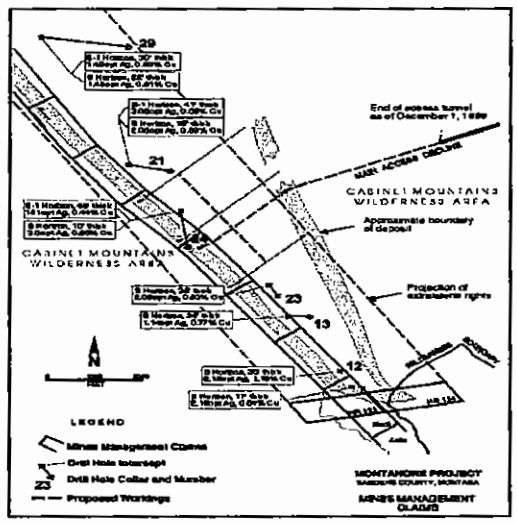
MONTANORE PROJECT

AMENDED APPLICATION

HARD ROCK OPERATING PERMIT

AMENDED PLAN OF OPERATIONS



Volume 2

Tables & Maps

December 2004

Mines Management, Inc.

TABLE 3-1
SURFACE WATER QUALITY PARAMETERS
FOR INITIAL BASELINE MONITORING PERIOD

Field Parameters	Common Ions	Metals [1]	Others
pH	Calcium (Ca)	Lead (Pb)	Nitrite and Nitrate as N
Specific Conductivity (SC)	Magnesium (Mg)	Copper (Cu)	Orthophosphate as P
Temperature (°C)	Sodium (Na)	Chromium (Cr)	Fluoride (F)
	Potassium (K)	Zinc (Zn)	Total Dissolved Solids (TDS)
	Carbonate (CO_3)	Cadmium (Cd)	Total Suspended Solids (TSS)
	Bicarbonate (HCO_3)	Iron (Fe)	Turbidity
	Chloride (Cl)	Aluminum (Al)	Hardness, as $CaCO_3$
	Sulfate (SO_4)	Manganese (Mn)	Alkalinity,as $CaCO_3$
		Mercury (Hg)	Ammonia
		Arsenic (As)	Total Kjeldahl Nitrogen as N
		Silver (Ag)	Total Phosphorous as P
		Molybdenum (Mo)	Oil & Grease [2]

1. 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.

2. Oil and Grease was analyzed once for each surface water site to establish baseline conditions.

TABLE 3-2
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)

TABLE 3-3
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)

Note: MPDES Permit No. MT-0030279 was issued November 1, 1997 with an expiration date of February 28, 2002. Discharge from the adit ceased in October 1998. Three outfalls were included in the 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 LB-300 is located downstream of the permitted outfalls.

TABLE 3-4
GENERAL RANGE OF CONCENTRATION FOR ALL SURFACE WATER PARAMETERS WITHIN THE BASELINE STUDY AREA (APRIL 1988 – APRIL 1989)

Parameter [1]	Minimum [2]	Maximum [2]
Aluminum	<0.1	0.5
Arsenic	<0.005	<0.005
Cadmium	0.0004	0.0092
Chromium	<0.02	<0.02
Copper	<0.001	0.008[2]
Iron	<0.05	0.36
Lead	<0.001	0.004[3]
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	0.25
Kjeldahl Nitrogen	<0.2	0.40[3]
Nitrate + Nitrite as N	<0.01	0.50[3]
Orthophosphate	<0.005	0.094
Total Phosphorus	<0.005	0.265
Sulfate	<1.0	6.0
Calcium	<1.0	15
Magnesium	<1.0	4.0
Sodium	<1.0	6.0
Potassium	<1.0	2.0
Chloride	<1.0	<1.0
Fluoride	<0.05	0.14
Total Alkalinity as $CaCO_3$	<1.0	60.0
Bicarbonate as HCO_3	<2.0	73
Carbonate as CO_3	0	0
Total Hardness	<6.0	50
Oil and Grease	<1	3
Total Suspended Solids	<1	11
Total Dissolved Solids	<1.0	70
Turbidity (NTU)	<0.1	5.3
Field pH (standard units)	5.8	8.4
Field SC (umhos/cm)	5	156
Temperature (°C)	0	18.0
Lab pH	4.6	8.0
Lab SC (umhos/cm)	0	118

1. NTU = nephelometric turbidity units; SC = specific conductance; C = Celsius; umhos/cm = micromhos per centimeter.
2. All values are in milligrams per liter (mg/L) unless noted in the first column.
3. Anomalous values exceeding the range were reported for these parameters: Copper = 0.012, 0.018, & 0.055 mg/L; Lead = 0.024 mg/L; Kjeldahl Nitrogen = 0.78 & 1.43 mg/L; and Nitrate + Nitrite as N = 2.00 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.

TABLE 3-5
GENERAL RANGE OF CONCENTRATIONS FOR GROUNDWATER PARAMETERS WITHIN THE BASELINE STUDY AREA (APRIL 1988 – APRIL 1989)

Parameter [1]	Minimum [2]	Maximum [2]
Aluminum	<0.1	1.6
Arsenic	<0.005	0.005
Cadmium	<0.001	0.006
Chromium	<0.02	0.03
Copper	<0.01	0.03
Iron	<0.05	0.92
Lead	<0.01	<0.01
Manganese	<0.02	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	1.38[3]
Sulfate	<1.0	8.0
Calcium	11.0	8.0
Magnesium	4.0	3.0
Sodium	<1.0	48.0
Potassium	<1.0	17.0
Chloride	<1.0	5.0
Fluoride	<0.05	0.23
Total Alkalinity as $CaCO_3$	37.0	242.0
Bicarbonate as HCO_3	63.0	236.0
Carbonate as CO_3	0	25.0
Total Hardness	40.0	215.0
Total Dissolved Solids (TDS)	57.0	191.0
Field pH	6.2	9.0
Field SC (umhos/cm)	84.0	335.0
Field Eh	+68	+320
Lab pH	6.2	9.0
Lab SC (umhos/cm)	90.0	60.0
Temperature (°C)	5.0	11.0

1. SC = specific conductivity; umhos/cm = micromhos per centimeter; °C = degees Celsius.
2. All values are in milligrams per liter (mg/L) unless noted in first column.
3. Anomalous values for nitrate+nitrite as N = 2.60 and 3.59 mg/L.

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

TABLE 3-6
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: Water quality samples collected after March 1989 are considered "interim" monitoring data. No groundwater samples were collected after 1995.

TABLE 5.1 FOREST SERIES AND HABITAT TYPES
MONTANORE PROJECT – LINCOLN COUNTY, MT

Western Hemlock Series

Western hemlock/queencup beadlily (570)

Western hemlock/oak fern (565)

Western Red Cedar Series

Western red cedar/devil's club (550)

Western red cedar/lady fern (540)

Mountain Hemlock Series

Mountain hemlock/queencup beadlily (620)

Mountain hemlock/beargrass (710)

Subalpine Fir Series

Subalpine fir/queencup beadlily (620)

Subalpine fir/menziesia (670)

Grand Fir Series

Grand fir/queencup beadlily (520)

Engelmann Spruce Series

Engelmann spruce/common horsetail (410)

Douglas-fir Series

Douglas-fir/common snowberry (310)

Douglas-fir/pinegrass (320)

TABLE 7-1. LIST OF MAJOR MAP UNITS, INTENSIVE STUDY AREAS MONTANORE PROJECT – LINCOLN COUNTY, MT

Map Unit Symbol	Map Unit Name
AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes.
AcG	Andic Cryochrepts glacial moraine, 0-15% slopes.
AdA	Andic Dystrochrepts lacustrine terraces, 0-10% slopes.
AdD	Andic Dystrochrepts, deep, 25-60% slopes.
AdR	Andic Dystrochrepts moderately deep and deep complex, 0-25% slopes.
AdS	Andic Dystrochrepts alluvial terraces, 0-15% slopes.
AdW	Dystrochrepts-Humaquepts complex, 0-15% slopes.
CbD	Cryochrepts-Cryumbrepts complex, bouldery surface, 15-60% slopes.
ROC	Rock outcrop-Rubble land complex, 15-90% slopes.
TcA	Typic Cryorthents avalanche chutes, 15-35% slopes.
TgC	Typic Glossoboralfs family, 0-15% slopes.
TcD	Typic Glossoboralfs family, 15-40% slopes.
ThA	Cumulic Humaquepts family, 0-3% slopes.
TpC	Typic Paleboralfs family, 0-15% slopes.

TABLE 7-2
TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS
MONTANORE PROJECT

Map Unit Symbol	Soil Composition Component (%)	Topsoil Suitability (depth *)	Total Area (Acres)	Total Area (Location)	Constraints
AcC	Andic Cryochrepts colluvial slopes	Moderate (29")	103.2	Ramsey	Excessive coarse fragments below 29"
AcG	Andic Cryochrepts Glacial moraines	Moderate (20")	36.7	Ramsey	Excessive coarse fragments below 20"
AdA	Andic Cryochprepts	High (65")	297.6	Tailings area	
AdD	Andic Dystroghrepts Deep	Moderate (9")	144.1	Tailings area, Percolation #1 & #2	Excessive coarse fragments below 9", unsuitable on slopes >50%
AdR	Andic Cryochrepts Moderately deep (60%)	Moderate (11")	285.3	Tailings area, Percolation #1	Excessive coarse fragments below 11"
	Andic Cryochrepts Deep (40%)	Moderate (9")			Excessive coarse fragments below 9"
AdS	Andic Cryochrepts	Moderate alluvial terraces (9")	42.1	Tailings area, Percolation #2	Very strong acid at 9" excessive coarse fragments and sand below 16"
AdW	Typic Humaquepts family (30%)	High (15")	129.3	Tailings area, Percolation #2	High water table below 15"
	AdA component (15%)	High (65")	---	---	
	AdD component (40%)	Moderate (9")	---	---	See AdD above
	AdS component (15%)	Moderate (9")	---	---	See AdS above

* Recommended Salvage

TABLE 7-2 Continued
TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS
MONTANORE PROJECT

Map Unit Symbol	Soil Composition Component (%)	Topsoil Suitability (depth *)	Total Area (Acres)	Total Area (Location)	Constraints
CbD	Typic Cryochrepts bouldery (70%)		102.3	Libby Creek, Ramsey	Excessive coarse fragments throughout; boulders unsuitable on slopes >50%
	Typic Cryumbrepts bouldery (20%)	Moderate unsuitable	---	---	Excessive coarse fragments throughout; boulders
	Rock outcrop/ Rubble land (10%)	unsuitable	---	---	---
ROC	Rock outcrop / Rubble land	Unsuitable	1.5	Libby Creek	---
TcA	Typic Cryorthents avalanche chutes	Unsuitable	60.3	Libby Creek, Ramsey	Excessive coarse fragments
TgC	Typic Glossoboralfs family	Moderate (33")	508.7	Tailings area, Percolation #1 & #2	Excessive coarse fragments below 33"
TgD	Typic Glossoboaralfs family	Moderate (33")	473.2	Tailings area	Excessive coarse fragments below 33"
ThA	Cumulic Humaquepts family	High (9")	1.2	Tailings area	High water table below 9"
TpC	Typic Paleboralfs family	Moderate (24")	353.5	Tailings area	Extremely acid below 24" Clay below 36" (excessive coarse fragments from 9-24", but this coarse material is needed for the dike faces)

* Recommended salvage.

TABLE 7-3

MAP UNIT INTERPRETATIONS, BEAR CREEK ROAD AND OTHER LINE CORRIDORS (Adapted from Kuennen and Gerhardt 1984)								
Map Unit	Soil Erodibility		Roads		Sediment Delivery	Regeneration		Revegetation
	Surface	Subsurface	Suitability	Limitation	Efficiency	Potential	Limitation	Potential
103	High	Moderate	Good	—	Low	High	Shallow soil	Fair
104	High	Moderate	Fair	Dust problems	Moderate	Slight	Wet soils in bogs	Good
112	High	High	Poor	Slumping	Low	High	Boggy areas	Good
322	High	High	Good	—	Moderate	High	—	Good
352	High	Moderate	Good	Steep slopes	Moderate	High	—	Good
401	High	Low	Poor	Steep slopes	High	Slight	Shallow, rocky soil	Very Poor
MAP UNIT INTERPRETATIONS, MILLER CREEK TO PLANT SITES ALTERNATIVE TRANSMISSION LINE (Adapted from Kuennen and Gerhardt 1984), cont								
Map Unit	Soil Erodibility		Roads		Sediment Delivery	Regeneration		Revegetation
	Surface	Subsurface	Suitability	Limitation	Efficiency	Potential	Limitation	Potential
407	High	Moderate	Good	—	Moderate	Slight	—	Poor
408	High	Moderate	Poor	Steep slopes, non-rippable	High	Moderate	Short growing season	Poor

TABLE 7-4
MAP UNIT INTERPRETATIONS AND SUMMARY
BEAR CREEK ROAD
(Adapted from Kuennen and Gerhardt, 1984)

Map Unit	Soil Erodibility		Roads		Sediment Delivery	Regeneration		Revegetation
	Surface	Subsurface	Suitability	Limitation	Efficiency	Potential	Limitation	Potential
103	High	Moderate	Good	---	Low	High	Shallow soil	Fair
104	High	Moderate	Fair	Dust problems	Moderate	Slight	Wet soils in bogs	Good
322	High	High	Good	---	Moderate	High	---	Good
407	High	Moderate	Good	---	Moderate	Slight	---	Poor

TABLE 7-5
MAP UNIT INTERPRETATIONS AND SUMMARY
LIBBY CREEK ROAD
(Adapted from Kuennen and Gerhardt, 1984)

Map Unit	Soil Erodibility		Roads		Sediment Delivery	Regeneration		Revegetation
Symbol	Surface	Subsurface	Suitability	Limitation	Efficiency	Potential	Limitation	Potential
102	High	High	Poor	Erosion slumping	Low	Slight	---	Good
103	High	Moderate	Good	---	Low	High	Shallow soil	Fair
108	High	High	Poor	Slumping	Low	High	Boggy area	Good
322	High	High	Good	---	Moderate	High	---	Good
407	High	Moderate	Good	---	Moderate	Slight	---	Poor

TABLE 9-1.
ACCIDENT RATE DATA AND SAFEY PROBLEMS
(HAZARDOUS SECTIONS FOR HIGHWAY 2, MILEPOST 32.7 TO 44.4)
(Montana Department of Highways, 1989)

LOCATION: Libby – East
ROUTE & MP: Highway 2 32.7 to 44.7

STATEWIDE AVERAGE (per million miles traveled)		STUDY AREA
ALL VEHICLE ACCIDENT RATE:	1.95	1.45
HIGH AVERAGE:	3.54	---
ALL VEHICLE SEVERITY RATE:	1.51	1.41
HIGH AVERAGE:	1.76	---
TRUCK ACCIDENT RATE:	1.47	1.41
HIGH AVERAGE:	3.44	---
TRUCK SEVERITY RATE:	1.55	2.12
HIGH AVERAGE:	---	---
% TRUCK =	8.4%	AVG. = 14%

I. VARIATIONS FROM AVERAGE OCCURRENCE:

On road = 63% AVG. = 52.5%

First Object Hit:

Light/power/signal pole =	6.5%	Avg.	=	1.9% (14 hits)	
Mailbox	=	2.3%	Avg.	=	0.5%

First Harmful Event:

MV in transport =	36.9%	Avg.	=	35.4%	
Animal	=	16.8%	Avg.	=	10.3%
Fixed Object	=	25.7%	Avg.	=	24.9%

II. HES CLUSERS OR PROJECTS:

Clusters:

Mileposts: 33.7 – 36.1
36.4 – 36.6
38.2 – 38.7
39.4 – 39.9

III. PROJECTS: None

Light Condition =	Dark =	48.6%	Avg. = 47.3%
Road Condition =	Icy =	37.3%	Avg. = 36.2%
	Wet =	8.9%	Avg. = 8.0%
Weather Condition =	Raining =	11.2%	Avg. = 6.4%

TABLE 12-1

ACRES DISTURBED WITHIN THE PERMIT AREA OF THE MONTANORE PROJECT

Facility		Disturbed Acres	Permit Acres
1.	Lower Libby Creek Portal Area	18.7	219.4
2.	Ramsey Creek Mine/Mill Site	44.9	185.2
3.	Waste Rock Disposal Area and Land Application Disposal No. 1	58.0	246.0
4.	Land Application Disposal No. 2	20.0	225.7
5.	Access Road – Lower Ramsey Creek Mine/Mill Site to Tailings Impoundment	99.4	214.9
6.	Access Road – Lower Libby Portal Site To Ramsey Creek Road	34.4	93.8
7.	Tailing Impoundment Area including All Borrow Sites	993.7	2,458.8
	TOTAL	**1,269.1**	**3,643.8**

Note:

- 22 Acres along USFS road No. 278 from Highway 2 to Bear Creek bridge will be disturbed due to upgrading. This is outside of the permit area.

TABLE 14-1
ESTIMATED MONTANORE EMPLOYMENT: CONSTRUCTION AND OPERATIONS

	YEAR 1				YEAR 2				YEAR 3				YEAR 4				YEAR 5			
EMPLOYMENT BY TYPE	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Construction Employment																				
Percent Local Hire	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Administrative	0	0	15	10	10	10	15	10	5	5	5	5	0	0	0	0	0	0	0	0
Technicians	0	0	15	10	10	10	15	10	10	10	5	5	0	0	0	0	0	0	0	0
Mechanics	0	0	15	10	10	10	15	10	10	10	5	0	0	0	0	0	0	0	0	0
Equipment Operators	0	0	60	60	50	70	80	60	5	5	40	20	0	0	0	0	0	0	0	0
Laborers	0	0	30	20	20	20	30	20	10	10	10	10	0	0	0	0	0	0	0	0
Total	0	0	150	170	110	130	190	170	80	80	90	55	0	0	0	0	0	0	0	0
Direct Employment - Mine	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Percent Local Hire	15	15	15	15	15	15	15	15	20	20	20	20	25	25	25	25	25	25	25	25
Administrative	15	15	15	15	15	15	15	15	20	20	20	20	25	25	25	25	25	25	25	25
Technicians	15	15	15	15	15	15	15	15	20	20	20	20	25	25	25	25	25	25	25	25
Mechanics	0	0	0	0	20	20	20	20	90	90	90	90	90	90	90	90	90	90	90	90
Equipment Operators	0	0	0	0	60	60	60	60	220	220	220	220	220	220	220	220	220	220	220	220
Laborers	0	0	0	0	20	20	20	20	90	90	90	90	90	90	90	90	90	90	90	90
Total	30	30	30	30	130	130	130	130	440	440	440	440	450	450	450	450	450	450	450	450
Total Project Employment	30	30	180	200	240	260	320	300	520	520	530	495	450	450	450	450	450	450	450	450

Source: Noranda Minerals Corp, Libby, Montana, July 1989

TABLE 16-1 TAILINGS IMPOUNDMENT ALTERNATIVES ANALYSIS

PARAMETER – ENGINEERING

Surface Water Control	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Watershed Area	2,430 acres	3,260 acres	1,140 acres
# of diversion dams required	2	2	1
# of diversion channels	2	2	1
Length of diversion channels	23,000 feet	16,000 feet	4,600 feet
Design diversion channel flow (PMF)	7,000 cfs west side 7,000 cfs east side	16,000 cfs west side 4,000 cfs east side	5,000 cfs
Estimated flow for 100 year event	148 cfs	187 cfs	81 cfs
Slope of hillside above diversion channels	2:1	2.5:1	4:1
Maximum relief above diversion channels	1,500 vertical feet	3,000 vertical feet	500 vertical feet
Total disturbed area from diversion channels	200 acres	140 acres	40 acres
Stability and maintenance of diversion channels	Hillside instability would be a source of continuing maintenance problems. Two suspected landslides have been identified near the damsite and more are likely to exist due to the steep topography. Diversion channels would not be reliable for long-term reclamation, as they would be subject to blockage by landslide debris during severe storms.	Hillside instability would be a source of continuing maintenance problems. Diversion channels would not be reliable for long-term reclamation, as they would be subject to blockage by landside debris during severe storms.	Because of the gentle slopes and low relief, hillside instability is not anticipated to be a source of maintenance problems. Diversion channel would be used for long-term reclamation.

	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Excavation volume to construct diversion channels	10 million cubic yards	7 million cubic yards	2 million cubic yards
Cost of diversion channel construction	$19 million	$13 million	$3.75 million
SUMMARY	Site is not well suited to watershed diversion due to 1) large watershed area and 2) height and steepness of mountain slopes on both sides of valley. The surface water control system would be costlier and less reliable than for Little Cherry Creek.	Site is not well suited to watershed diversion due to 1) large watershed area and 2) mountain slopes of both sides of valley. The surface water control system would be costlier and less reliable than for Little Cherry Creek	Topography is well suited to watershed diversion. Surface water control can be accomplished safely and economically.

PARAMETER – ENGINEERING

Pipeline Considerations	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Length of pipeline	5.2 miles	7.4 miles	6.4 miles
Pipeline flow	Pressurized pipe required to pump over ridge between Libby Creek and Midas Creek.	Pressurized pump required to pump over pass west of Midas Point.	Gravity flow
# of creek crossings	2 – Libby Creek and Ramsey Creek	2 – Ramsey Creek and Libby Creek	1 – Poorman Creek

PARAMETER – ENGINEERING

Tailings Impoundment	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Tailings storage capacity	120 million tons	120 million tons	120 million tons
Maximum dam height	460 feet	440 feet	370 feet
Maximum crest length	4,100 feet	5,000 feet	10,000 feet
Final impoundment area	370 acres	440 acres	460 acres
Volume of starter embankments	4.2 million CY	4.3 million CY	2.3 million CY
Total volume of final dam	32.5 million CY	21.4 million CY	31.5 million CY
Source of borrow materials	Diversion channel excavation and areas within and adjacent to reservoir.	Diversion channel excavation and downstream of dam.	Diversion channel excavation and areas within and adjacent to reservoir.
Seepage control at dam	Foundation soils and bedrock generally have very low permeability (10^5 to less than 10^{-6} cm/sec). Bedrock is shallower than at Little Cherry. Artesian conditions were not observed in the foundation, although the potential for artesian pressures exists due to the mountainous site topography.	Site not investigated with field explorations. Based on surface reconnaissance, bedrock may be shallower than at Little Cherry Creek, but soils may be more pervious. Potential for artesian pressures in dam foundation exists due to the mountainous site topography.	Foundation soils generally have low permeability (10^{-5} to 10^{-6} cm/sec). Bedrock permeability is of the same order as that of the foundation soils. Artesian conditions exist in foundation soils and will require control by relief wells.
Length of realigned roads	9,700 feet	3,500 feet	2,500 feet

	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Long-term stability of dams	Because the diversion channels would not be reliable for long term reclamation, the final dam would require a spillway excavated into one of the dam abutments and enough freeboard for the spillway to pass the PMF without overtopping.	Because the diversion channels would not be reliable for long term reclamation, the final dam would require a spillway excavated into one of the dam abutments and enough freeboard for the spillway to pass the PMF without overtopping.	Tailings surface would be graded to drain upstream toward a natural outlet at the backside of the impoundment and into Bear Creek. No spillway or crest freeboard would be required at the dam.
Cost and time schedule for final design	$1 to 1.5 million 1 to 2 years	$1 to 1.5 million 1 to 2 years	$.3 to .4 million 5 to 6 months
Cost of starter impoundment (not including diversion channels)	$20 million	$21 million	$11.8 million
SUMMARY	Site would require initial construction of large started tailings dam and diversion dams. Long-term reclamation of impoundment would be complicated by length and dimensions of stream diversions.	Site would require initial construction of large started tailings dam and diversion dams. Long-term reclamation of impoundment would be complicated by length and dimensions of stream diversions.	Site requires comparatively smaller initial dams and is best suited to a reclamation plan that minimizes the potential for tailings erosion and transport.

