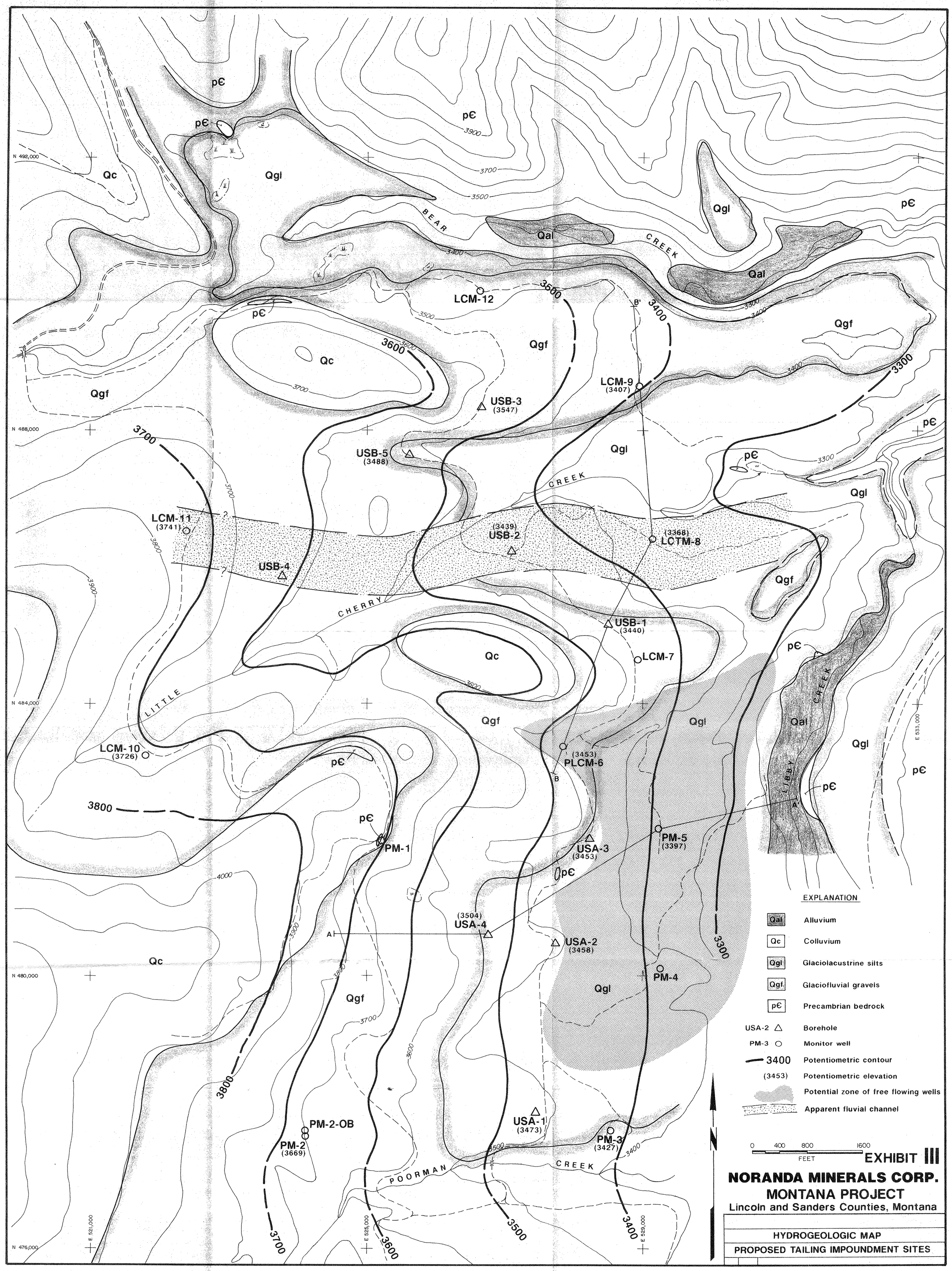
Lincoln and Sanders Counties, Montana

HYDROGEOLOGIC MAP

E.P. NO.	PROJ. NO.		
SCALE 1" = 2000'		CHECKED	DATE
DRAWN	DATE	PROJ. ENGR.	DATE
DWG. NO.	EXHIBIT II		REVISION

EXHIBIT III

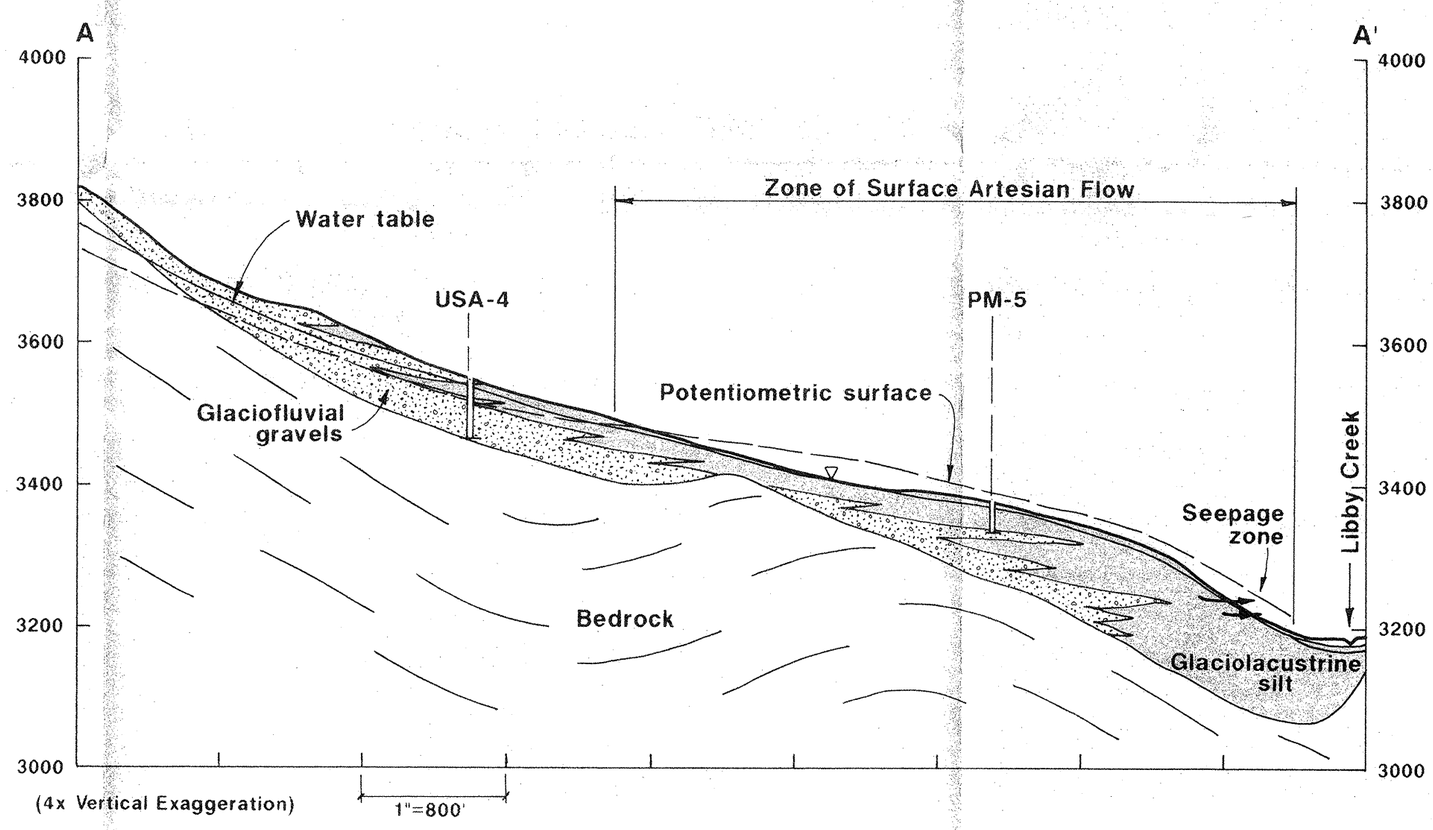
Chen-Northern, Inc.


BEAR CREEK
CHERRY CREEK
LITTLE CHERRY CREEK
POORMAN CREEK
LIBBY CREEK
LCM-12
LCM-9 (3407)
USB-3 (3547)
USB-5 (3488)
LCM-11 (3741)
USB-4
USB-2 (3439)
LCTM-8 (3368)
USB-1 (3440)
LCM-7
LCM-10 (3726)
PLCM-6 (3453)
PM-1
USA-3 (3453)
PM-5 (3397)
USA-4 (3504)
USA-2 (3458)
PM-4
PM-2-OB
PM-2 (3669)
USA-1 (3473)
PM-3 (3427)
EXPLANATION
Qal Alluvium
Qc Colluvium
Qgl Glaciolacustrine silts
Qgf Glaciofluvial gravels
pЄ Precambrian bedrock
USA-2 Borehole
PM-3 Monitor well
3400 Potentiometric contour
(3453) Potentiometric elevation
Potential zone of free flowing wells
Apparent fluvial channel
0 400 800 1600
FEET
EXHIBIT III
NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana
HYDROGEOLOGIC MAP
PROPOSED TAILING IMPOUNDMENT SITES