PARAMETER - ENVIRONMENTAL ISSUES

Fisheries	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Impacts to fisheries	Nursery fishery and good spawning habitat	Nursery fishery and poor spawning habitat	Nursery fishery and moderate spawning habitat
Miles of stream affected	2.4 miles	3.1 miles	1.3 miles

PARAMETER - ENVIRONMENTAL ISSUES

Wetlands	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Acreage of Wetlands Affected	6.5 acres	45 acres	32.9 acres
Function and Value of Wetlands affected	Wildlife habitat	Wildlife habitat; waterfowl nesting habitat	Wildlife habitat; waterfowl nesting habitat
SUMMARY	Minor impacts to wetlands	Moderate impacts to wetlands; mitigation potential low near project area	Moderate impacts to wetlands; mitigation potential high near project area

PARAMETER - ENVIRONMENTAL ISSUES

Wildlife	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Impacts to wildlife	Loss of summer / fall big game habitat	Loss of summer / fall big game habitat	Loss of summer / fall big game habitat
SUMMARY	Moderate impacts to big game and wildlife habitat	Moderate impacts to big game and wildlife habitat	Loss of moose winter range; moderate impacts to big game and wildlife habitat

PARAMETER - ENVIRONMENTAL ISSUES

Threatened and endangered and sensitive species	**MIDAS CREEK**	**STANDARD LAKE**	**LITTLE CHERRY CREEK**
Impacts to T/E and Sensitive species	Inhibits access to spring grizzly bear habitat on Horse Mountain; removes tailed frog habitat; impacts 77 grizzly bear habitat units	Inhibits access to spring grizzly bear habitat between Cabinet Mountains and habitat east of Howard Lake; removes tailed frog habitat; impacts 98 grizzly bear habitat units	Minimal impact on grizzly bear habitat and movement; removes tailed frog habitat; effects population of northern beachfern; impacts fewest grizzly bear habitat units
SUMMARY	Moderate impacts to grizzly bear and other sensitive species	Moderate impacts to grizzly bear and other sensitive species	Minor impacts to grizzly bear and moderate impact to other sensitive species

PARAMETER - ENVIRONMENTAL ISSUES

Timber	**MIDAS CREEK**	**STANDARD LAKE**	**LITTLE CHERRY CREEK**
Acreages of old-growth affected	206 acres	0 acres	18 acres
Potential loss of productive timberland	High	Moderate	Low

AFFECTS ON SCHEDULING MINE DEVELOPMENT

	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Compatibility with Noranda's plans and schedules	Would require 2.5 to 3 years for tailings impoundment construction	Would require 2.5 to 3 years for tailings impoundment construction	Would require 1.5 to 2 years for tailings impoundment construction
Costs of delays	Estimate $15 million lost interest on investment and 1 year delay in positive cash flow over Little Cherry Creek alternative	Estimate $15 million lost interest on investment and 1 year delay in positive cash flow over Little Cherry Creek alternative	Constructed per project schedule
SUMMARY	Significant cost and scheduling impacts to project	Significant cost and scheduling impacts to project	Meets project cost and time schedule estimates

VISUALS

	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Variety Class / Visual Quality Objectives	B/Moderation/ Maximum/moderation	B/Partial Retention/ Moderation	B/Moderation
Visual Sensitivity/ Visual Absorption Capacity/ Visibility from established viewpoints	2 / Moderate / High	2 / Moderate / High	2 / Moderate High / Moderate
SUMMARY	Visible from USFS #231 North Libby Creek Point, Libby Divide Trail Viewpoint and Libby Divide Trail at Horse Mtn Viewpoint	Eliminates USFS #231 North Vista Point (under dam), visible from USFS #231 South Vista Points and Great Northern Mtn Viewpoint	Visible from Snowshoe Peak, Horse Mtn and USFS #231

RECREATION

Impacts to recreation	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Roads eliminated or rerouted	USFS #4778	USFS #6745 and 231	USFS #231
SUMMARY	Impacts Libby Creek road by increased activity and diminishes pleasure activity of driving Libby Creek route, impacts recreational access to Howard Lake campground.	Impacts Libby Creek road by increased activity and diminishes pleasure activity of driving Libby Creek route, impacts recreational access to Howard Lake campground from both the south and the north.	Libby Creek Road slightly impacted.

COMPATIBILITY WITH FOREST PLAN

	MIDAS CREEK	STANDARD LAKE	LITTLE CHERRY CREEK
Management Area Designation	13 and 15	2, 13 and 14	13 and 14
SUMMARY	Sold old growth and some high yield timber areas	Includes roadless recreation areas, old growth timber and managed timber harvest	Includes both old growth timber areas and managed timber harvest areas

TABLE 16-2
CONSTRUCTION MATERIAL SUMMARY[a]

ZONE	DESCRIPTION	MATERIAL	SOURCE	LIFT THICKENS (IN.)	COMPACTION
1	Earthfill	Clayey silty and silty gravelly soils, coarse particles routed to exterior slopes	On-site borrow and diversion channel excavation	8-12	95% ASTM D698
2	Cycloned Sand	10% finer than 0.074mm (No. 200 Sieve)	Mill operation	8 (parallel to slope)	4 passes of D8 Dozer [b]
3	Rockfill	24 inches maximum size	Mine waste or quarry	24	4 passes of 10-ton vibratory roller or D8 Dozer [b]
4	Filter	Well-graded, 1-inch maximum size and not more than 2% finer than 0.074mm	Mine waste, quarry or import	9	4 passes of D8 Dozer [b]
5	Blanket Drain	Well-graded, 3-inch maximum size	Mine waste, quarry or import	12	4 passes of D8 Dozer [b]
6	Riprap	Well-graded, 30-inch average size	Mine waste or quarry	36	Dumped

Notes:

a. Subject to confirmation during final design.
b. Or equivalent dozer

TABLE 16-3
ESTIMATED CONSTRUCTION QUANTITIES

Fill	Maximum Embankment Height (ft)	Embankment Length (ft)	Zone 1: Earthfill (c.y.)	Zone 2: Coarse Tailings (c.y.)	Zone 3: Rockfill (c.y.)	Zone 4: Filter (c.y.)	Zone 5: Blanket Drain (c.y.)	Zone 6: Riprap (c.y.)	Excavation (c.y.)	Total Embankment Fill (c.y.)
Starter Dam	120	3,050	762,000		433,000	30,000				1,225,000
Toe Dike	100	6,600			789,000	75,000				864,000
Final Dam	380	5,950		27,844,000		463,000	281,000			28,588,000
North Earthfill Saddle Dam	40	1,400	111,000							111,000
South Earthfill Saddle Dam	130	3,550	1,681,000		465,000	37,000				2,183,000
Total Tailings Retention Dam										32,971,000
Diversion Dam	85	850	173,000		66,000	5,000		8,000		252,000
Seepage Collection Dam	80	500	66,000		42,000	7,000		2,000		117,000
Excavation: Diversion Channel								56,000	1,755,000	---
Collection Ditches								12,000	24,000	---
Seepage Collection Pond									240,000	---
TOTALS			2,793,000	27,844,000	1,795,000	617,000	281,000	78,000	2,019,000	33,340,000

Stripping – 1,000,000 c.y.

TABLE 16-4

SUMMARY OF FIELD PERMEABILITY TEST RESULTS

Borehole	Material	Type of Test	Permeability (10^{-6} cm/sec)
USB-3	Weathered rock	Packer Test	<1 to 29
USB-4	Silty sandy gravel, cobbles and boulders	Constant Head	100 to 1800
USB-5	Gravelly silty sand Silty clay-clayey silt	Constant Head Constant Head	14 to 70 3 to 7
LCTM-8	Silty sandy gravel, cobbles and boulders	Pump Test	130
LCT-9	Silty gravel with boulders	Slug Test	90
LCM-10	Gravel, silt and sand	Slug Test	2
LCM-11	Silty sandy gravel, cobbles and boulders	Slug Test	24
PLCM-6 (shallow)	Silty sandy gravel	Slug Test	1900
PLCM-6 (deep)	Silty sandy gravel	Flow Test (Constant Drawdown)	4500 to 6900
DH-1	Gravelly sandy silt Weathered rock	Constant Head Packer Test	<1 to 6 2
DH-2	Weathered rock	Packer Test	16 to 234
DH-4	Weathered rock	Packer Test	14 to 20
DH-5	Clayey sandy silt, cobbles and boulders Weathered rock	Constant Head Packer Test	<1 to 28 <1 to 2
DH-6	Clayey sandy silt, gravel and cobbles	Constant Head	<1
DH-7	Weathered rock	Packer Test	23 to 79
DH-8	Weathered rock	Packer Test	4 to 7
DH-9	Weathered rock	Packer Test	72 to 115
DH-10	Weathered rock	Packer Test	131 to 721
DH-11	Cobbles, gravel, sand, silt and clay Weathered rock	Packer Test Packer Test	7 2
DH-13	Weathered rock	Packer Test	2 to 146

TABLE 16-4

SUMMARY OF FIELD PERMEABILITY TEST RESULTS

Borehole	Material	Type of Test	Permeability (10^{-6} cm/sec)
DH-14	Weathered rock	Packer Test	12 to 46
DH-17	Cobbles, gravel, and clayey sandy silt	Constant Head	<1
	Weathered Rock	Packer Test	<1
DH-18	Clayey sandy silt	Constant Head	<1 to 2
DH-19	Weathered rock	Packer Test	87 to 196
DH-20	Gravels, cobbles and boulders in clayey sandy silt	Constant Head	<1 to 2
	Weathered Rock	Packer Test	<1 to 2
DH-21	Silt and sand	Falling Head	5
	Silty gravel with sand	Packer Test	<1 to 2
	Weathered rock	Packer Test	<1 to 4
DH-22	Silty sand with gravel	Falling Head	20
	Silty sand with gravel	Packer Test	17 to 21
	Weathered rock	Packer Test	8 to 16
DH-23	Silt with gravel	Packer Test	<1
	Silt	Falling Head	4
DH-24	Clayey gravel with sand	Falling Head	7
	Clayey gravel with sand	Packer Test	<1 to 750
	Weathered rock	Packer Test	310 to 450
DH-25	Clay with gravel	Packer Test	<1 to 2
DH-26	Clayey gravel with sand	Packer Test	<1 to 75

TABLE 16-4

SUMMARY OF FIELD PERMEABILITY TEST RESULTS

Borehole	Material	Type of Test	Permeability (10^{-6} cm/sec)
DH-27	Clayey gravel with cobbles	Packer Test	<1 to 20
	Weathered rock	Packer Test	<1 to 2
DH-31	Silty gravel with sand	Packer Test	<1
	Weathered rock	Packer Test	<1 to 4
DH-32	Weathered rock	Packer Test	<1
DH-32a	Gravelly clay with sand	Packer Test	<1 to 33
DH-38	Sandy clay	Falling Head	<1
	Clayey gravel and cobbles	Packer Test	<1 to 34
	Weathered rock	Packer Test	<1
DH-39	Silty gravel	Packer Test	<1
	Weathered rock	Packer Test	50 to 57
	Slightly weathered rock	Packer Test	<1 to 53
DH-40	Silty gravel with sand and cobbles	Packer Test	<1 to 9
	Weathered rock	Packer Test	<1 to 10
DH-41	Weathered rock	Packer Test	<1 to 10
DH-42	Weathered rock	Packer Test	<1 to 13
DH-43	Silty gravel with sand	Packer Test	2
	Weathered rock	Packer Test	<3 to 13
DH-44	Sandy clay; silty gravel	Packer Test	<1
DH-46	Weathered rock	Packer Test	<1 to 56
DH-47	Silty gravel and cobbles with sand	Packer Test	<2
DH-48	Slightly weathered rock	Packer Test	2 to 3
DH-49	Weathered rock	Packer Test	<3 to 29
DH-50	Slightly weathered rock	Packer Test	93 to 152
DH-51	Weathered rock	Packer Test	15 to 46

TABLE 16-5
SIGNIFICANT EARTHQUAKES IN SITE REGION [1]

Date	Location	Magnitude [2]	Maximum Intensity [3]	Approx. Distance to Project Site (Miles)
2-25-71	S.E. of Libby, MT	---	IV	14
6-26-64	Marion, MT	4.7	IV	21
3-12-18	Lake Pend Oreille, ID	---	IV	27
4-15-52	Whitepine, MT	---	IV	30
8-16-60	Sandpoint, ID	---	IV	47
7-10-30	Missoula, MT	---	V	48
12-19-57	Wallace, ID	5.0	VI	48
11-28-56	Wallace, ID	---	V	48
5-9-44	Wallace, ID	---	IV	48
6-8-54	Wallace, ID	---	V	50
9-34-61	Wallace, ID	---	IV	51
11-1-42	WA/ID border	---	VI	52
9-23-45	Flathead Lake, MT	5.5[5]	VII	65
2-4-75	Creston/Kalispell, MT [8]	4.6	VI	66
3-31-52	Big Fork, MT	5.5[5]	VII	70
7-31-69 to 10-30-70	Canada (9 events)[4]	5.0 to 5.3	VI	116 to 128
12-20-72	Canada	5.1	VI	116
7-16-36	Milton-Freewater, OR	5.75[5]	VII	205
8-17-59	Hebgen Lake, MT	7.5[6]	X, V[7]	293
10-28-83	Borah Peak, ID	7.3[6]	IX, V[7]	310

Notes:

(1) Sources of data: NOAA data file and Qamar and Stickney (1983). Earthquakes with M less than 5 and more than 50 miles from the site are not included.

(2) Magnitudes are body wave magnitudes (m_b) except as otherwise noted.

(3) Epicentral Modified Mercalli Intensity.

(4) Swarm of 9 earthquakes with M greater than 5.

(5) Estimated magnitude.

(6) Surface wave magnitude (M_s).

(7) Reported local intensity at Libby, Montana.

(8) Representative event; numerous other earthquakes with M less than 5 have occurred near Flathead Lake.

TABLE 16-6
SOIL PARAMETERS FOR STABILITY ANALYSES

Description	Wet Unit Weight (pcf)	Saturated Unit Weight* (pcf)	Effective Friction Weight (degrees)	Effective Angle Cohesion (psf)
Starter Dam Earthfill	124	133	35	0
Cycloned Sand	110	123	33	0
Toe Dike and Starter Dam Rockfill	140	145	42	0
Foundation Layer 1	---	135	35	0
Foundation Layer 1	125	---	0**	2000**
Foundation Layer 2	---	141	38	0
Fine Tailings	---	110	0	0

* Materials below phreatic surface.
** Total stress parameters; all other parameters are in terms of effective stresses.

TABLE 16-7
RESULTS OF STABILITY ANALYSES

Case	Load Condition	Embankment Stage	Slope	Minimum Acceptable Factor of Safety [a]	Calculated Factor of Safety
1A	End-of-Construction	Starter Dam [b]	Upstream	1.3	1.41
1B	End-of-Construction	Starter Dam	Downstream	1.3	1.55-2.02
2A	Steady-State Seepage	Starter Dam	Downstream	1.5	1.62
2B	Steady-State Seepage	Final Dam [c]	Downstream	1.5	1.97
3	Design Flood [d]	Final Dam	Downstream	1.4	1.65
4A	Seismic [e]	Starter Dam	Downstream	1.0	1.23
4B	Seismic [e]	Final Dam	Downstream	1.0	1.46

Notes:

a. From Corps of Engineers (1970)
b. Crest El. 3,500
c. Crest El. 3,700
d. 24-hour PMP plus Snowmelt
e. Seismic Coefficient = 0.10g

MONTANA PROJECT

WATER CHEMISTRY DATA

TABLE 16-8

	GROUNDWATER[a]													LIBBY CREEK[a] (STATION LB-2000)		TAILINGS EFFLUENT[c]	
WELL:	LCM-011[b]		LCM-010		LCTM-008	PLCM-6SH		PLCM-6DP		PLCM-6DP		LCM-009					
DATE:	8-15-88	10-22-88	8-16-88	11-3-88	8-17-88	8-18-88	10-21-88	8-18-88	10-21-88	8-18-88	10-21-88	8-19-88	10-21-88	10-17-88	11-14-88		
PARAMETER																	PARAMETER
pH - Field	9	8.4	6.9	-	7.1	8.9	8.1	7.1	7.3	7.2	-	7.2	7.1				pH - Field
pH - Lab	9	8.5	7.4	7.6	7.2	8.7	8.1	7.8	7.8	7.8	7.8	7.2	7.2	7.4	7.2	7.6	pH - Lab
SC - Field	240	173	154	-	186	196	161	180	162	170	-	202	184				SC - Field
SC - Lab	244	189	156	154	193	208	198	177	176	179	178	208	196	65	23		SC - Lab
(mg/l):																	(mg/l):
TDS	148	100	108	100	108	145	112	102	101	90	96	112	115	41	22		TDS
TSS														< 1	2		TSS
Hardness	137	77	57	47	95	119	86	92	93	80	93	110	86	26	8		Hardness
Calcium	30	19	16	12	23	31	21	25	24	22	24	29	21	7	3	12	Calcium
Magnesium	15	7	4	4	9	10	8	7	8	6	8	9	8	2	< 1	3	Magnesium
Sodium	48	11	12	10	7	8	5	4	2	2	2	8	7	1	1	13	Sodium
Potassium	3	3	7	5	2	2	1	< 1	1	< 1	< 1	2	2	< 1	1	24	Potassium
Alkalinity, total	203	101	81	78	96	122	106	94	92	97	92	108	94	34	11		Alkalinity, total
Alkalinity, bicarb.	197	123	9	95	117	129	129	115	112	118	112	132	115	41	13		Alkalinity, bicarb.
Alkalinity, carb.	25	0	0	0	0	10	0	0	0	0	0	0	0	0	0		Alkalinity, carb.
Alkalinity, hydrox.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		Alkalinity, hydrox.
Chloride	4	2	5	2	< 1	1	< 1	1	1	< 1	< 1	2	2	< 1	< 1		Chloride
Fluoride	0.12	0.12	0.11	0.21	0.09	0.11	0.14	0.09	0.1	0.06	0.1	0.12	0.15	< 0.05	< 0.05		Fluoride
Nitrate & Nitrite	0.58	0.32	0.11	0.32	0.87	0.15	0.57	0.04	0.04	0.03	0.03	0.65	1.38	0.03	0.09		Nitrate & Nitrite
Sulfate	7	11	6	3	3	2	1	1	< 1	1	1	3	2	2	1		Sulfate
Aluminum	< 0.1	< 0.01	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.8	< 0.1	< 0.1	0.1	Aluminum
Arsenic	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	Arsenic
Cadmium	< 0.001	< 0.001	0.001	0.001	0.006	0.002	< 0.002	0.001	< 0.001	0.004	0.002	0.003	0.002	0.0007	0.0005	< 0.001	Cadmium
Chromium	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	Chromium
Copper	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.001	< 0.001	< 0.01	Copper
Iron	< 0.05	< 0.05	< 0.05	0.07	< 0.05	< 0.05	0.14	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.55	< 0.05	0.06	0.05	Iron
Lead	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.001	< 0.001	< 0.01	Lead
Manganese	0.81	0.02	0.33	1.09	0.14	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.76	0.13	< 0.02	< 0.02	0.06	Manganese
Mercury	< 0.0002	< 0.0002	< 0.0002	0.0003	< 0.0002	< 0.0002	0.0003	< 0.0002	0.0002	< 0.0002	0.0002	< 0.0002	0.0002	< 0.0002	< 0.0002	< 0.001	Mercury
Molybdenum	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.01	Molybdenum
Silver	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.0003	< 0.0002	< 0.005	Silver
Zinc	< 0.02	< 0.02	< 0.02	< 0.02	0.2	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.21	< 0.02	< 0.02	< 0.02	< 0.01	Zinc
Ammonia																	Ammonia
Antimony																0.01	Antimony
Cobalt																< 0.01	Cobalt
Beryllium																< 0.005	Beryllium
Barium																< 0.1	Barium
Selenium																< 0.005	Selenium
Phosphorous														0.01	< 0.005		Phosphorous
Nickel																< 0.03	Nickel

NOTES:

a. From Chen-Northern (1989).

b. Wells are located in the vicinity of impoundment site.

c. From Energy Laboratories Inc., Water Analysis, Final Tailings Solution, Cycle 5, 12-20-88.

TABLE 16-9

TAILINGS EFFLUENT WATER CHEMISTRY DATA

	Troy Tailings Pond	Montanore Tailings Effluent
pH-Lab	7.5 S.U.	7.5 S.U.
Sc-Lab	366 µmhos/cm	214 µmhos/cm
TDS	---	131
Calcium	18	12
Magnesium	5.9	2.3
Sodium	20	12
Potassium	31	---
Chloride	6.0	6.1
Sulfate	23	12
Alkalinity (total)	---	76
Alkalinity (bicarb)	---	76
Aluminum	.5	---
Cadmium	< .003	---
Copper	<.011	---
Iron	.05	---
Lead	<.018	---
Manganese	.046	---
Silver	< .003	---
Zinc	.021	---
Nitrate	15.5	---
Ammonia	6.9	---

Notes:

1. All values milligrams per liter except as noted.
2. ASARCO Troy data from Montanore Water Quality Bureau Files, mean values from approximately 50 samples for common ions and one to six samples for dissolved metals.
3. Montanore tailings effluent from locked cycle testing cycle 5 (same sample as used for Table 16-12).

TABLE 16-10
COMPARISON OF WATER QUALITY PREDICTED FOR MONTANORE PROJECT ORE AND WATER QUALITY IN ASARCO TROY PROJECT TAILINGS POND

Parameter	ASARCO Troy Project	Noranda Montanore Project
Ph	7.5	7.6
Calcium	18	12
Magnesium	5.9	3
Sodium	20	13
Potassium	31	24
Aluminum	---	0.1
Arsenic	< 0.001	< 0.005
Cadmium	< .003	< .0001
Chromium	---	< 0.02
Copper	< .011	< 0.01
Iron	.05	0.05
Lead	<. 018	<0.01
Manganese	.016	0.06
Mercury	---	<0.001
Molybdenum	---	0.01
Silver	< .003	<0.005
Zinc	.021	<0.01
Ammonia	---	---
Antimony	---	0.01
Cobalt	---	<0.01
Beryllium	---	<0.005
Barium	---	<0.1
Selenium	<0.002	<0.005
Phosphorous	---	---
Nickel	---	<0.03

Notes:

- All parameters measured as dissolved and in mg/L except as indicated.
- There are few differences between these two data sets. Zinc in the Troy project decant water is higher than in the Montanore Project water but the difference is relatively small.
- Presently, the water quality from the Noranda metallurgical testing is the best estimate of probable project water quality.

TABLE 17-1
WATER RIGHTS IN PROJECT
AREA VICINITY

USE (A)	RATE (B)	PRIORITY DATE	QTR SECT.	SECT.	TWNSHP	RANGE	SOURCE NAME	OWNER NAME
MN			SENESE	18	28N	30W	LIBBY CREEK	PETERSON, MELDON
IR	646.00 G	5/8/1901	SENWSW	1	29N	31W	LIBBY CREEK	RAMBO, VIOLA
ST		4/1/1912	SESWNE	7	29N	30W	LIBBY CREEK	US DEPT OF AGRICULTURE FOREST
DM	40.00 G	2/1/1920	SESWSW	29	29N	30W	LIBBY CREEK	MAKI, TERRENCE
OR	1.71 C	3/25/1927	SESENE	5	28N	30W	LIBBY CREEK	COUP, JACK
OR	1.71 C	3/25/1927	SESENE	5	28N	30W	LIBBY CREEK	BEEBE, JOHN
OR	408.00 G	4/1/1927	SESESE	30	29N	30W	LIBBY CREEK	MAKI, TERRENCE
ST	30.00 G	4/1/1927	SENESW	29	29N	30W	LIBBY CREEK	MAKI, TERRENCE
OR	80.00 G	4/1/1927	NESWSW	29	29N	30W	LIBBY CREEK	MAKI, TERRENCE
ST	30.00 G	4/1/1927	SESESE	30	29N	30W	LIBBY CREEK	MAKI, TERRENCE
IR	.38 C	8/9/1930	SESENW	19	29N	30W	LIBBY CREEK	DECKER, CHARLES
FR	897.60 G	9/11/1930	SWSWNE	1	29N	31W	LIBBY CREEK	MONTANA, STATE DEPT OF FISH
FW	897.60 G	9/11/1930	SWNWNE	1	29N	31W	LIBBY CREEK	MONTANA, STATE DEPT OF FISH
FP	50.00 G	9/11/1930	SWSWNE	1	29N	31W	LIBBY CREEK	MONTANA, STATE DEPT OF FISH
DM	20.00 G	9/11/1930	SWSWNE	1	29N	31W	LIBBY CREEK	MONTANA, STATE DEPT OF FISH
DM	15.00 G	6/3/1936	SWNWNW	16	28N	30W	LIBBY CREEK	MCGRAW, ALLEN
FR	10.00 C	8/10/1942	SWSENW	1	29N	31W	LIBBY CREEK	MONTANA, STATE DEPT OF FISH
ST		5/31/1947	NENWNW	20	29N	30W	LIBBY CREEK	BOYD, JOHN
DM	4.00 G	5/31/1947	SENWNW	20	29N	30W	LIBBY CREEK	BOYD, JOHN
IR	.87 C	5/31/1947	E2NWNW	20	29N	30W	LIBBY CREEK	BOYD, JOHN
IR	323.00 G	9/1/1947	SESENE	30	29N	30W	LIBBY CREEK	TANGEN, ILENE
DM	30.00 G	12/31/1947	NENWSW	29	29N	30W	LIBBY CREEK	TANGEN, ILENE
DM	20.00 G	6/15/1955	NENENE	24	29N	31W	LIBBY CREEK	HUNTBERGER, GARY
ST	20.00 G	6/15/1955	NENENE	24	29N	31W	LIBBY CREEK	HUNTBERGER, GARY
ST		4/1/1961	NENWSE	13	29N	31W	LIBBY CREEK	CRISMORE, CAROL
IR	30.00 G	4/1/1961	SENESE	13	29N	31W	LIBBY CREEK	CRISMORE, CAROL
IR	30.00 G	4/1/1961	NENWSE	13	29N	30W	LIBBY CREEK	CRISMORE, WILLIAM
DM	10.00 G	3/13/1963	SWSESW	30	29N	30W	LIBBY CREEK	BEEBE, JOHN
ST	10.00 G	3/13/1963	SWSESW	30	29N	30W	LIBBY CREEK	BEEBE, JOHN
IR	96.00 G	5/3/1963	E2SWNW	19	29N	30W	LIBBY CREEK	MICHELS, GERALD

TABLE 17-1
WATER RIGHTS IN PROJECT
AREA VICINITY

USE (A)	RATE (B)	PRIORITY DATE	QTR SECT.	SECT.	TWNSHP	RANGE	SOURCE NAME	OWNER NAME
CN	.22 C	6/1/1963	SWSESW	30	29N	30W	LIBBY CREEK	US DEPT OF AGRICULTURE FOREST
IR	1.00 C	6/1/1963	NWNESW	19	29N	30W	LIBBY CREEK	MAURER, DOROTHY
ST		9/1/1963	NENWSW	19	29N	30W	LIBBY CREEK	MAURER, DOROTHY
IR	15.00 G	8/1/1965	NENESW	1	29N	31W	LIBBY CREEK	HALVORSON, JEANETTE
DM	15.00 G	11/17/1972	SENESW	1	29N	31W	LIBBY CREEK	EVANS, CHARLES
IR	.11 C	6/29/1973	E2NESW	1	29N	31W	LIBBY CREEK	EVANS, KELLY
ST		6/29/1973	E2NESW	1	29N	31W	LIBBY CREEK	EVANS, CLAIRE
MN	100.00 G	2/28/1980	NWSESE	18	28N	30W	LIBBY CREEK	BECKSTROM, KENNETH
MN	200.00 G	4/29/1985	S2NE	17	28N	30W	LIBBY CREEK	ERICKSMOEN, WILLIAM
MN	400.00 G	12/2/1986	SENENE	18	28N	30W	LIBBY CREEK	AUMCO
PA	100.00 G	4/21/1988	SENENE	11	27N	31W	LIBBY CREEK	US BORAX & CHEMICAL CORP
ED	20.00 G	4/21/1988	NESWSW	15	27N	31W	LIBBY CREEK	US BORAX & CHEMICAL CORP
MN			NESENE	13	28N	31W	BEAR CREEK	LIBBY PLACER MINING COMPANY
MN			SWNESW	21	28N	31W	BEAR CREEK	LIBBY PLACER MINING COMPANY
MN			SESWNW	2	27N	31W	RAMSEY CREEK	LIBBY PLACER MINING COMPANY
MN	1.00 C	12/17/1900	NESESE	3	27N	31W	RAMSEY CREEK	LIBBY PLACER MINING COMPANY
ED	20.00 G	4/21/1988	SESENW	9	27N	31W	RAMSEY CREEK	NORANDA MINERALS CORP
MN			SWSENW	35	28N	31W	POORMAN CREEK	LIBBY PLACER MINING COMPANY
MN			SWSWSE	25	28N	31W	POORMAN CREEK	LIBBY PLACER MINING COMPANY
MN			SWSENW	35	28N	31W	POORMAN CREEK	LIBBY PLACER MINING COMPANY
ED	100.00 G	4/21/1988	SENENE	35	28N	31W	POORMAN CREEK	NORANDA MINERALS CORP
ED	100.00 G	4/21/1988	NWNWNW	26	28N	31W	L. CHERRY CREEK	NORANDA MINERALS CORP

(A) CM - Commercial; DM - Domestic; FW - Fish/Wildlife; IN - Industrial; IR - Irrigation; MN - Mining;
SS - Supplemental Sprinkler Irrigation; ST - Stock Water; ED - Exploratory Drilling; FR - Fish Raceways;
FP - Fire Protection; PA - Pollution Abatement

(B) G = Gallons per Minute; C = Cubic Feet per second

TABLE 29-1
PROPOSED ANALYSES FOR SURFACE AND GROUND WATER SAMPLES

Specific conductivity (1.0) §	Flow or static water level (wells)
Total suspended solids (1.0)	Aluminum (0.1)
Total dissolved solids (1.0)	Arsenic (0.005)
Sodium (1.0)	Cadmium (0.0001)
Calcium (1.0)	Chromium (0.004)
Magnesium (1.0)	Copper (0.001)
Potassium (1.0)	Iron (0.05)
Carbonate (1.0)	Lead (0.0007)
Bicarbonate (1.0)	Manganese (0.02)
Chloride (1.0)	Mercury (0.0002)
Sulfate (1.0)	Silver (0.0002)
Nitrite + Nitrate as N (0.01)	Zinc (0.02)
Total Kjeldahl nitrogen as N (0.2)	Field Temperature (°C)
Total phosphorous as P (0.005)	Total alkalinity (as $CaCO_3$) (1.0)
Ammonia (0.05)	Total hardness (as $CaCO_3$) (1.0)
pH	Turbidity (0.1)

Source: Chen-Northern, Inc. 1991b; revised by the agencies

§ Proposed analytical detection limits are shown in parentheses in mg/L.

TABLE 29-2

PROPOSED SURFACE WATER MONITORING STATIONS

Station	Location	Purpose
Libby Creek		
LB 200	Above Libby Creek adit	Provide reference station on Upper Libby Creek
LB 300	Upstream of the Howard Lake confluence	Assess potential impacts from the Libby Creek land application area (LAD)
LB 1000	Downstream of Poorman Creek and Midas Creek confluences	Assess potential cumulative impacts from Ramsey Creek and Libby Creek LAD area and plant site
LB 2000	Downstream of Little Cherry Creek confluence	Assess potential impacts from tailings impoundment
LB 3000	Upstream of the Crazyman Creek confluence	Assess potential cumulative impacts from upstream sources
Ramsey Creek		
RA 100	Above Ramsey Creek plant site	Provide reference station on upper Ramsey Creek
RA 200	Below Ramsey Creek Site	Assess potential impacts from the plant site
RA 550	Above Libby Creek	Assess potential impacts from the plant site and Ramsey Creek LAD area
Little Cherry Creek		
LC 100	Above tailings impoundment	Provide reference station on Little Cherry Creek
LC 800	Upstream from the Libby Creek confluence	Assess potential impacts from tailings impoundment
Poorman Creek		
PM 500	Upstream on Poorman Creek	Provide reference station on upper Poorman Creek
PM 1000	Upstream from the Libby Creek confluence	Assess potential impacts from Ramsey Creek LAD area
Bear Creek		
BC 500	Upstream from any disturbance and above USFS Road #278	Provide reference data from an undisturbed tributary station

TABLE 29-3
PROPOSED AQUATIC LIFE MONITORING STATIONS

Station	Location	Purpose
Libby Creek		
L 10 (LB 200)	Above Libby Creek Adit	Provide reference station on upper Libby Creek
L 9 (LB 300)	Upstream of the Howard Lake confluence	Assess potential impacts from the Libby Creek LAD area
L 3 (LB 1000)	Downstream of Poorman Creek and Midas Creek confluences	Assess potential cumulative impacts from Ramsey Creek and Libby Creek LAD area and plant site
L 2 (LB 2000)	Upstream of Bear Creek	Assess potential cumulative impacts from upstream sources in conjunction with continuous surface water flow monitoring
L 1 (LB 3000)	Upstream of Crazyman Creek confluence	Assess potential cumulative impacts from upstream sources
Ramsey Creek		
Ra 2 (LC 800)	Upstream from Libby Creek confluence	Assess potential impacts from the Ramsey Creek plant site and LAD area
Little Cherry Creek		
LC 1 (LC 800)	Upstream from Libby Creek confluence	Assess potential impacts from tailings impoundment
Poorman Creek		
PO 1 (PM 1000)	Upstream from Libby Creek confluence	Assess potential impacts from Ramsey Creek LAD area
Bear Creek		
Be 2 (BC 500)	Upstream from any disturbance and above USFS Road #278	Provide reference data from an undisturbed tributary station

TABLE 30-1
AVERAGE PROCESS MINE WATER BALANCE, (gpm)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 16
MINE AND ADIT DISCHARGE							
Total Discharge	588	631	674	717	760	1,188	1,198
Discharge to LAD	0	0	0	0	0	78	183
Net Discharge to Mill	588	631	674	717	760	1,110	1,015
OFFICE INFLOW							
Potable Water	11	11	11	11	11	11	11
OFFICE OUTFLOW							
Discharge to Tailings Pond	11	11	11	11	11	11	11
MILL INFLOW							
Net Discharge from Adit	588	631	674	717	760	1,110	1,015
Makeup Water	0	20	385	377	370	0	0
Water in Ore	90	131	166	166	166	166	166
Thickener Reclaim	4,672	6,835	8,652	8,652	8,652	8,652	8,652
Tailings Reclaim	421	826	810	775	739	759	854
Subtotal	5,771	8,443	10,687	10,687	10,687	10,687	10,687
MILL OUTFLOW							
Tailings to Thickener	5,768	8,438	10,681	10,681	10,681	10,681	10,681
Water in Concentrate	3	5	6	6	6	6	6
Subtotal	5,771	8,443	10,687	10,687	10,687	10,687	10,687
THICKENER INFLOW							
Tailings from Mill	5,768	8,438	10,681	10,681	10,681	10,681	10,681
THICKENER OUTFLOW							
Coarse Tailings to Impoundment	289	423	535	535	535	535	535
Fine Tailings to Impoundment	807	1,180	1,494	1,494	1,494	1,494	1,494
To Mill	4,672	6,835	8,652	8,652	8,652	8,652	8,652
Subtotal	5,768	8,438	10,681	10,681	10,681	10,681	10,681
TAILINGS POND INFLOW							
Storage	0	131	0	0	0	0	0
Precipitation	260	343	425	508	590	800	1,020
Coarse Tailings from Thickener	289	423	535	535	535	535	535
Fine Tailings from Thickener	807	1,180	1,494	1,494	1,494	1,494	1,494
Embankment Seepage Return	222	344	449	477	501	593	673
Relief Well Return	60	80	100	120	140	240	390
Sanitary Waste Water	11	11	11	11	11	11	11
Subtotal	1,649	2,512	3,014	3,145	3,271	3,673	4,123
TAILINGS POND OUTFLOW							
Dust Suppression (evaporation)	4	6	8	10	12	22	42
Enhanced Evaporation	0	0	0	0	0	20	40
Natural Evaporation	115	191	268	344	420	570	730
Water in Coarse Tailings	81	119	150	150	150	150	150
Water in Fine Tailings	625	916	1,159	1,159	1,159	1,159	1,159
Seepage into Groundwater	50	110	170	230	290	400	475
Seepage Through Embankment	222	344	449	477	501	593	673
Tailings Reclaim to Mill	421	826	810	775	739	759	854
Subtotal	1,518	2,512	3,014	3,145	3,271	3,673	4,123
TOTAL PROJECT BALANCE	131	0	0	0	0	0	0
Excess to storage							

TABLE 30-2
RANGE OF VALUES FOR "CLEAN" MINE INTERFLOW WATER QUALITY

Parameter[1]	Minimum (mg/L)	Maximum (mg/L)	Troy Mine Discharge[2]
Field pH	6.6	7.5	
Lab pH	5.8	7.5	7.3
Lab Specific Conductance (umhos/cm)	9	30	
Aluminum	<0.1	0.0006	<0.1
Ammonia			9.4
Arsenic	<0.005	<0.005	<0.0005
Barium			<0.1
Cadmium	<0.0008	0.002	<0.001
Chromium	<0.02	<0.02	
Copper	<0.001	0.002	0.07
Iron	<0.05	<0.05	
Lead	<0.001	<0.001	<0.01
Manganese	<0.02	<0.02	0.55
Mercury	<0.0002	<0.0002	<0.001
Molybdenum	<0.05	<0.05	
Silver	<0.0002	0.0004	<0.005
Zinc	<0.02	0.06	0.02
Total Suspended Solids	1.0	5.0	2920
Total Dissolved Solids	4.0	14.0	205
Nitrate & Nitrite as N	0.05	0.20	
Nitrogen as N			8.2
Sulfate	<1.0	4.5	32
Total Phosphorus	<0.005	0.006	<0.01
Hardness	<3	16	89
Calcium	<1	4.4	26
Magnesium	<1	1.3	6
Sodium	<1	2	11
Potassium	<1	2	3
Total Alkalinity as $CaCO_3$	3	13	
Bicarbonate as HCO_3	4	16	66
Carbonate at $CaCO_3$	0	1	0
Chloride	<1	<2	<1
Fluoride	<0.05	0.09	
Turbidity	<0.1	1.3	

1 Parameter Minimums and Maximums derived from baseline statistics of surface water samples collected at LB-100, 2 spring samples collected at SP-05, and Heidelberg adit discharge.

2 Dissolved metals values reported for Troy Mine Discharge; sample collected December 17, 1987

TABLE 30-3 **ADIT FLOW WATER QUALITY DATA**
Libby Adit (station PR +2,462, 3-28-90)
Location 2,462 Feet from Portal Reference Point

Sample Date: **3-28-90**
Analysis: **Chen Northern, Inc., Billings, Montana**

CATIONS	**mg/L**
Total Hardness as $CaCO_3$	96
Calcium as Ca	25
Magnesium as Mg	8
Sodium as NA	10
Potassium as K	<1
ANIONS	**mg/L**
Total Alkalinity as $CaCO_3$	112
Bicarbonate Alkalinity as HCO_3	123
Carbonate Alkalinity as CO_3	7
Hydroxide Alkalinity as OH	0
Chloride as C_l	1
Fluoride as F	0.10
Nitrate + Nitrite as N	0.10
Sulfate as SO_4	10
METALS, DISSOLVED	**mg/L**
Aluminum as Al	<0.1
Arsenic as As	<0.005
Cadmium as Cd	<0.001
Chromium as Cr	<0.02
Copper as Cu	<0.01
Iron as Fe	<0.05
Lead as Pb	<0.01
Manganese as Mn	0.06
Mercury as Hg	<0.0002
Molybdenum as Mo	<0.05
Silver as Ag	<0.001
Zinc as Zn	<0.02

TABLE 30-4 **ADIT FLOW WATER QUALITY DATA**
Libby Adit (station PR +2,010, 5-28-90)
Location 2,010 Feet from Portal Reference Point

Sample Date: **5-28-90**
Analysis: **Chen Northern, Inc., Billings, Montana**

CATIONS	**mg/L**
Total Hardness as $CaCO_3$	118
Calcium as Ca	19
Magnesium as Mg	8
Sodium as NA	22
Potassium as K	<1
ANIONS	**mg/L**
Total Alkalinity as $CaCO_3$	111
Bicarbonate Alkalinity as HCO_3	135
Carbonate Alkalinity as CO_3	0
Hydroxide Alkalinity as OH	0
Chloride as C_1	4
Fluoride as F	0.05
Nitrate + Nitrite as N	<0.01
Sulfate as SO_4	6
METALS, DISSOLVED	**mg/L**
Aluminum as Al	<0.1
Arsenic as As	<0.005
Cadmium as Cd	<0.001
Chromium as Cr	<0.02
Copper as Cu	<0.01
Iron as Fe	<0.05
Lead as Pb	<0.01
Manganese as Mn	0.03
Mercury as Hg	<0.0002
Molybdenum as Mo	<0.05
Silver as Ag	<0.001
Zinc as Zn	<0.02

TABLE 30-5 **ADIT FLOW WATER QUALITY DATA**
Libby Adit (station PR +2,713, 6-11-90)
Location 2,713 Feet from Portal Reference Point

Sample Date: **6-11-90**
Analysis: **Chen Northern, Inc., Billings, Montana**

CATIONS	**mg/L**
Total Hardness as $CaCO_3$	102
Calcium as Ca	26
Magnesium as Mg	9
Sodium as NA	11
Potassium as K	<1
ANIONS	**mg/L**
Total Alkalinity as $CaCO_3$	104
Bicarbonate Alkalinity as HCO_3	127
Carbonate Alkalinity as CO_3	0
Hydroxide Alkalinity as OH	0
Chloride as C_1	1
Fluoride as F	0.08
Nitrate + Nitrite as N	<0.01
Sulfate as SO_4	17
METALS, DISSOLVED	**mg/L**
Aluminum as Al	<0.1
Arsenic as As	<0.005
Cadmium as Cd	<0.001
Chromium as Cr	<0.02
Copper as Cu	<0.01
Iron as Fe	<0.05
Lead as Pb	<0.01
Manganese as Mn	0.05
Mercury as Hg	<0.0002
Molybdenum as Mo	<0.05
Silver as Ag	<0.001
Zinc as Zn	<0.01

TABLE 30-6 **ADIT FLOW WATER QUALITY DATA**
Libby Adit (station PR +5,700, 3-21-91)
Location 5,700 Feet from Portal Reference Point

Sample Date: **3-21-91**
Analysis: **Chen Northern, Inc., Billings, Montana**

CATIONS	**mg/L**
Total Hardness as $CaCO_3$	55
Calcium as Ca	17
Magnesium as Mg	3.0
Sodium as NA	23
Potassium as K	0.2
ANIONS	**mg/L**
Total Alkalinity as $CaCO_3$	81
Bicarbonate Alkalinity as HCO_3	0
Carbonate Alkalinity as CO_3	0
Hydroxide Alkalinity as OH	0
Chloride as C_l	9
Fluoride as F	0.06
Sulfate as SO_4	7
METALS, DISSOLVED	**mg/L**
Arsenic as As	<0.001
Lead as Pb	<0.0004
Mercury as Hg	*0.00006
Silver as Ag	<0.0001
INORGANIC	**mg/L**
Electrical Conductivity (µmhos/cm)	208
pH (S.U.)	8.0
Total Dissolved Solids	102
NUTRIENTS	**mg/L**
Ammonia Nitrogen as N	0.15
Nitrate + Nitrite as N	0.30
Nitrite as N	<0.05
Ortho-Phosphate as P	0.005
Total Kjeldahl Nitrogen as N	0.25
Total Phosphorous as P	0.006

* Re-sampled and re-analyzed 6-14-91. Minimum detection limit not reached during first attempt due to background interference.

TABLE 30-7 **ADIT FLOW WATER QUALITY DATA**
Libby Adit (station PR +8,685, 5-21-91)
Location 8,685 Feet from Portal Reference Point

Sample Date: **5-21-91**
Analysis: **Chen Northern, Inc., Billings, Montana**

METALS, DISSOLVED	mg/L
Aluminum as Al	<0.1
Arsenic as As	<0.001
Cadmium as Cd	<0.0001
Chromium as Cr	<0.02
Copper as Cu	<0.001
Iron as Fe	<0.05
Lead as Pb	<0.0004
Manganese as Mn	0.02
Mercury as Hg	<0.00004
Molybdenum as Mo	<0.05
Silver as Ag	<0.0001
Zinc as Zn	<0.02

TABLE 30-8

PRELIMINARY WATER BALANCE FOR MONTANORE MINE PROJECT - YEAR 10
(1992 EIS Values for 20,000 tpd & Updated Values for 12,500 tpd)

	20,000 tpd 1992 EIS (gpm)	12,500 tpd Updated (gpm)
Mine and Adit Discharge		
Total Discharge	1,188	1,188
Discharge to LAD Areas	78	494
Net Discharge to Mill	1,110	694
Office Inflow		
Potable Water	11	11
Office Outflow		
Discharge to TSF	11	11
Mill Inflow		
Net Discharge from Adit	1,110	694
Additional Water Makeup	0	0
Water in Ore*	166	104
From Thickener*	8,652	5,408
From TSF*	759	474
Subtotal	10,687	6,680
Mill Outflow		
Tailings to Thickener	10,681	6,676
Water in Concentrate*	6	4
Subtotal	10,687	6,680
Thickener Inflow		
Tailings from Mill	10,681	6,676
Thickener Outflow		
Coarse Tailings to TSF*	535	334
Fine Tailings to TSF*	1,494	934
To Mill*	8,652	5,408
Subtotal	10,681	6,676
Tailings Impoundment Inflow		
Storage	0	0
Precipitation	800	800
Coarse Tailings from Thickener*	535	334
Fine Tailings from Thickener*	1,494	934
Embankment Seepage Return*	593	371
Seepage Interception Return**	240	225
Sanitary Wastes	11	11
Subtotal	3,673	2,675
Tailings Impoundment Outflow		
Discharge to LAD Areas	0	0
Dust Suppression	22	22
Enhanced Evaporation	20	20
Natural Evaporation	570	570
Water in Coarse Tailings*	150	94
Water in Fine Tailings*	1,159	724
Seepage into Groundwater***	400	400
Seepage through Embankment*	593	371
To Mill*	759	474
Subtotal	3,673	2,675
Net Discharge to Groundwater (Discharge to LAD + seepage to GW - percentage of relief well return)	272	669

Notes:
tpd = tons per day; gpm = gallons per minute.
* Updated values based on proportion of updated tonnage (12,500 tpd) to original tonnage (20,000 tpd) = x 0.625.
** Seepage interception return for 20,000 tpd scenario is 60% effective, whereas for 12,500 tpd is 56% effective.
*** Reduced seepage into groundwater may occur due to improved seepage interception system for 12,500 tpd scenario; however, actual seepage will be determined after completing detailed design work for interception system.