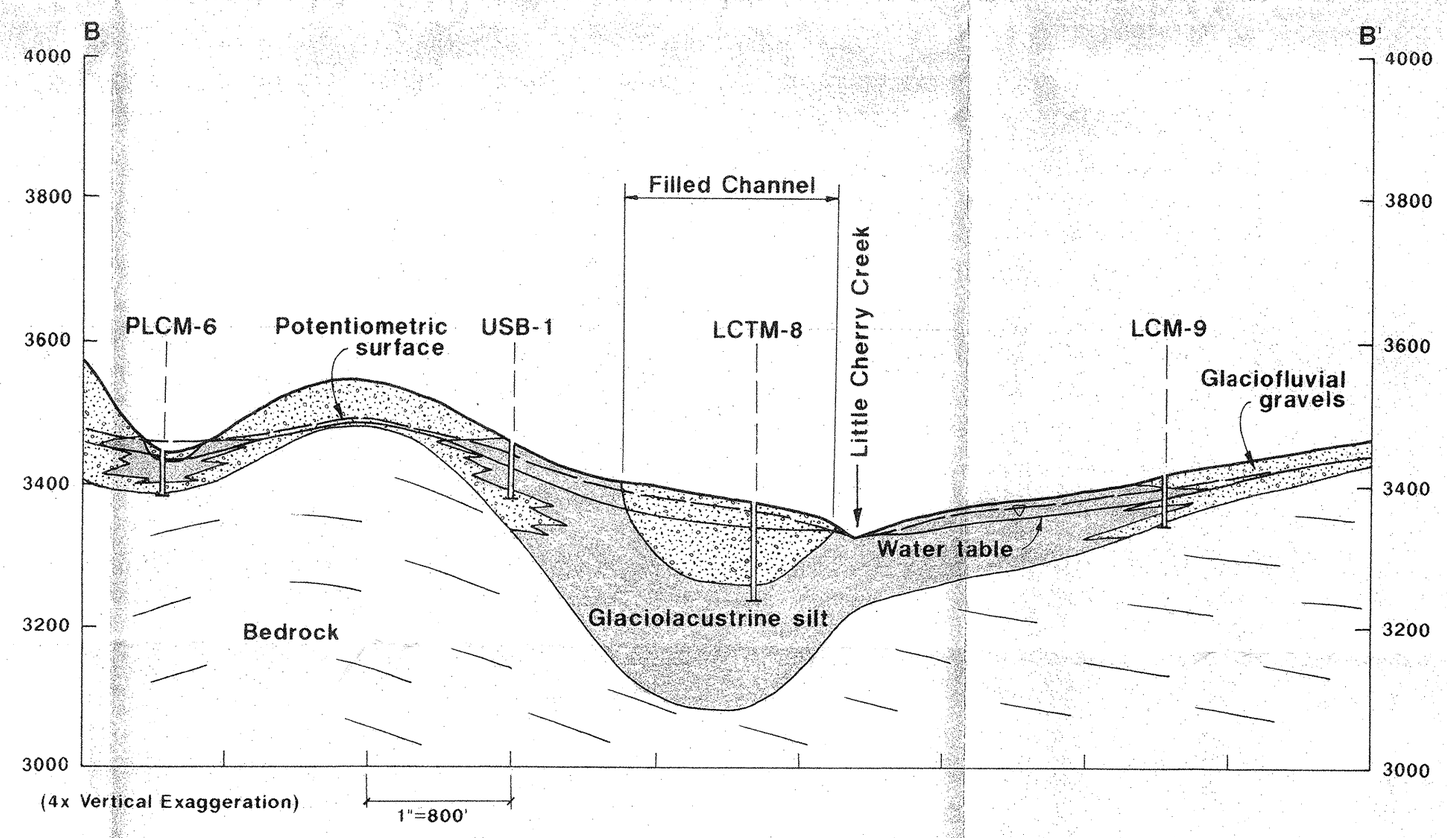
Chen-Northern, Inc.

EXHIBIT IV

HYDROGEOLOGIC CROSS - SECTIONS



POORMAN IMPOUNDMENT SITE



LITTLE CHERRY IMPOUNDMENT SITE

NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln and Sanders Counties, Montana

HYDROGEOLOGIC CROSS SECTIONS

EXHIBIT **IV**