TABLE 38-1

WEAK-ACID METALS EXTRACTABLE ANALYSIS FOR VARIOUS ROCK TYPES*

(mg/l in extract)

Parameter	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Cu
Tailings	<0.004	0.4	<0.01	<0.02	0.13	<0.01	<0.025	<0.01	0.25
Lower Revett	<0.004	0.3	<0.01	<0.02	0.09	<0.01	<0.025	<0.01	0.06
Foot Wall	<0.004	0.4	<0.01	<0.02	0.05	<0.01	<0.025	<0.01	0.04
Raw Ore	<0.004	0.1	<0.01	<0.02	0.26	<0.01	<0.025	<0.01	1.4
Waste Zone	<0.004	<0.1	<0.01	<0.02	0.64	<0.01	<0.025	<0.01	0.05

* TCLP Method (40 CFR Part 268 Appendix I)

TABLE 38-2
WHOLE ROCK ANALYSIS FOR VARIOUS ROCK TYPES *

Parts per million

Parameter	Tailings	Lower Revett	Foot Wall	Raw Ore	Barren Zone
K	19,300	19,800	34,700	19,200	13,600
Na	9,770	11,600	10,400	9,860	14.400
Ca	2,040	1,640	1,540	2,060	6,560
Mg	2,100	980	9,300	2,130	760
As	7	7	10	7	7
Al	35,000	32,900	64,600	35,300	29,500
Ba	520	720	740	520	440
Be	<5	<5	7	<5	<5
Cd	<5	<5	<5	<5	<5
Cr	115	40	68	55	60
Cu	330	19	93	7,880	7
Co	8	<5	14	8	<5
Fe	7,230	3,500	23,200	8,160	2,830
Pb	<5	<5	<5	50	350
Mn	280	215	500	310	640
Hg	<5	<5	<5	<5	<5
Mo	8	<5	5	8	5
Ni	61	30	46	36	43
Se	<5	<5	<5	<5	<5
Ag	7	12	8	66	5
Sb	<5	---	<5	<5	<5
Zn	13	---	140	22	13

* Alkali fusion method (ASTM D 3682)

TABLE 38-3

ACID-BASE POTENTIAL FOR VARIOUS ROCK TYPES [1]

Rock Type	Neutralization Potential (ppt)[2]	Acid Potential (meg/100 gm)	Acid-Base Potential (ppt)[2]
Tailings	8	<1	+8
Lower Revett	6	<1	+6
Foot Wall	8	<1	+8
Raw Ore	9	24	-3
Waste Zone	22	9	+18
Waste Zone (HR 21)	6	16	-2
Waste Zone (HR 25)	5	75	-32
Waste Zone (HR 26)	2	12	-4

Notes:

1) American Society of Agronomy; Monograph #9, Method 28-2.2.3 and 23C

2) Tons $CaCO_3$/1000 tons dry material

"+" = Lime Excess; "-" = Lime Deficiency

TABLE 38-4
ACID-BASE POTENTIAL LIBBY CREEK DECLINE
(ENERGY LABORATORIES, INC., BILLINGS, MT)

DATA RECEIVED	SAMPLE I.D. LCA	SULFIDES VISUAL EST. %	POTENTIALS - WASHED SAMPLE ABP	NP	AP	NP/AP	SAMPLE INTERVAL FROM	TO	THICKNESS FEET
03-Mar-91	7897		14	28	28	1.00	7,897.0	7,909.0	12.0
03-Mar-91	7791		12	29	35	0.83	7,791.0	7,803.0	12.0
25-Mar-91	8003		-2	17	37	0.46	8,003.0	8,015.0	12.0
25-Mar-91	8100		14	22	17	1.29	8,100.0	8,112.0	12.0
16-Apr-91	8200		16	27	21	1.29	8,200.0	8,212.0	12.0
16-Apr-91	8299		1	20	36	0.56	8,299.0	8,306.0	12.0
16-Apr-91	8401		21	33	23	1.43	8,401.0	8,413.0	12.0
19-Apr-91	8497		18	29	23	1.26	8,497.0	8,509.0	12.0
19-Apr-91	8594		10	36	53	0.68	8,597.0	8,606.0	12.0
11-Jun-91	8993		-8	15	13	1.15	8,993.0	9,005.0	12.0
11-Jun-91	9494		-6	11	33	0.33	9,494.0	9,506.0	12.0
08-Aug-91	10055		-2	3	11	0.27	10,055.0	10,067.0	12.0
07-Oct-91	10097		-3	15	36	0.43	10,091.0	10,103.0	12.0
07-Oct-91	10193		-6	17	47	0.36	10,193.0	10,205.0	12.0
07-Oct-91	10294		-20	11	62	0.18	10,294.0	10,306.0	12.0
08-Aug-91	10500		-6	9	30	0.30	10,500.0	10,512.0	12.0
07-Oct-91	10592		-5	13	36	0.36	10,592.0	10,604.0	12.0
07-Oct-91	10689		-2	15	24	0.63	10,689.0	10,701.0	12.0
07-Oct-91	10798		24	25	3	8.33	10,798.0	10,810.0	12.0
07-Oct-91	10897		8	17	19	0.89	10,897.0	10,909.0	12.0
07-Oct-91	11088		11	17	11	1.55	11,088.0	11,100.0	12.0
07-Oct-91	11198		23	23	1	23.00	11,198.0	11,210.0	12.0
07-Oct-91	11296		8	12	8	1.50	11,296.0	11,308.0	12.0
07-Oct-91	11398		33	34	1	34.00	11,398.0	11,410.0	12.0
07-Oct-91	11495		-6	28	67	0.42	11,495.0	11,207.0	12.0
07-Oct-91	11594		10	21	35	0.60	11,594.0	11,606.0	12.0
07-Oct-91	11701		31	31	1	31.00	11,701.0	11,713.0	12.0
07-Oct-91	11796		28	30	4	7.50	11,796.0	11,808.0	12.0
07-Oct-91	11889		49	49	1	49.00	11,889.0	11,901.0	12.0
07-Oct-91	11995		20	22	3	7.33	11,995.0	12,007.0	12.0
07-Oct-91	12097		3	14	23	0.61	12,097.0	12,109.0	12.0
07-Oct-91	12193		17	21	8	2.63	12,193.0	12,205.0	12.0
09-Dec-91	12500		16	16	<1	16.00	12,500.0	12,512.0	12.0
09-Dec-91	12995		<1	<1	<1	1.00	12,995.0	13,007.0	12.0

TA[illegible]38-4
ACID-BASE POTENTIAL LIBBY CREEK DECLINE
(ENERGY LABORATORIES, INC., BILLINGS, MT)

DATA RECEIVED	SAMPLE I.D. LCA	SULFIDES VISUAL EST. %	POTENTIALS - WASHED SAMPLE ABP	NP	AP	NP/AP	SAMPLE INTERVAL FROM	TO	THICKNESS FEET
09-Dec-91	13502		<1	<1	<1	1.00	13,502.0	13,514.0	12.0
10-Jan-92	13986		11	11	<1	11.00	13,986.0	13,998.0	12.0
09-Aug-90	4028	1.5	18	25	14	1.79	4,028.0	4,040.0	12.0
13-Sep-90	4507	1.0	43	43	1	43.00	4,507.0	4,519.0	12.0
24-Oct-90	4929	1.0	9	15	11	1.36	4,929.0	5,001.0	12.0
14-Dec-90	5453	1.0	10	16	13	1.23	5,453.0	5,465.0	12.0
14-Dec-90	5992	1.0	20	30	21	1.43	5,992.0	6,004.0	12.0
28-Jan-91	6483	2.0	-1	14	31	0.45	6,483.0	6,495.0	12.0
20-Feb-91	6603	2.0	-3	18	42	0.43	6,603.0	6,615.0	12.0
12-Feb-91	6992	2.0	-15	5	40	0.13	6,992.0	7,004.0	12.0
12-Feb-91	6669	2.0	38	38	1	38.00	6,669.0	6,681.0	12.0
12-Feb-91	6796	2.0	-2	12	28	0.43	6,796.0	6,808.0	12.0
12-Feb-91	6897	2.0	-2	16	34	0.47	6,897.0	6,909.0	12.0
12-Feb-91	7107	2.0	-18	12	59	0.20	7,107.0	7,119.0	12.0
12-Feb-91	7197	2.0	-5	12	35	0.34	7,197.0	7,209.0	12.0
12-Feb-91	7298	2.0	19	39	40	0.98	7,298.0	7,310.0	12.0
12-Feb-91	7401	2.0	-17	14	62	0.23	7,401.0	7,413.0	12.0
12-Feb-91	7499	2.0	-4	15	38	0.39	7,499.0	7,511.0	12.0
28-Feb-91	7592		2	13	22	0.59	7,592.0	7,604.0	12.0
28-Feb-91	7699		10	28	10	2.80	7,699.0	7,711.0	12.0
29-Jan-90	848	2.0	28	33	11	3.00	848.0	863.0	15.0
06-Feb-90	846	2.0	-4	3	13	0.23	846.0	860.0	12.0
06-Feb-90	873	2.0	0	4	9	0.44	873.0	883.0	10.0
06-Feb-90	874	2.0	4	10	11	0.91	874.0	888.0	14.0
06-Feb-90	885	2.0	-6	1	13	0.08	885.0	889.0	14.0
06-Feb-90	895	2.0	0	6	12	0.50	895.0	901.0	6.0
06-Feb-90	972	2.0	-1	4	9	0.44	972.0	986.0	14.0
06-Feb-90	986	2.0	-5	1	11	0.09	986.0	1,000.0	14.0
06-Feb-90	1000	2.0	1	6	9	0.67	1,000.0	1,014.0	14.0
14-Feb-90	1136	2.0	21	24	7	3.43	1,136.0	1,150.5	14.5
14-Feb-90	1146	2.0	15	26	21	1.24	1,146.0	1,145.0	10.0
14-Feb-90	1040	2.0	15	22	14	1.57	1,040.0	1,055.5	15.5
14-Feb-90	1055	2.0	13	19	11	1.73	1,055.0	1,070.0	15.0
14-Feb-90	1212	2.0	20	22	4	5.50	1,212.0	1,225.5	14.0

TA_ _38-4
ACID-BASE POTENTIAL LIBBY CREEK DECLINE
(ENERGY LABORATORIES, INC., BILLINGS, MT)

DATA RECEIVED	SAMPLE I.D. LCA	SULFIDES VISUAL EST. %	POTENTIALS - WASHED SAMPLE ABP	NP	AP	NP/AP	SAMPLE INTERVAL FROM	TO	THICKNESS FEET
17-Apr-90	1992	1.0	-5	10	31	0.32	1,992.0	2,008.0	16.0
17-May-90	2729	1.5	-3	32	70	0.46	2,729.0	2,745.0	16.0
18-Jun-90	3056	1.0	38	39	1	39.00	3,056.0	3,072.0	16.0
13-Jul-90	3685	1.0	29	37	8	2.06	3,685.0	3,701.0	16.0
22-Dec-89	550	1.0	-6	4	19	0.21	550.0	565.0	20.0
27-Dec-89	580	2.0	7	22	31	0.71	580.0	596.5	31.5
05-Jan-90	613	2.0	13	31	37	0.84	613.0	620.5	24.0
09-Jan-90	628	2.0	-4	7	22	0.32	628.0	641.0	20.5
09-Jan-90	654	2.0	-1	10	21	0.48	654.0	659.5	18.5
10-Jan-90	665	2.0	8	17	17	1.00	665.0	669.5	10.0
16-Jan-90	674	2.0	13	21	16	1.31	674.0	984.0	14.5
16-Jan-90	694	2.0	10	15	9	1.67	694.0	701.0	17.0
16-Jan-90	708	2.0	12	17	10	1.70	708.0	716.5	15.5
18-Jan-90	725	2.0	21	26	11	2.36	725.0	728.5	12.0
18-Jan-90	732	2.0	54	61	14	4.36	732.0	740.0	11.5
18-Jan-90	748	2.0	12	28	31	0.90	748.0	755.5	15.5
18-Jan-90	763	2.0	7	24	33	0.73	763.0	771.0	15.5
29-Jan-90	779	2.0	1	19	35	0.54	779.0	787.0	8.0
29-Jan-90	795	2.0	9	18	18	1.00	795.0	807.0	20.0
07-Oct-91	795		5	23	36	0.64			0.0
29-Jan-90	819	2.0	16	21	9	2.33	819.0	848.0	29.0

Notes: ABP VAR 201.4; ABP AVG 8.9; ABP CT 89;
ABP MAX 54; APB MIN -20

ABP = acid base potential; NP = neutral potential;
AP = acid potentia; Tons per 1000 tons of $CaCO_3$ equivalent

TABLE 42-1
SOIL ACREAGES, SALVAGE DEPTHS AND VOLUMES

			Salvage Depth (in)		Volumes (yd)^3		
Disturbance	**Map Unit**	**Acreage**	**Lift -1**	**Lift -2**	**Lift -1**	**Lift -2**	**Total**
Tailings Impoundment							
	TpC	268.1	9	18	324,401	540,758	865,159
	TgD	117.5	8	25	126,378	394,930	521,308
	TgC	52.6	8	25	56,574	176,835	233,409
	AdA	39.5	10	12	53,105	63,727	116,832
	ThA	1.3	9	---	1,573	---	1,573
	AdR mod deep 60%	32.3	11	---	47,738	---	47,738
	AdR deep 40%	21.5	9	---	26,039	---	26,039
	AwD Family					---	
	AwD 30%	18.7	15	---	37,752	---	37,752
	AdA 15%	9.4	10	12	12,584	15,165	27,749
	AdD 40%	25.0	9	---	30,201	---	30,201
	AdS 15%	9.4	9	---	11,325	---	11,325
		595.3			**727,670**	**1,191,415**	**1,895,235**
Borrow Site "C"					**78,650**	**78,650**	**157,300**
Borrow Site "D"					**171,820**	**171,820**	**343,640**
Seepage Collection Pond							
	AdA	2.5	10	---	3,361	---	3,361
	TgD	8.6	8	25	9,249	28,905	38,154
	AdW Family						
	AdW 30%	0.7	15	---	1,482	---	1,482
	AdA 15%	0.3	10	---	423	---	423
	AdD 40%	0.9	9	---	1,089	---	1,089
	AdS 15%	0.3	9	---	381	---	381
		13.3			**15,985**	**28,905**	**44,890**
Diversion Ditch							
	TpC	4.0	9		4,840		4,840

TABLE 42-1
SOIL ACREAGES, SALVAGE DEPTHS AND VOLUMES

			Salvage Depth (in)		Volumes $(yd)^3$		
Disturbance	**Map Unit**	**Acreage**	**Lift -1**	**Lift -2**	**Lift -1**	**Lift -2**	**Total**
Diversion Ditch							
	AdD	11.3	9		13,673		13,673
	TgD	7.7	8		8,281		8,281
	AdR						
	mod deep	10.0	11		14,818		14,818
	deep	6.7	9		8,082		8,082
	AdW	1.5	15	---	3,025	---	3,025
	AdA	0.8	10	---	1,008	---	1,008
	AdD	2.0	9	---	2,420	---	2,420
	AdS	0.8	9	---	907	---	907
		44.8			**57,054**		**57,054**
Ramsey Creek Facilities							
	AcC	28.1	18	---	68,002	---	68,002
	AcG	12.6	18	---	30,492	---	30,492
	TcA	2.6	---	---	---	---	
	CbD	1.6	---	---	---	---	
		44.9			**98,494**		**98,494**
Libby Creek Facilities							
	AcC	16.5	18	---	39,930		39,930
	TcA	2.2	---	---			
		18.7			**39,930**		**39,930**
Waste Rock Disposal Area and Water Disposal Area No. 1							
	TgC	42.6	8	25	45,818	143,183	189,001
	AdD	15.4	9	---	18,392		18,392
		58.0			**69,938**	**143,183**	**207,393**
Water Disposal Area No. 2							
	TgC	20.0	8		21,511	67,222	88,733
		20.0			**21,511**	**67,222**	**88,733**

TABLE 43-5

REVEGETATION MIXTURES AND SEEDING/PLANTING METHODS BY DISTURBANCE

	Revegetation	Revegetation Method			
Disturbance	**Mixture**	**Drill**	**Broadcast**	**Hydroseed**	**Plant**
Tailings Facility					
Impoundment surface	Interim, Mixture 2	X			X
Main embankment	Interim, Mixture 2	X	X	X	X
Toe dike	Interim, Mixture 2		X	X	X
North saddle dam	Mixture 2		X	X	
South saddle dam	Mixture 2		X	X	X
Diversion dam	Mixture 2		X	X	X
Diversion channel	Mixture 1		X	X	X
Seepage dam	Interim, Mixture 2		X	X	X
Seepage pond	Interim, Mixture 2		X	X	X
Seepage ditches	Interim, Mixture 2		X	X	
Borrow area	Interim	X	X	X	
Roads (access, haul)	Interim*, Mixture 2		X	X	
Soil stockpiles/sites	Interim, Mixture 2	X	X	X	
Water control structures	Interim, Mixture 2		X	X	X
Pump station	Interim, Mixture 2				
Ramsey plant site					
Cut/fill slopes	Mixture 1		X	X	X
Patio	Mixture 1	X	X	X	X
Temporary access road	Interim, Mixture 1		X	X	
Soil stockpiles/sites	Interim, Mixture 1		X	X	
Water control structures	Interim, Mixture 1		X	X	
Portal patio	Mixture 1		X	X	
Portal patio face	Mixture 1		X	X	
Libby adit					
Patio	Mixture 1		X	X	X
Waste rock dump	Mixture 1		X	X	X
Water disposal site	Mixture 1		X	X	X
Soil stockpiles/sites	Interim, Mixture 1		X	X	
Water control structures	Interim, Mixture 1		X	X	
Transportation corridors					
Bear Creek access road					
Highway 2 - Bear Creek bridge	Mixture 2		X	X	
Bear Creek bridge - plant site	Interim, Mixture 1		X	X	
Tailings single land road	Interim, Mixture 2		X	X	
Libby Creek road	Interim, Mixture 1		X	X	
Powerline Corridors	Interim, Mixtures 1&2		X	X	

TABLE 30-8

PRELIMINARY WATER BALANCE FOR MONTANORE MINE PROJECT - YEAR 10
(1992 EIS Values for 20,000 tpd & Updated Values for 12,500 tpd)

		20,000 tpd 1992 EIS (gpm)	12,500 tpd Updated (gpm)
Mine and Adit Discharge			
	Total Discharge	1,188	1,188
	Discharge to LAD Areas	78	494
	Net Discharge to Mill	1,110	694
Office Inflow			
	Potable Water	11	11
Office Outflow			
	Discharge to TSF	11	11
Mill Inflow			
	Net Discharge from Adit	1,110	694
	Additional Water Makeup	0	0
	Water in Ore*	166	104
	From Thickener*	8,652	5,408
	From TSF*	759	474
	Subtotal	10,687	6,680
Mill Outflow			
	Tailings to Thickener	10,681	6,676
	Water in Concentrate*	6	4
	Subtotal	10,687	6,680
Thickener Inflow			
	Tailings from Mill	10,681	6,676
Thickener Outflow			
	Coarse Tailings to TSF*	535	334
	Fine Tailings to TSF*	1,494	934
	To Mill*	8,652	5,408
	Subtotal	10,681	6,676
Tailings Impoundment Inflow			
	Storage	0	0
	Precipitation	800	800
	Coarse Tailings from Thickener*	535	334
	Fine Tailings from Thickener*	1,494	934
	Embankment Seepage Return*	593	371
	Seepage Interception Return**	240	225
	Sanitary Wastes	11	11
	Subtotal	3,673	2,675
Tailings Impoundment Outflow			
	Discharge to LAD Areas	0	0
	Dust Suppression	22	22
	Enhanced Evaporation	20	20
	Natural Evaporation	570	570
	Water in Coarse Tailings*	150	94
	Water in Fine Tailings*	1,159	724
	Seepage into Groundwater***	400	400
	Seepage through Embankment*	593	371
	To Mill*	759	474
	Subtotal	3,673	2,675
Net Discharge to Groundwater (Discharge to LAD + seepage to GW - percentage of relief well return)		272	669

Notes:
tpd = tons per day; gpm = gallons per minute.
* Updated values based on proportion of updated tonnage (12,500 tpd) to original tonnage (20,000 tpd) = x 0.625.
** Seepage interception return for 20,000 tpd scenario is 60% effective, whereas for 12,500 tpd is 56% effective.
*** Reduced seepage into groundwater may occur due to improved seepage interception system for 12,500 tpd scenario; however, actual seepage will be determined after completing detailed design work for interception system.

TABLE 43-1

CANOPY COVER IN LITTLE CHERRY CREEK SITE

Species	Percent Canopy Cover		Change in Canopy Cover[1]
	Logged Areas	Unlogged Areas	
Western red cedar	8.3%	21.8%	+13.5
Lodgepole pine	4.1%	5.8%	+ 1.7
Douglas-fir	3.4%	5.9%	+ 2.5
Western larch	6.0%	9.9%	+ 3.9
Black cottonwood	1.4%	---	- 1.4
Western white pine	0.9%	4.5%	+ 3.6
Engelmann spruce	0.8%	4.7%	+ 3.9
Western Hemlock	0.6%	19.2%	+18.6
Twinflower	1.5%	8.2%	+ 6.7
Snowbrush ceanothus	2.9%	---	- 2.9
Baldhip rose	0.8%	1.9%	+ 1.1
Dwarf bilberry	2.3%	1.6%	- 0.7
White spirea	3.6%	1.0%	- 2.6
Sitka alder	1.1%	---	- 1.1
Oregongrape	1.5%	0.3%	- 1.2
Trumpet honeysuckle	1.2%	0.1%	- 1.1
Serviceberry	1.0%	0.3%	- 0.7
Kinikinnick	4.8%	0.2%	- 4.6
Pachistima	1.8%	0.5%	- 1.3
Beargrass	3.1%	8.2%	+ 5.1
White clover	2.0%	---	- 2.0
Virginia strawberry	6.8%	0.2%	- 6.6
Fireweed	2.1%	---	- 2.1
Tall annual willow-herb	1.5%	---	- 1.5
Western goldthread	1.0%	7.5%	+ 6.5
Bracken fern	1.1%	2.1%	+ 1.0
Pipsissewa	0.1%	2.6%	+ 2.5
Queencup Beadlily	0.2%	1.6%	+ 1.4
Heartleaf arnica	---	3.9%	+ 3.9
Pinegrass	12.4%	1.2%	-11.2
Western fescue	2.2%	0.1%	- 2.1
Northwest sedge	3.8%	0.2%	- 3.6
Purple reedgrass	1.8%	---	- 1.8

[1] The plus values indicate that a species is more common in unlogged sites, whereas the minus values indicate that the species increases on logged sites.

TABLE 43-2

POTENTIAL PLANT MATERIAL DEALERS

Big Sky Wholesale Seeds, Inc. Shelby, MT 59474	Nishek Nursery Route 1, Box 516 Bonners Ferry, ID 33805
Bitterroot Native Growers 451 Quast Lane Corvallis, MT 59840	Northplan Seed Producers, Inc. PO Box 9107 Moscow, ID 83843
Bitterroot Nursery 521 NE Eastside Highway Corvallis, MT 59828	NPI-Granite 1697 West 2100 North PO Box 177 Lehi, UT 84043
Clifty View Rt. 1, Box 509 Bonners Ferry, ID 83805	Plato Nursery HCR 60, Box 1 Bonners Ferry, ID 83805
Division of Forestry Nursery (DSL) 2705 Spurgin Road Missoula, MT 59801	Revegetation Services, Inc. PO Box 2306 Great Falls, MT 59401
Eisenman Seed Co. PO Box 129 Fairfield, MT 59436	State Nursery and Seed Co. 3790 Highway 12 West Helena, MT 59601
Globe Seed and Feed Company PO Box 445 Twin Falls, ID 83301	Treasure State Seed Co. Box 656 Fairfield, MT 59436
Jacklin Seed Co. West 17300 Jacklin Ave. Post Falls, ID 83854	USDA Forest Service Coeur d'Alene Nursery 3600 Nursery Road Coeur d'Alene, ID 83814
Lawyer Nursery Rt. 2, PO Box 95 Plains, MT 59859	Western Seed and Supply, Inc. Box 57 Charlo, MT 59824
Marchie's Nursery 1845 South Third West Missoula, MT 59801	Western Seed and Supply, Inc. Box 67 Ronan, MT 59864
Montana Seeds, Inc. Rt. 3, Box 45B Conrad, MT 59425	Winterfield Ranch Seed PO Box 97 Swan Valley, ID 83449
Mountain Home Nursery Box 127 DeBorgia, MT 59830	

Note: Original list provided by Noranda, suppliers may be deleted and/or added to meet seed requirements

TABLE 43-3

REVEGETATION MIXTURE ONE

Species	Seeding Rate (PLS)[1] Pounds/Acre	Seeding Rate (PLS)[1] PLS/sq. ft
GRASSES		
Agropyron trachycaulum	2.0	7
Agrostis alba	0.1	11
Alopecurus pratensis	0.75	10
Deschampsia cespitosa	0.25	14
Elymus Canadensis	4.0	10
Festuca arundinacea	2.0	10
Phleum pratense[2]	0.25	7
Poa ampla[3]	0.5	10
FORBS[4]		
Fragaria virginiana	1-2	10-20
Trifolium repens		
Xerophyllum tenax		
TOTAL	**10.85 – 11.85**	**89-99**

SHRUBS[5]	**Planting rate (Stems/acre)**
Acre glabrum	
Alnus sinuate	
Amelanchier alnifolia	
Cornus stolonifera	
Menziesia ferruginea	
Ribes lacustre	
Salix scouleriana	
Sorbus sitchensis	
TOTAL	**200**
TREES	
Abies lasiocapra	85
Pinus contorta	85
Picea engelmannii	85
Pseudotsuga menziesii	180
TOTAL	**435**

[1] Rates given are for drill seeding; rates will be doubled for broadcast seeding.
[2] If commercially available, Phleum aplinum will be substituted
[3] If commercially available, Pa alpinum will be substituted.
[4] Seeding rate given is for a combination of any or all species listed.
[5] Planting rate for shrubs is a combination of any or all species listed based on site conditions such as aspect, moisture, temperature, etc.

TABLE 43-4
REVEGETATION MIXTURE TWO

Species	Seeding Rate (PLS)[1] Pounds/Acre	Seeding Rate (PLS)[1] PLS/sq. ft
GRASSES		
Agropyron riparium	3.0	11
Agropyron trachycaulum	2.0	7
Agrostis alba	0.1	11
Bromus marginatus	5.0	10
Dactylic glomerata	0.5	8
Elymus Canadensis	4.0	10
Festuca ovina	0.5	8
Phleum pretense	0.25	7
Poa compressa	0.10	6
FORBS[2]		
Achillea millefolium	1-2	10-20
Anaphalis margaritacea		
Epilobium angustifolium		
Hedysarum boreale		
Lupinus sericeus		
Trifolium repens		
TOTAL	**16.45 – 17.45**	**88-98**

SHRUBS[3]	**Planting rate (Stems/acre)**
Berberis repens	
Ceanothus velutinus[4]	
Rubus ideaus	
Salix scouleriana	
Spirea betulifolia	
Symphoricarpos albus	
Rosa gymnocarpa	
Vaccinium globulare	
TOTAL	**200**
TREES	
Larix occidentalis	85
Pinus monticola	85
Pinus contorta	85
Pseudotsuga menziesii	180
TOTAL	**435**

[1] Rates given are for drill seeding; rates will be doubled for broadcast seeding.
[2] Seeding given is for a combination of any or all species listed.
[3] Planting rate given for shrubs is for a combination of any or all species listed based on site conditions such as aspect, moisture, temperature, etc.
[4] C. sangineus may be substituted for C. velutinus to assess differences in species performance and wildlife use.

TABLE 44-1
ACID BASE POTENTIAL AND TOTAL LEAD OF MONTANORE DRILL CORE SAMPLES

Hole ID	Category	LITH	NP	AP	Pb (ppm)	ABP
HR-10	HGPB	QT	11	18	16,000	-7
	LGPB	SQ	20	8	1,980	12
	FWB-5	ST	13	1	7	12
HR-11	LGPB	QT	27	31	1,970	-4
	FWB-5	QT	3	3	5	0
HR-14	HGPB	ST	13	7	2,450	6
	FWB-5	QT	2	2	10	0
	FWB-20	QT	4	<1	20	4
HR-15	FWB-5	QT	8	<1	30	8
HR-16	HWB1-20	QT	1	2	7	-1
	HWB1-5	QT	4	2	36	2
	HGPB	SQ	3	5	14,600	-1
	LGPB	ST	13	14	1,350	-1
	FWB-5	ST	9	<1	14	9
HR-18	HWB1-20	QT	2	2	12	0
	HWB1-5	SQ	4	3	7	1
	HGPB	QT	8	2	6,120	6
	LGPB	QT	15	3	1,790	12
	FWB-5	QT	8	5	17	3
	FWB-20	QT	2	2	5	0
HR-19	HWB1-20	ST	3	4	91	-1
	HWB1-5	SQ	4	2	139	2
	HGPB	ST	6	3	6,720	3
	LGPB	ST	15	4	3,550	11
	FWB-5	ST	56	6	19	50
HR-20	HWB1-20	ST	9	1	5	8
	HWB1-5	ST	4	1	12	3
	HGPB	SQ	5	5	14,200	0
	LGPB	ST	19	23	2,330	-4
HR-21	HWB1-20	ST	11	1	14	10
	HWB1-5	SQ	16	1	5	15
	HGPB	QT	2	3	11,800	-1
	LGPB	SQ	15	16	2,620	-1
	FWB-5	ST	3	5	5	-2
	FWB-20	QT	6	<1	1,670	6

TABLE 44-1
ACID BASE POTENTIAL AND TOTAL LEAD OF MONTANORE DRILL CORE SAMPLES

Hole ID	Category	LITH	NP	AP	Pb(ppm)	ABP
HR-22	HWB1-20	QT	3	2	7	1
	HWB1-5	QT	7	6	12	1
	HGPB	ST	2	6	19,400	-4
	LGPB	ST	15	11	1,650	4
	FWB-5	QT	2	3	10	-1
	FWB-20	QT	10	3	10	7
HR-23	HGPB	ST	36	5	3,060	31
	FWB-5	QT	18	1	12	17
HR-24	HWB1-20	SQ	4	1	7	3
	HWB1-5	QT	3	5	65	-2
	HGPB	SQ	6	4	3,270	2
	LGPB	QT	18	8	9,260	10
	FWB-5	ST	6	<1	24	6
HR-25	HWB1-20	QT	4	3	46	1
	HWB1-5	QT	6	1	17	5
	HGPB	ST	<1	<1	2,090	0
	LGPB	QT	19	4	17,400	15
	FWB-5	SQ	4	<1	17	4
	FWB-20	SQ	2	<1	10	2
HR-29	HWB1-20	SQ	10	6	542	4
	HWB1-5	SQ	1	2	3,340	-1
	HGPB	QT	3	2	2,200	1
	LGPB	QT	3	9	17,700	-6
	FWB-5	SQ	12	2	3	10
	FWB-20	QT	1	2	3	-1
HR-30	HWB1-20	SQ	1	14	1,100	-13
	HWB1-5	ST	27	2	5,790	25
	HGPB	SQ	3	9	11,900	-6
	LGPB	SQ	11	<1	3,670	11
	FWB-5	QT	4	3	7	1
	FWB-20	SQ	1	5	3	-4

PB = LEAD
HWB1-20 = 20 FEET ABOVE HANGING WALL OF B1 ZONE
HWB1-5 = 5 FEET ABOVE HANGING WALL OF B1 ZONE
LGPB = LOW GRADE LEAD
HGPB = HIGH GRADE LEAD
FWB-5 = 5 FEET BELOW FOOT WALL OF B ZONE
FWB-20 = 20 FEET BELOW FOOT WALL OF B ZONE
LITH = LITHOLOGY; QT = QUARTZITE; SQ = SILTY QUARTZITE; ST = SILTITE
NP = NEUTRALIZATION POTENTIAL
AP = ACID POTENTIAL
ABP = ACID BASE POTENTIAL (TONS $CaCO_3$/1000 TONS)

TABLE 44-2

AVG ACID BASE POTENTIAL OF MONTANORE EXPLORATION DRILL CORE

CATEGORY	# SAMPLES	SQ	# SAMPLES	QT	# SAMPLES	AVG	# SAMPLES
HWB1-20	3	-2	3	-0.25	4	+1	10
HWB1-5	2	+4.5	4	+1.5	4	+5.2	10
HGPB	4	-2.7	3	+3	6	+3.5	13
LGPB	5	+5.8	4	+3	3	+3.5	12
FWB-5	5	+7	2	+3.6	7	+8.1	14
FWB-20	0	-1	2	+3.2	5	+2	7
AVERAGE	**19**	**+2.2**	**18**	**+2.5**	**29**	**+4.2**	**66**

HWB1-20 = 20 FEET ABOVE HANGING WALL OF B1 ZONE
HWB1-5 = 5 FEET ABOVE HANGING WALL OF B1 ZONE
LGPB = LOW GRADE LEAD
HGPB = HIGH GRADE LEAD
FWB-5 = 5 FEET BELOW FOOT WALL OF B ZONE
FWB-20 = 20 FEET BELOW FOOT WALL OF B ZONE
LITH = LITHOLOGY; QT = QUARTZITE; SQ = SILTY QUARTZITE; ST = SILTITE
NP = NEUTRALIZATION POTENTIAL
AP = ACID POTENTIAL
ABP = ACID BASE POTENTIAL (TONS $CaCO_3$/1000 TONS)

TABLE 44-3
ACID BASE POTENTIAL OF MONTANORE EXPLORATION DRILL CORE SAMPLES ORE ZONE

LAB I.D.	HOLE I.D.	FEET	ZONE	LITHOLOGY	TOTAL SULFUR, %	NON-SULFATE SULFUR, %	HOT H_2O EXTRACTABLE SULFUR, %	NEUTRALIZATION POTENTIAL TONS/1000 TONS	ACID POTENTIAL meg/1000g	ACID BASE POTENTIAL TONS/1000 TONS
17861	HR-10	720-722	B zone	Q	0.35	0.35	<.01	9.00	22.00	-5.00
17862	HR-11	992-994	B zone	Q	0.39	0.39	<.01	7.00	24.00	-5.00
18611	HR-12	1000-1002	B zone	Q	0.34	0.34	<.01	1.00	21.00	-9.00
17864	HR-13	1678-1680	B zone	Q	0.38	0.38	<.01	7.00	23.00	-5.00
17865	HR-14	1007-1009	B zone	S	0.95	0.95	<.01	5.00	59.00	-24.00
17866	HR-15	1696-1698	B zone	Q	0.39	0.39	<.01	<1.0	24.00	-12.00
17867	HR-16	2777-2779	B1 zone	SQ	0.05	0.05	<.01	<1.0	3.00	-2.00
17868	HR-16	2883-2885	B zone	Q	0.28	0.28	<.01	10.00	18.00	1.00
17869	HR-17	1775-1777	B1 zone	S	0.36	0.36	<.01	5.00	23.00	-6.00
17870	HR-17	1846-1848	B zone	S	0.54	0.54	<.01	18.00	34.00	1.00
17871	HR-18	1775-1777	B1 zone	Q	0.17	0.17	<.01	8.00	11.00	2.00
17872	HR-18	1839-1841	B zone	S/SQ	0.15	0.15	<.01	7.00	9.00	2.00
17874	HR-19	2445-2447	B zone	Q	0.01	0.01	<.01	4.00	1.00	4.00
17873	HR-19	2345-2347	B1 zone	S	0.05	0.05	<.01	2.00	3.00	0.00
17875	HR-20	3242-3244	B zone	S	0.49	0.49	<.01	3.00	31.00	-12.00
17876	HR-21	2946-2948	B1 zone	SQ	0.34	0.33	<.01	<1.0	21.00	-10.00
18598	HR-22	2020-2022	B1 zone	Q	0.05	0.05	<.01	<1.0	3.00	-2.00
18599	HR-23	2266-2268	B zone	Q	0.03	0.03	<.01	1.00	2.00	0.00
18600	HR-24	2924-2926	B1 zone	Q	0.06	0.06	<.01	<1.0	4.00	-2.00
18601	HR-24	3224-3226	B zone	SQ	0.18	0.13	<.01	15.00	8.00	11.00
18602	HR-25	3334-3336	B zone	SQ	0.07	0.07	<.01	3.00	4.00	0.00
18603	HR-26	3686-3688	B zone	S	0.36	0.36	<.01	4.00	23.00	-7.00
18604	HR-28	3537-3539	B zone	S	0.18	0.18	<.01	<1.0	11.00	-6.00
18606	HR-29	4468-4470	B zone	S	0.37	0.37	<.01	<1.0	23.00	-12.00
18605	HR-29	4387-4389	B1 zone	S	0.46	0.46	<.01	<1.0	29.00	-14.00
18607	HR-30	4266-4268	B zone	SQ	0.40	0.40	<.01	<1.0	25.00	-13.00
18609	HR-31	3551-3553	B zone	SQ	0.15	0.15	<.01	<1.0	9.00	-5.00

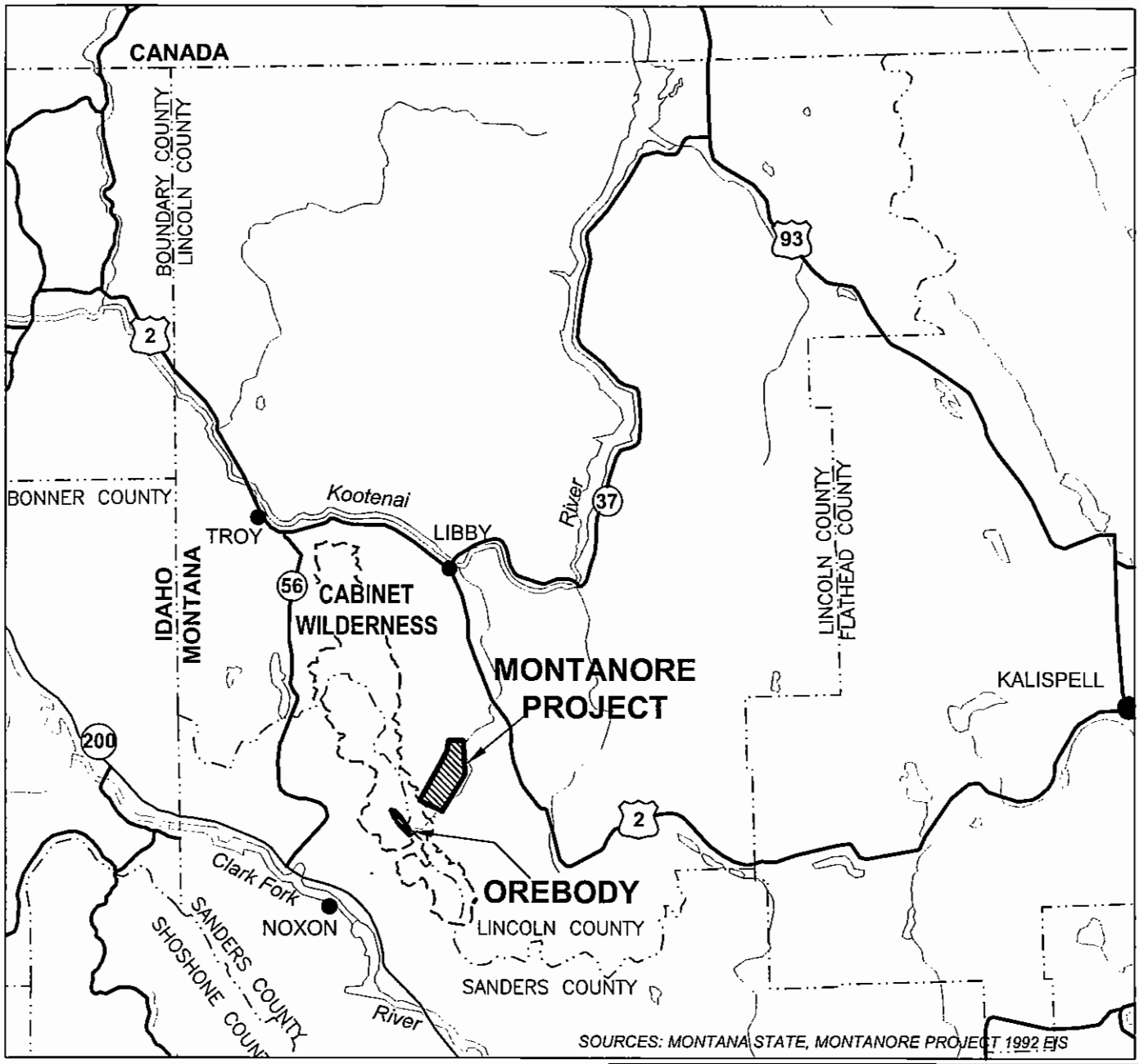
S = SILTITE
SQ = SILTY QUARTZITE
Q = QUARTZITE

ANALYSIS DATE: 6/91
ENERGY LABORATORIES, INC.
BILLINGS, MONTANA

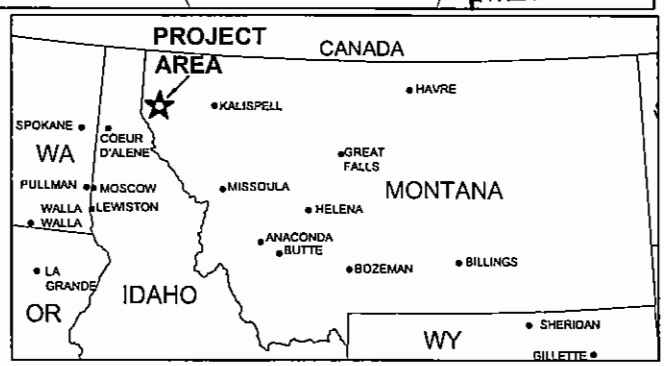
avg ABP = - 4.8

TABLE 48-1
MONTANORE PROJECT RECLAMATION SCHEDULE
(Time in Years Since First Year of Production)

Disturbance	Interim Reclamation	Construction Period	Operational Period	Post-Operational Period
Tailings Facility				
Impoundment surface	1-16			17-18
Main embankment	1-16			17-18
Toe Dike	-1-14		15-16	
North saddle dam	10-11			17-18
South saddle dam				17-18
Diversion dam		-2		
Diversion channel		-1		
Seepage dam	-1			18+
Seepage pond	-1			18+
Seepage ditches	-1			18+
Borrow area	-1			
Roads (access, haul)	-1			17-18
Soil stockpiles/sites	-2-16			17-18
Water control structures	-1			17-18
Pump Station	-1			17-18
Plant Site				
Cut/fill slopes		-1		
Patio				17-18
Temporary access road	-1		1	
Soil stockpiles/sites	-1			17-18
Water control structures	-1			17-18
Portals				17-18
Portal patio	-1			17-18
Libby adit area				
Portal				17-18
Patio				17-18
Waste rock dump			-1	
Water disposal site				17-18
Soil stockpile/site	-2			17-18
Water control structures	-2			17-18
Transportation Corridors				
Bear Creek access road		-2		
Tailings/plant site corridor	-1			17-18
Powerline corridors	-2			17-18



0 15 MILE

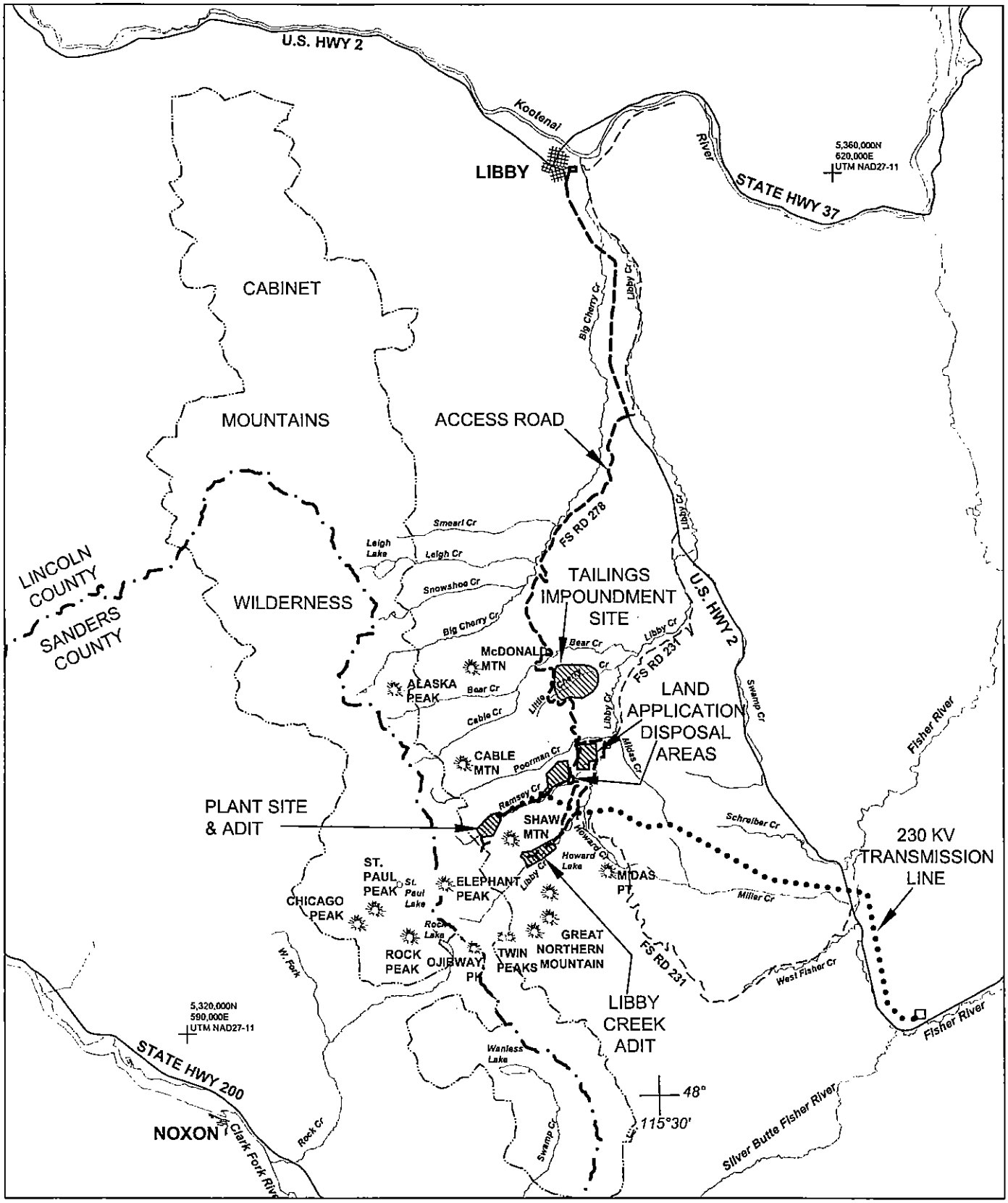


MINES MANAGEMENT, INC.	FIGURE 1	
	SCALE: AS SHOWN	DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS	

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

GENERAL PROJECT & OREBODY LOCATION

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

SOURCES: USFS, MONTANORE PROJECT 1992 EIS

0 20,000 FT

0 4 MILE

MINES MANAGEMENT, INC.

FIGURE 2

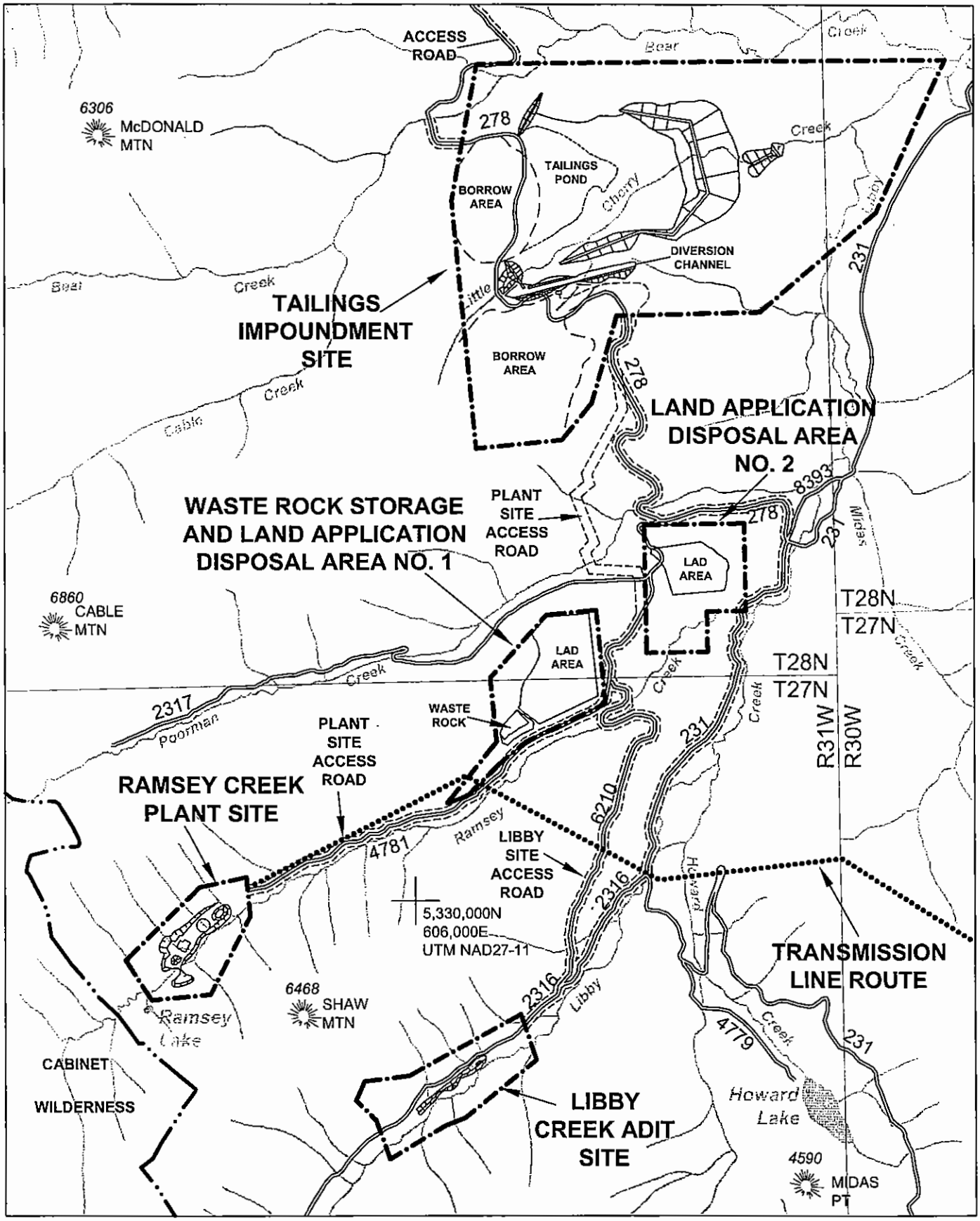
SCALE: 1"=4 MILES | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

PROPOSED LOCATION OF PROJECT FACILITIES

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

ORIGINAL PERMIT BOUNDARY

ROAD CORRIDOR

SOURCES: USFS, MONTANORE PROJECT 1992 EIS

0 4000 FT

0 1 MILE

MINES MANAGEMENT, INC.

FIGURE 3

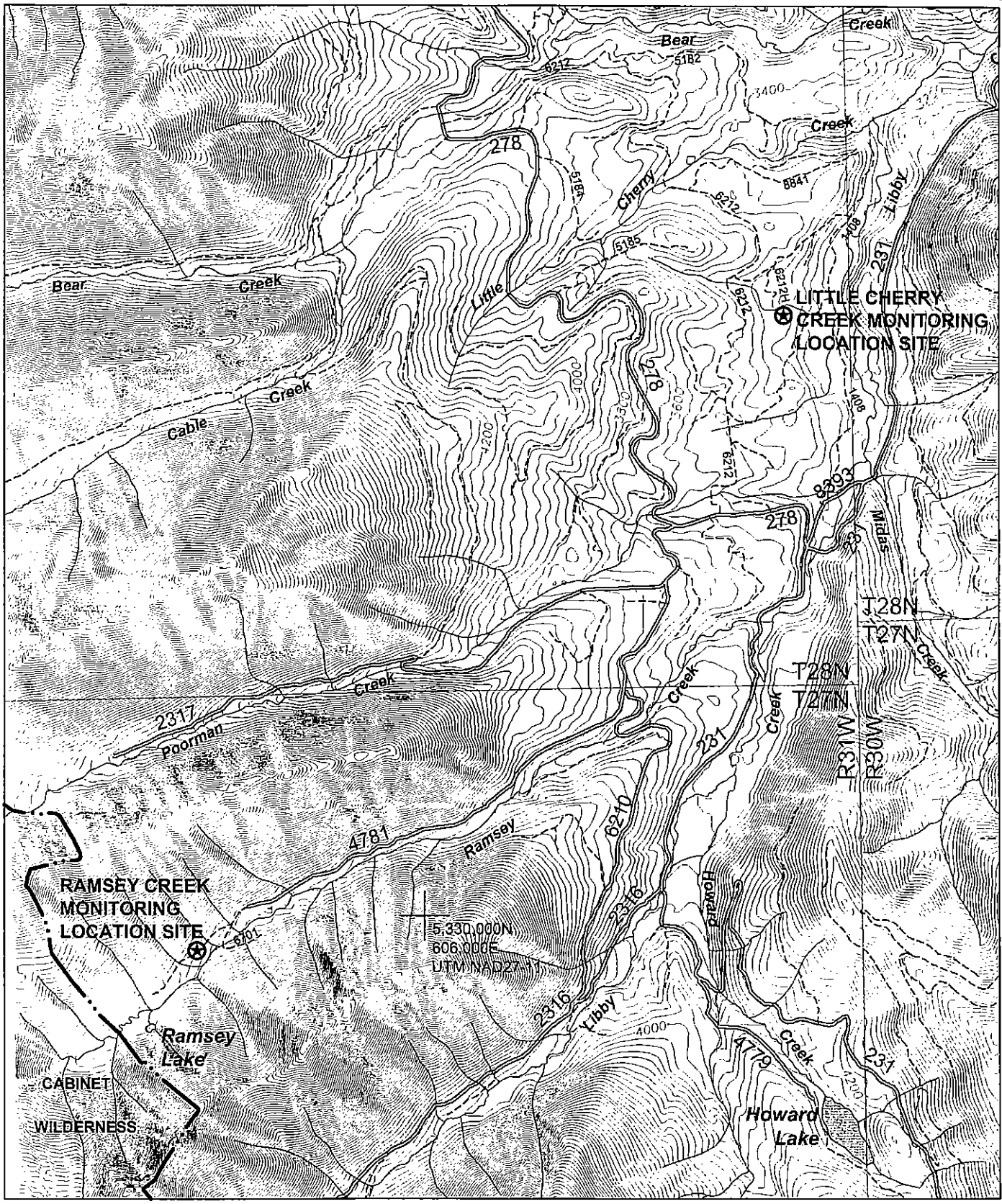
SCALE: 1"=4000' DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

GENERAL LOCATION OF PROPOSED MINE FACILITIES

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



SOURCES: USFS, USGS & MONTANORE PROJECT DATA

N
W E
S

0 4000 FT

0 1 MILE

MINES MANAGEMENT, INC.	FIGURE 4
	SCALE: 1"=4000' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

AIR MONITORING SITES

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

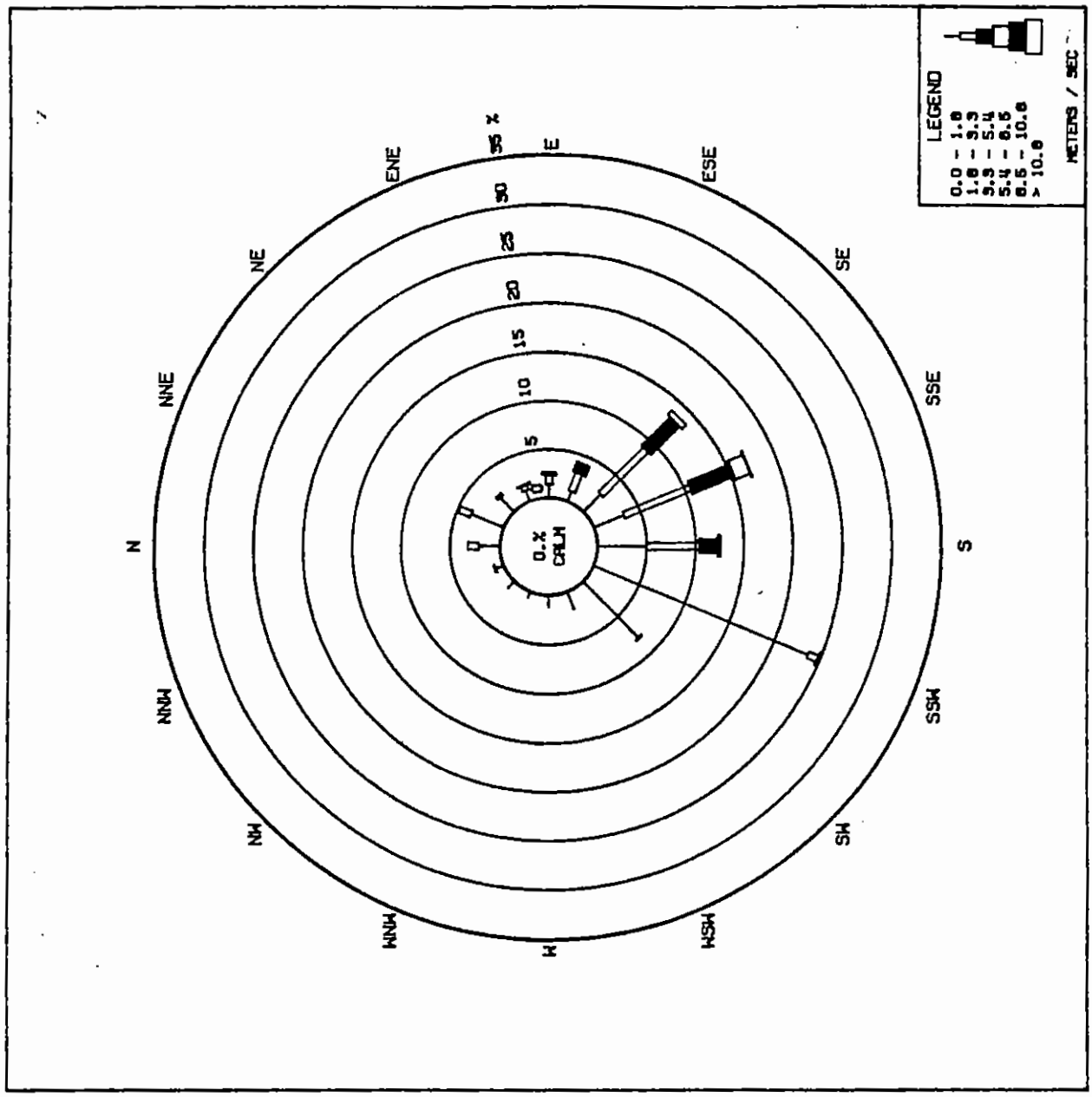


FIG. 5

Ramsey Creek
Wind Rose

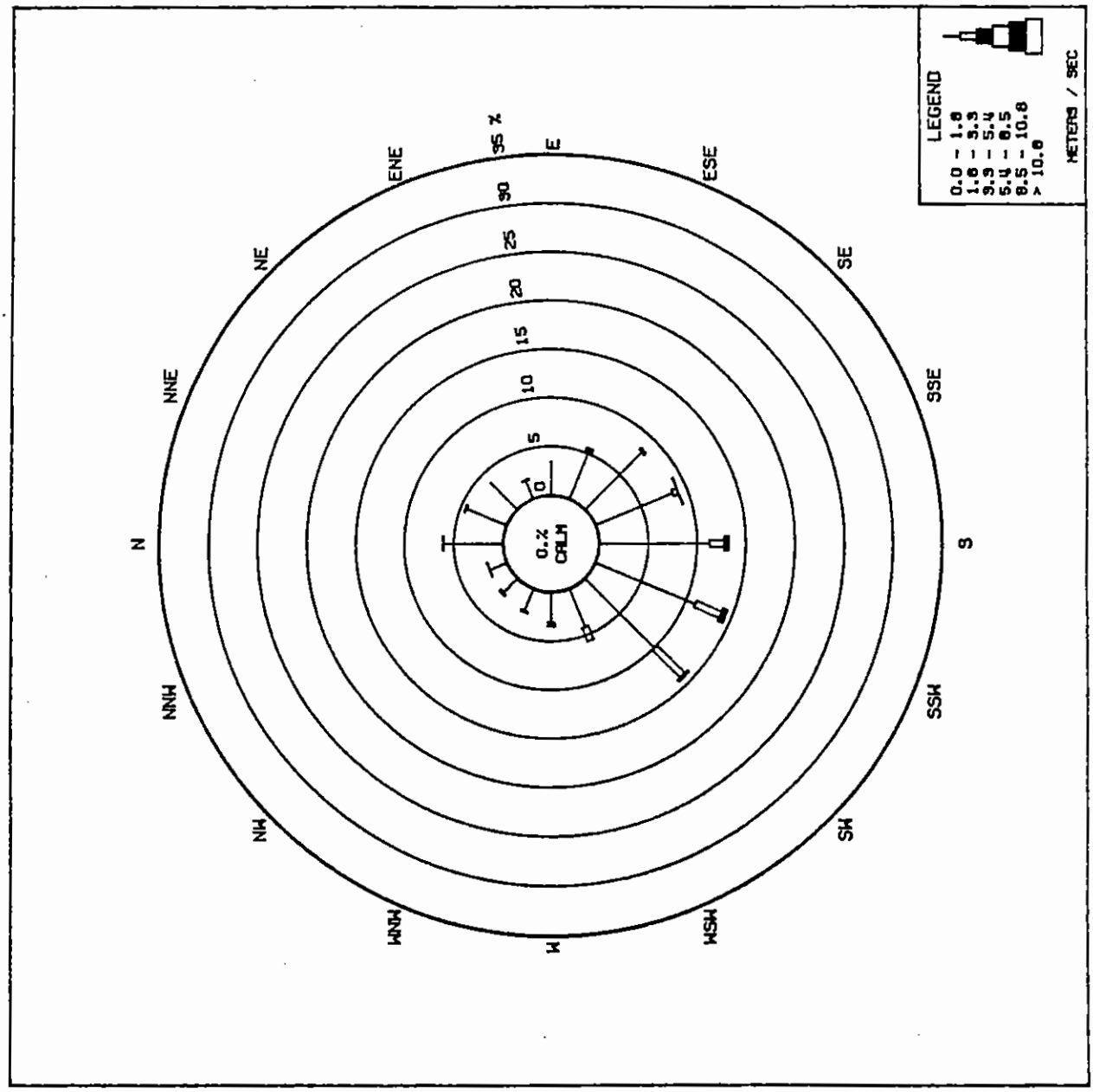
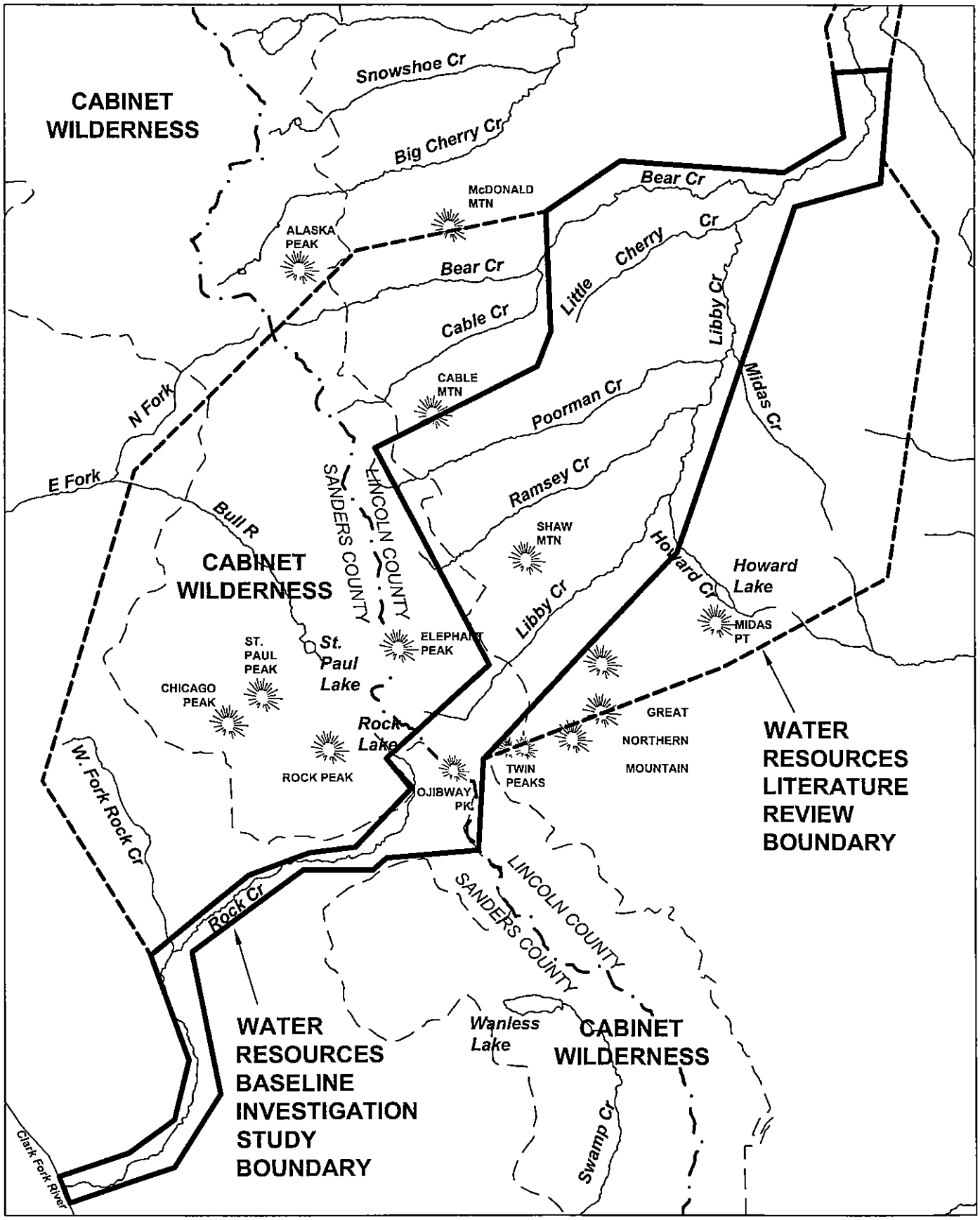


FIG. 6

Little Cherry Creek
Wind Rose



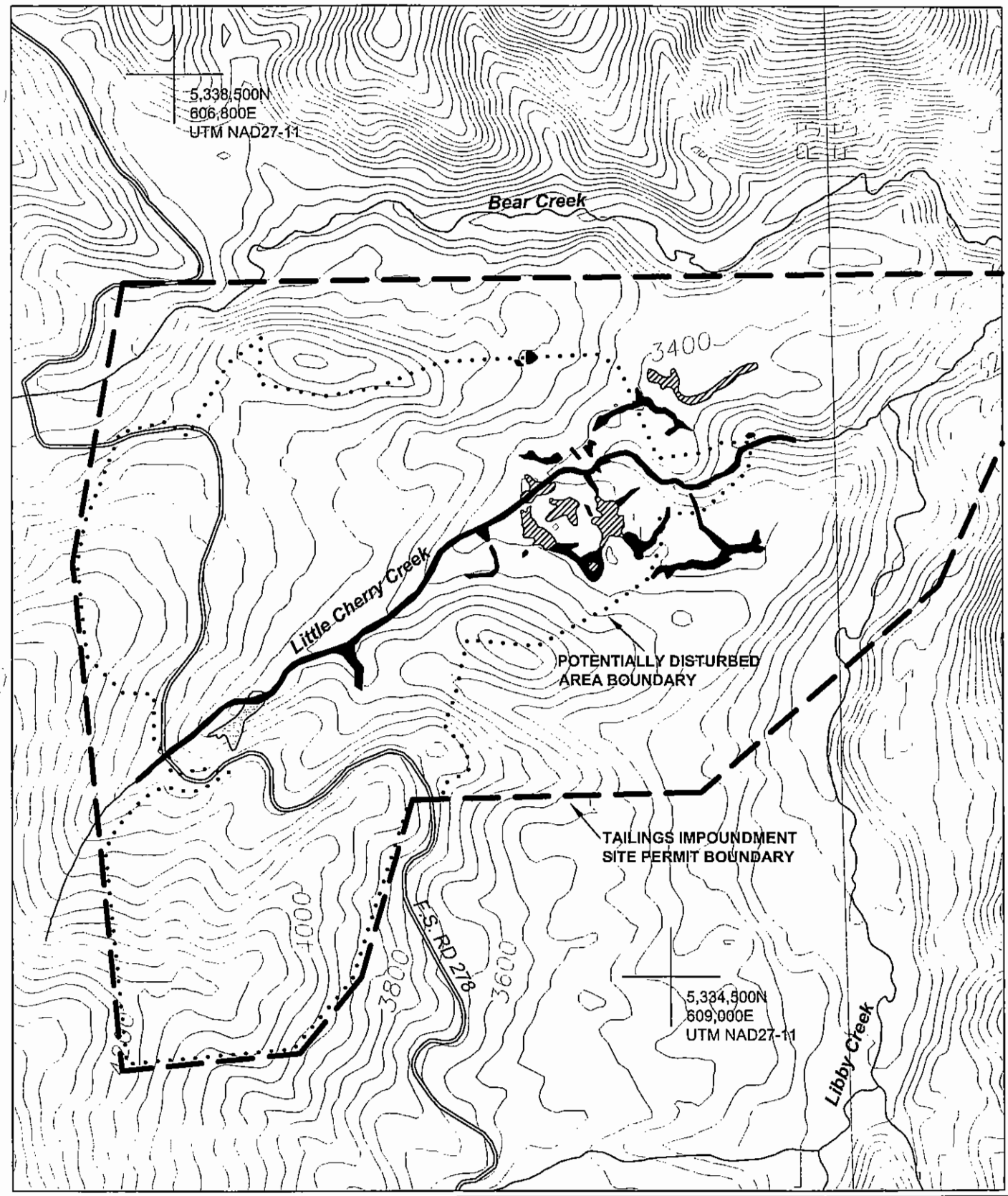
SOURCES: USFS, MONTANORE PROJECT DATA

MINES MANAGEMENT, INC.	FIGURE 7
	SCALE: 1"=2 miles / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

WATER RESOURCES STUDY AREA

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

SOURCES:
USFS, USGS, MONTANORE PROJECT DATA

Wetlands
Wetlands Complex
Seep Area

0 2,000 FT

MINES MANAGEMENT, INC.

FIGURE 8

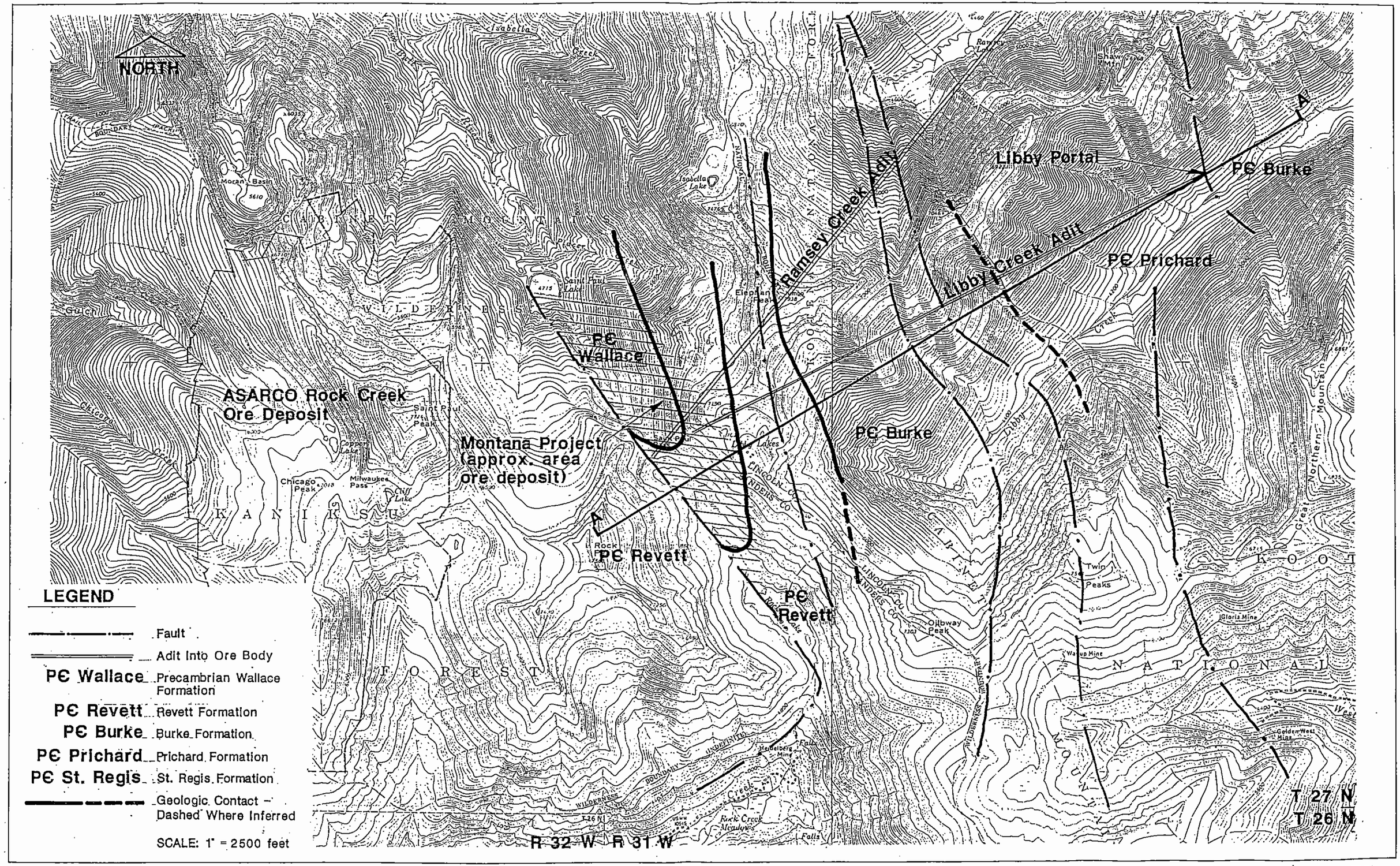
SCALE: 1"=2,000' | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

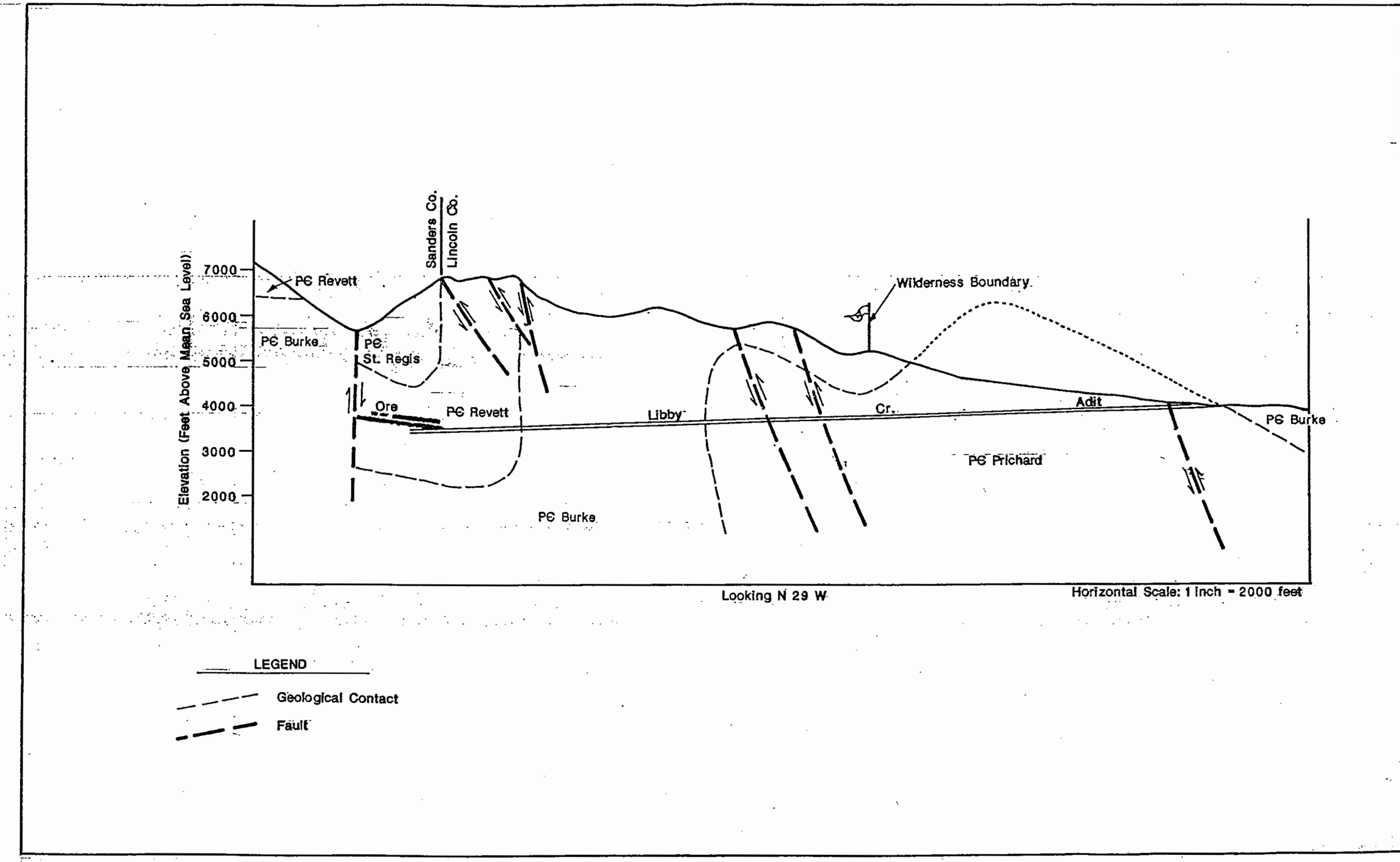
JURISDICTIONAL WETLANDS-IMPOUNDMENT AREA

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

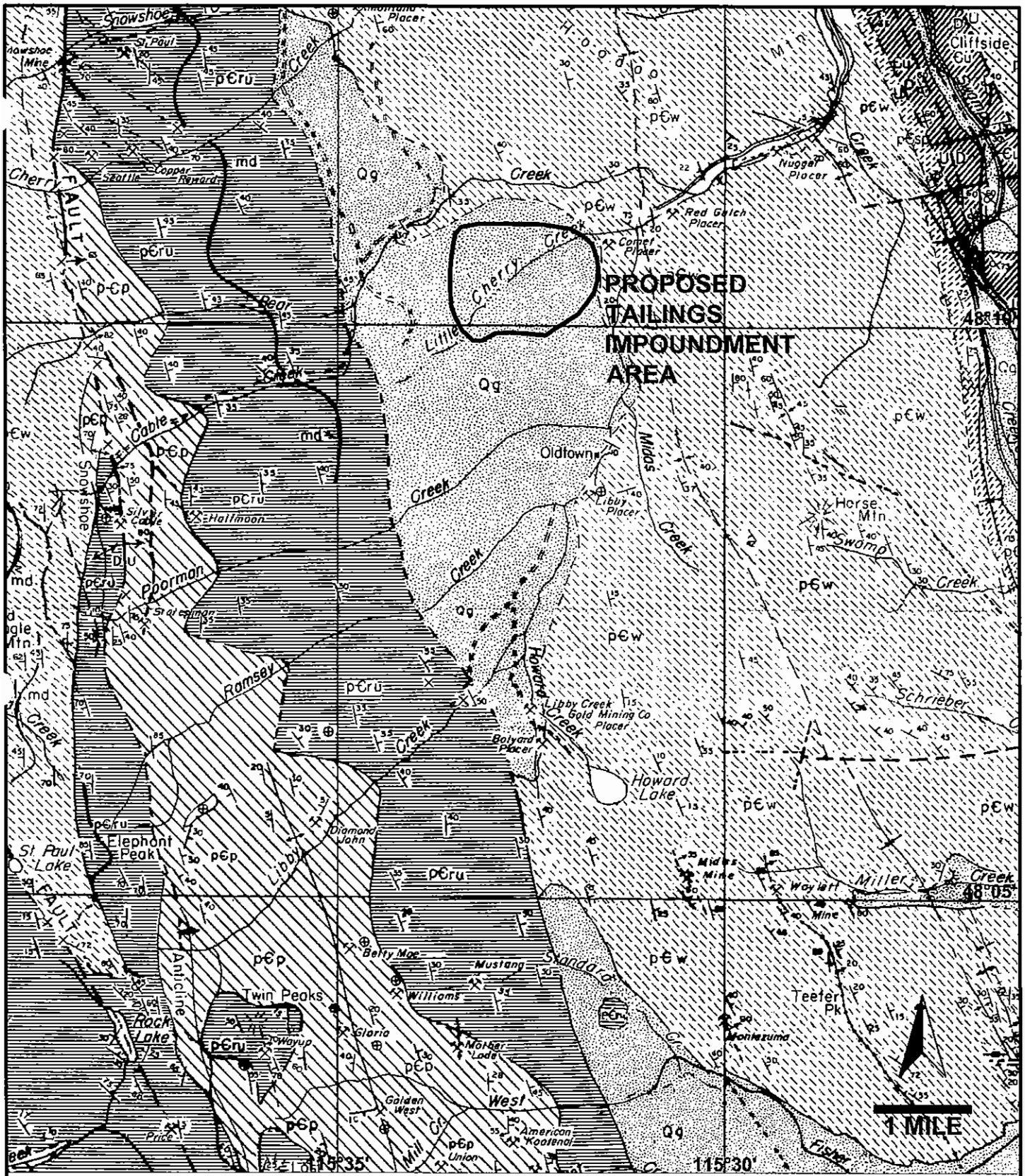


Rev. 4-90

Mines Management, Inc. – Montanore Project
Figure 9 - General Project Geology



Mines Management, Inc. – Montanore Project
Figure 10
Geologic Cross Section – Libby Creek Adit



Qg Quaternary Glacial Deposits

pCw Wallace Formation

pCru Ravalli Group Undifferentiated
- St. Regis Formation
- Revett Quartzite
- Burke Formation

pCp Pritchard Formation

Source: Montana Bureau Mines & Geology Bulletin 79 Plate 1

MINES MANAGEMENT, INC.

FIGURE 11

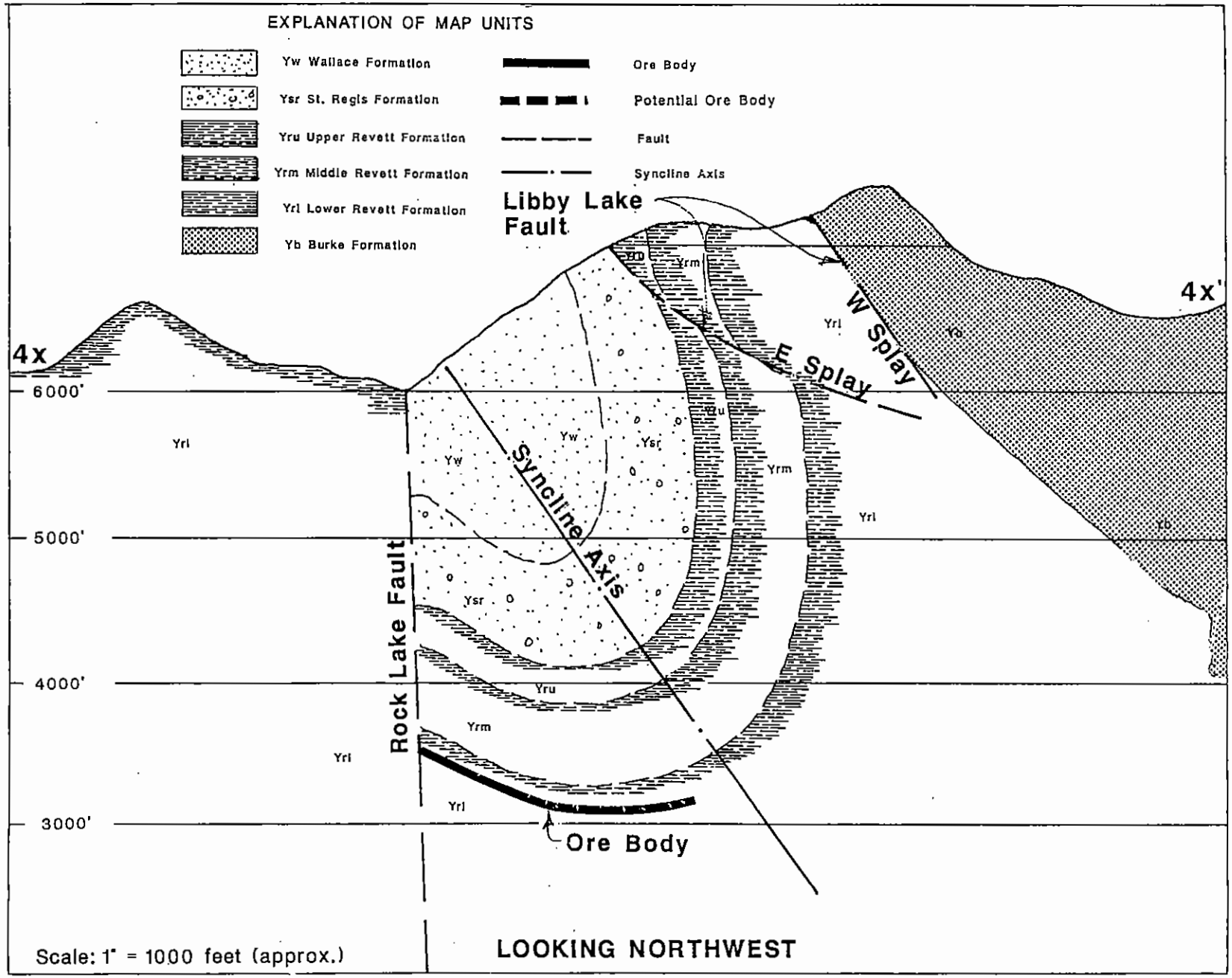
SCALE: AS SHOWN | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

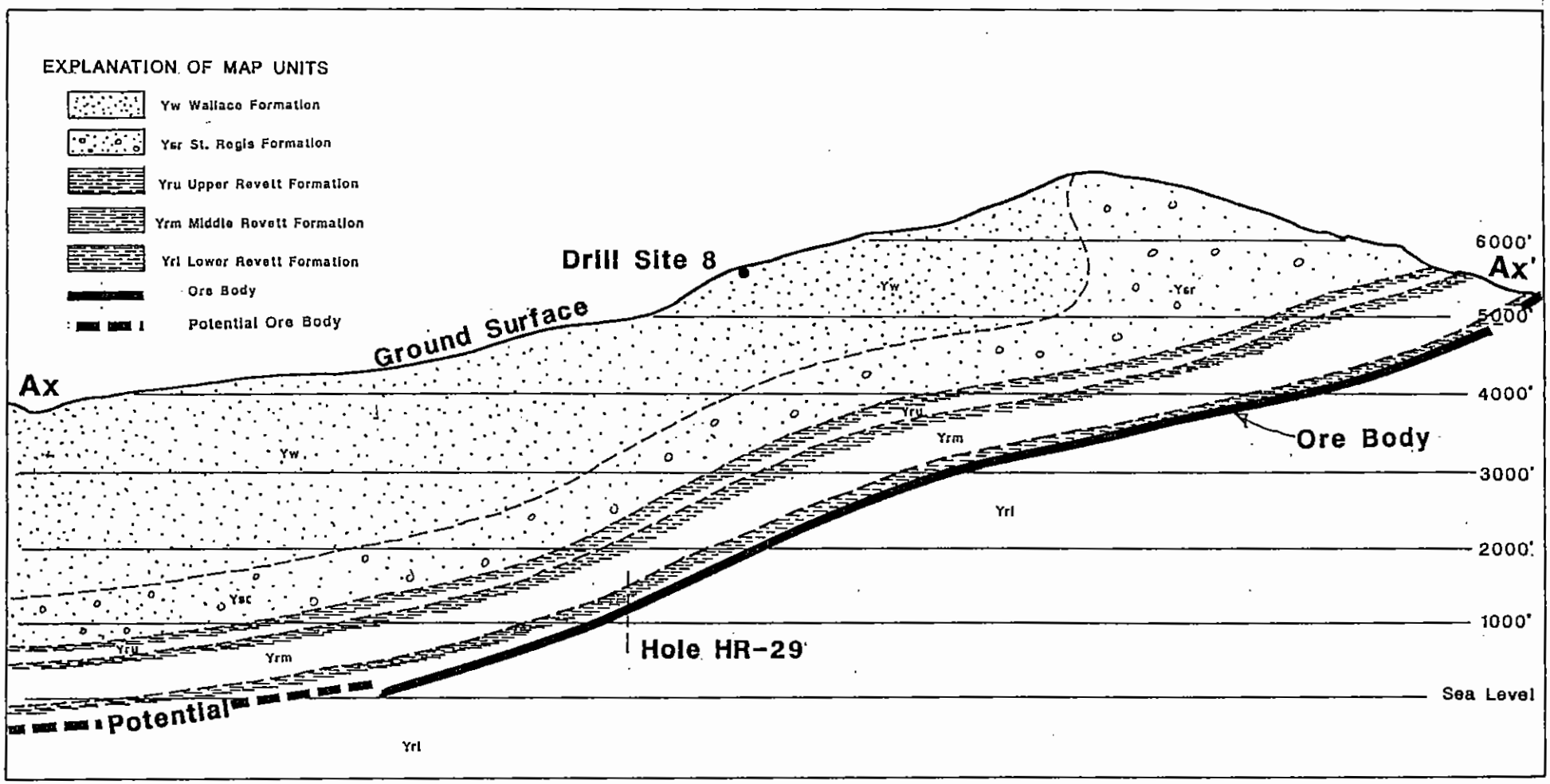
REGIONAL GEOLOGIC MAP

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



Rev. 4-90

FIGURE 12
Ore Body Cross-Section



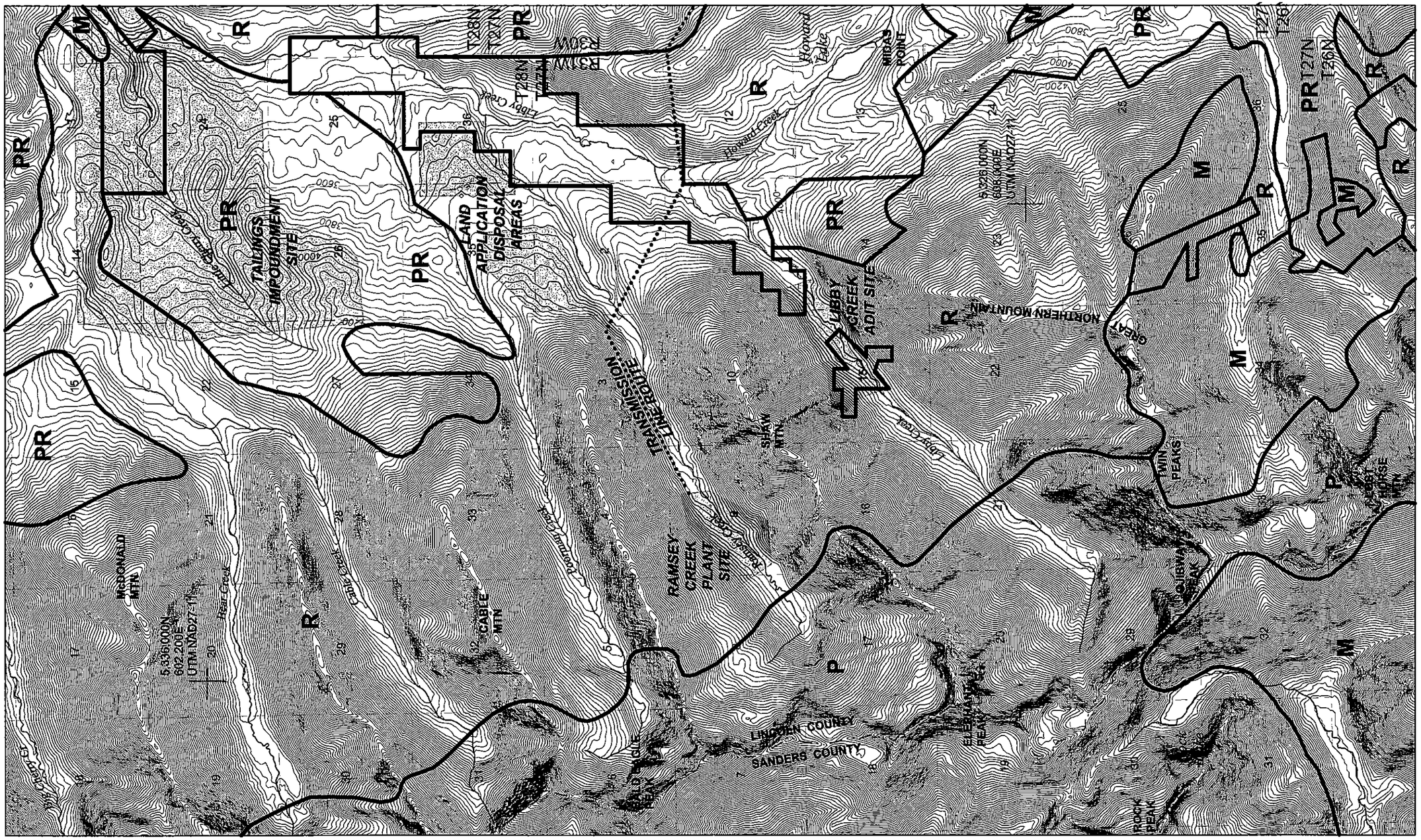
Scale: 1" = 1600' (approx.)

LOOKING NORTHEAST

Rev. 8/22/89

Ore Body Longitudinal Section

FIG. 13



SOURCES:
USFS, USGS, MONTANORE PROJECT DATA

P PRESERVATION
R RETENTION
PR PARTIAL RETENTION
M MODIFICATION & MAXIMUM MODIFICATION
NOTE: BLANK AREAS NOT RATED

NORTH

0 4,000 FT

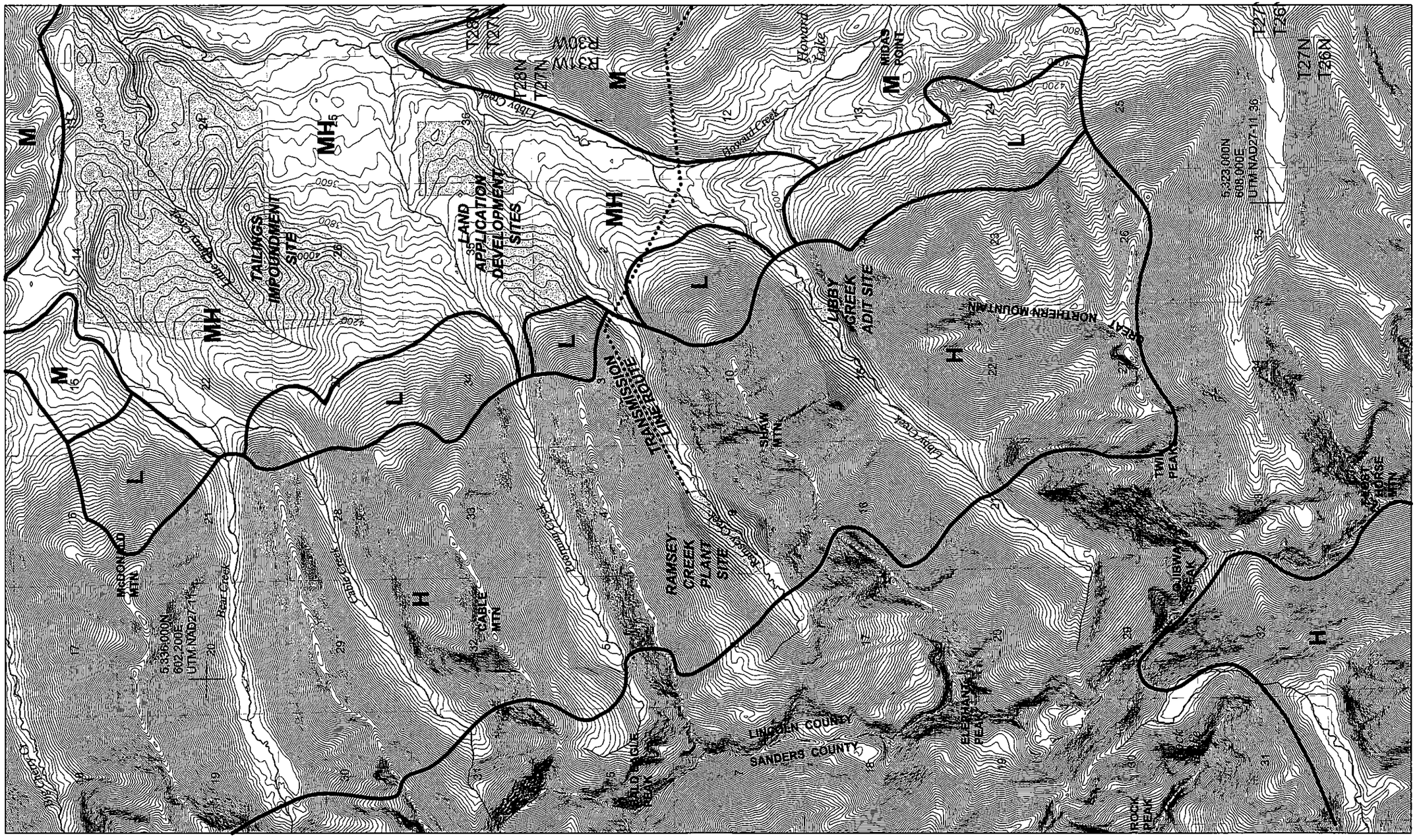
MINES MANAGEMENT, INC.

FIGURE 14	
SCALE: 1"=4,000'	DATE: DEC. 2004
DRAWN: JASPER GEOGRAPHICS	

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

VISUAL QUALITY OBJECTIVES

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



SOURCES:
USFS, USGS, MONTANORE PROJECT DATA

L LOW VISUAL ABSORPTION CAPABILITY (VAC)
M MODERATE VAC
MH MODERATE-HIGH VAC
H HIGH VAC

NORTH

0 4,000 FT

MINES MANAGEMENT, INC.

FIGURE 15

SCALE: 1"=4,000' | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

VISUAL ABSORPTION CAPABILITY

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

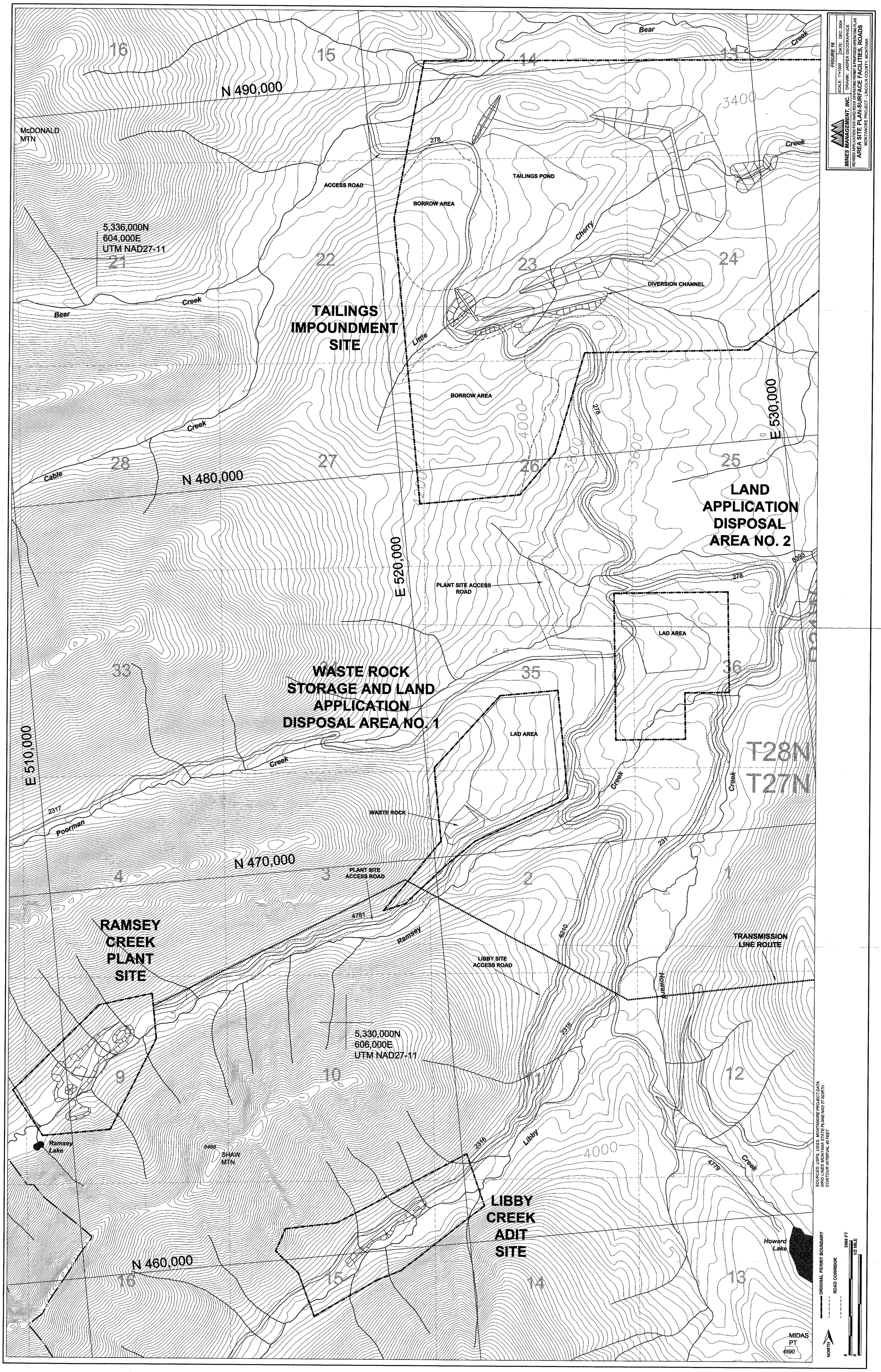
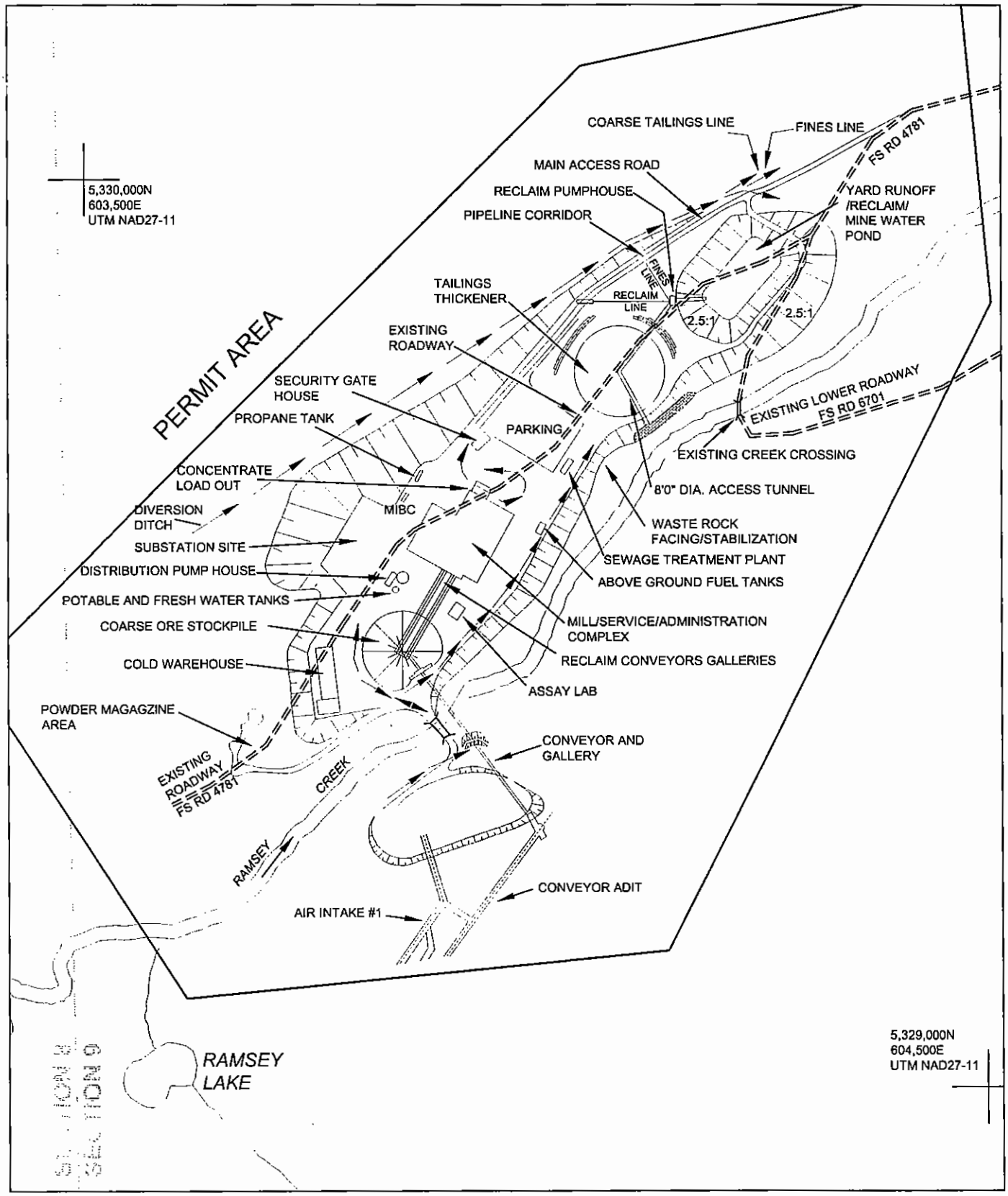


FIGURE 16
SCALE: 1"=1000'
DATE: DEC. 2004
DRAWN: JASPER GEOGRAPHICS
MINES MANAGEMENT, INC.
REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN
AREA SITE PLAN-SURFACE FACILITIES, ROADS
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA
McDONALD MTN
N 490,000
N 480,000
N 470,000
N 460,000
E 510,000
E 520,000
E 530,000
5,336,000N
604,000E
UTM NAD27-11
5,330,000N
606,000E
UTM NAD27-11
ACCESS ROAD
BORROW AREA
TAILINGS POND
DIVERSION CHANNEL
TAILINGS IMPOUNDMENT SITE
PLANT SITE ACCESS ROAD
LAND APPLICATION DISPOSAL AREA NO. 2
LAD AREA
WASTE ROCK STORAGE AND LAND APPLICATION DISPOSAL AREA NO. 1
WASTE ROCK
RAMSEY CREEK PLANT SITE
LIBBY SITE ACCESS ROAD
TRANSMISSION LINE ROUTE
LIBBY CREEK ADIT SITE
Bear Creek
Cherry Creek
Little Cable Creek
Poorman Creek
Ramsey Creek
Libby Creek
Howard Creek
Ramsey Lake
Howard Lake
SHAW MTN
MIDAS PT
T28N
T27N
ORIGINAL PERMIT BOUNDARY
ROAD CORRIDOR
NORTH
3000 FT
1/2 MILE
SOURCES: USFS, USGS, MONTANORE PROJECT DATA
GRID LINES MONTANA STATE PLANE NAD 27 NORTH
CONTOUR INTERVAL 40 FEET



N
W E
S

0 500 FT

0 1/8 MILE

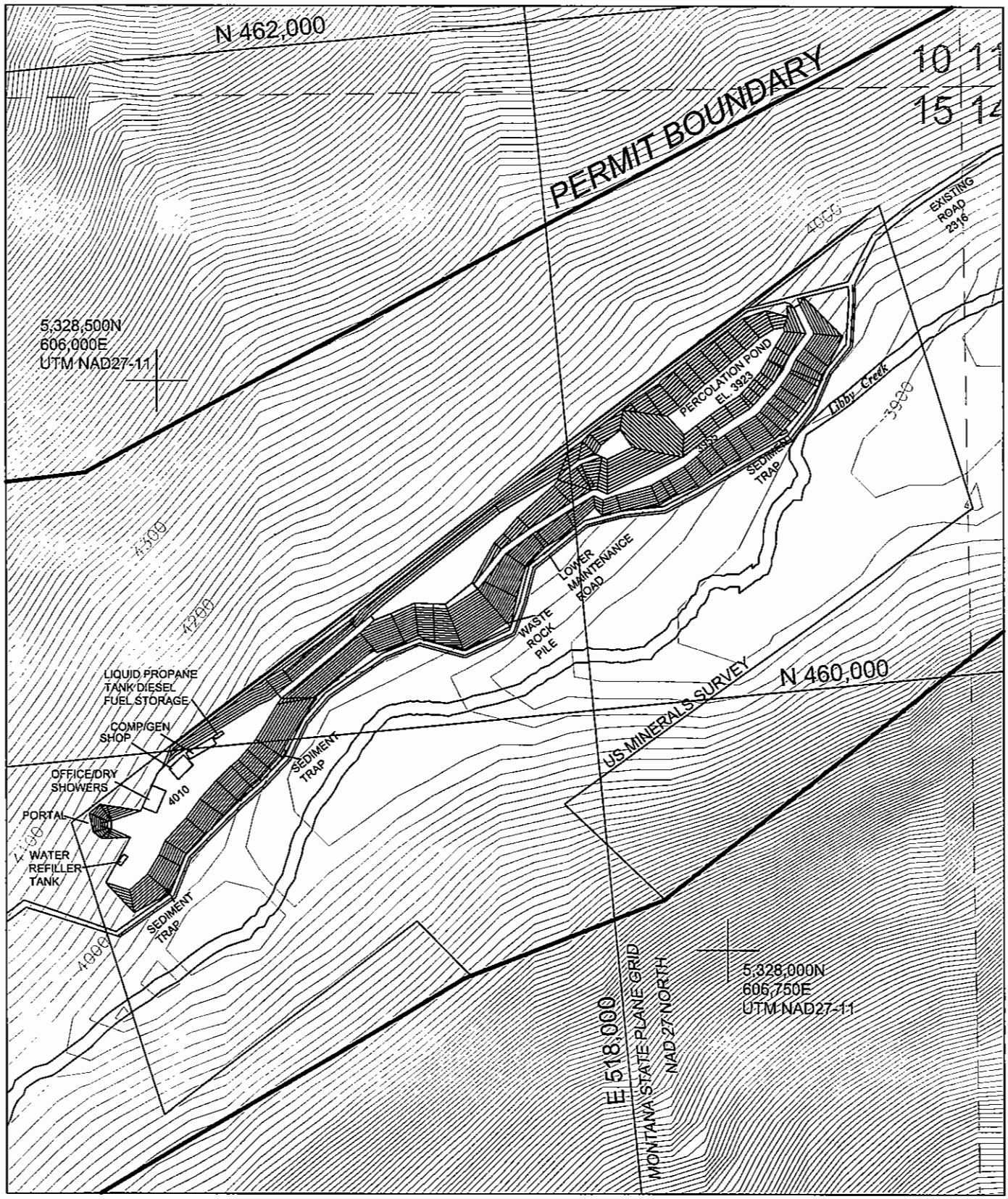
SOURCES: USFS, MONTANORE PROJECT 1992 EIS

MINES MANAGEMENT, INC.	***FIGURE 17***
	SCALE: 1"=500' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

RAMSEY CREEK PLANT SITE

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

0 400 FT

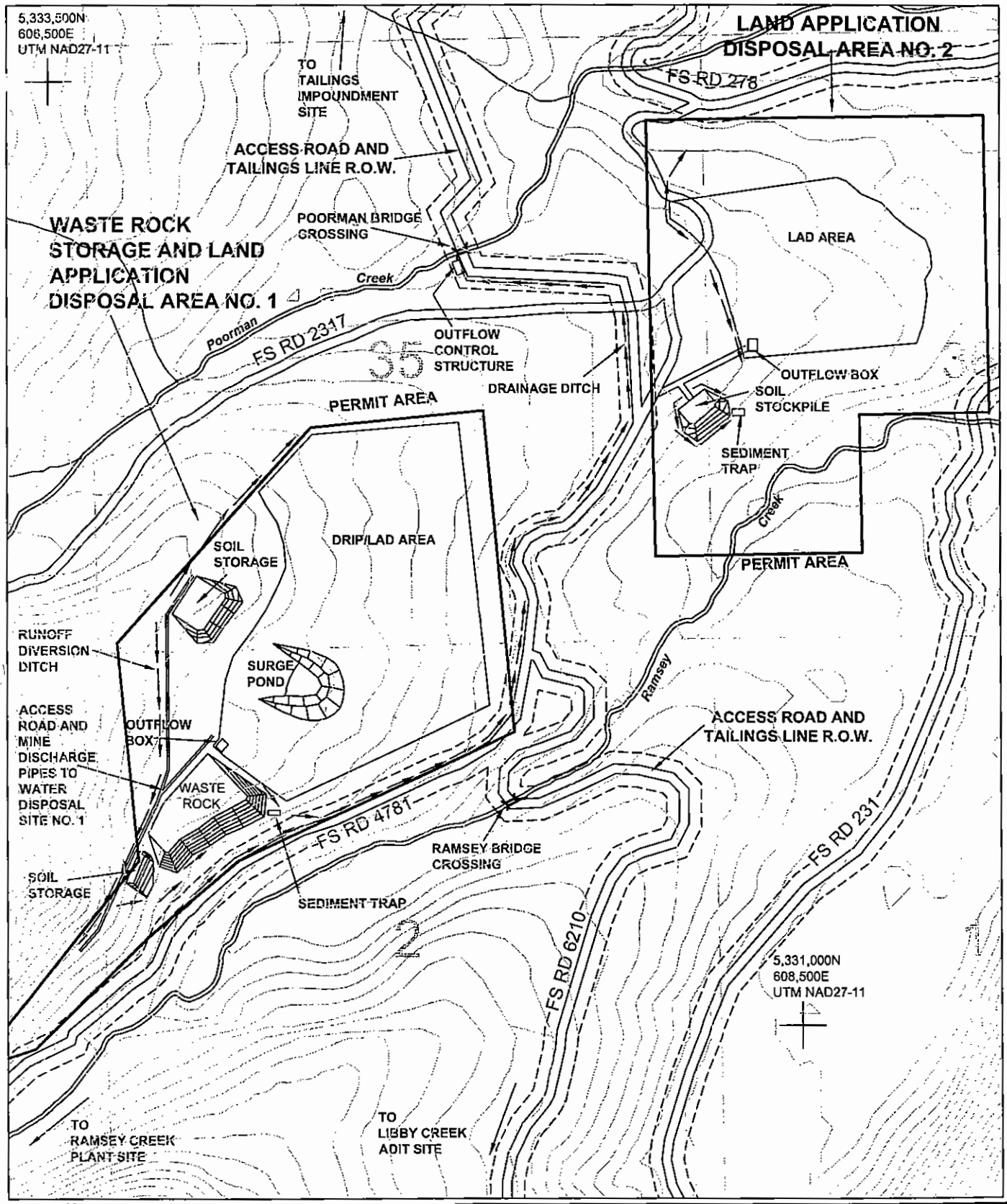
SOURCES: USFS, USGS, MONTANORE PROJECT DATA

MINES MANAGEMENT, INC.	***FIGURE 18***
	SCALE: 1"=400' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

LIBBY CREEK ADIT SITE - RECLAIMED

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

ORIGINAL PERMIT BOUNDARY

ROAD CORRIDOR

SOURCES: USFS, MONTANORE PROJECT 1992 EIS

0 1,500 FT

0 1/4 MILE

MINES MANAGEMENT, INC.

FIGURE 19

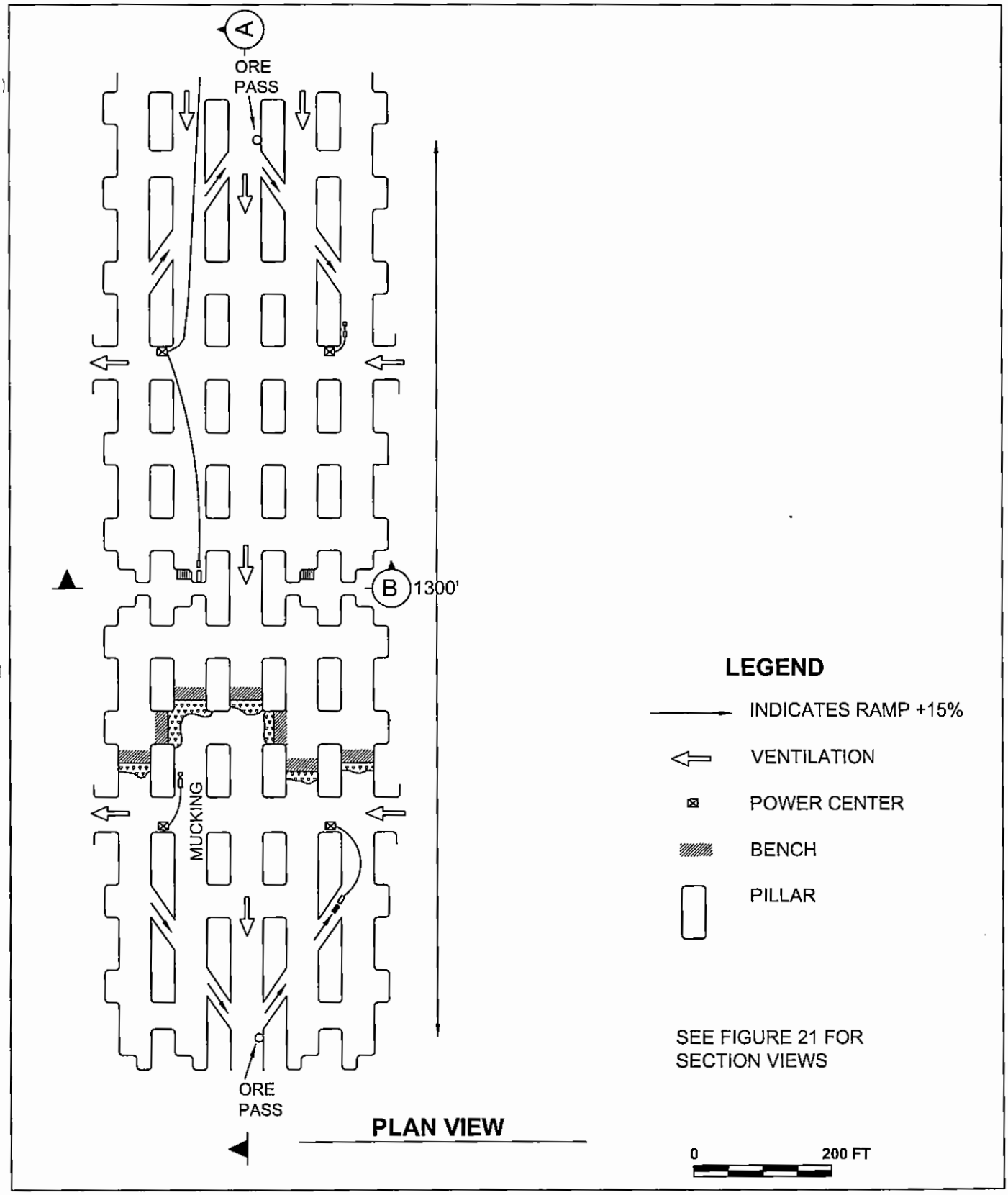
SCALE: 1"=1,200' | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

WASTE ROCK STORAGE & LAD AREAS

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



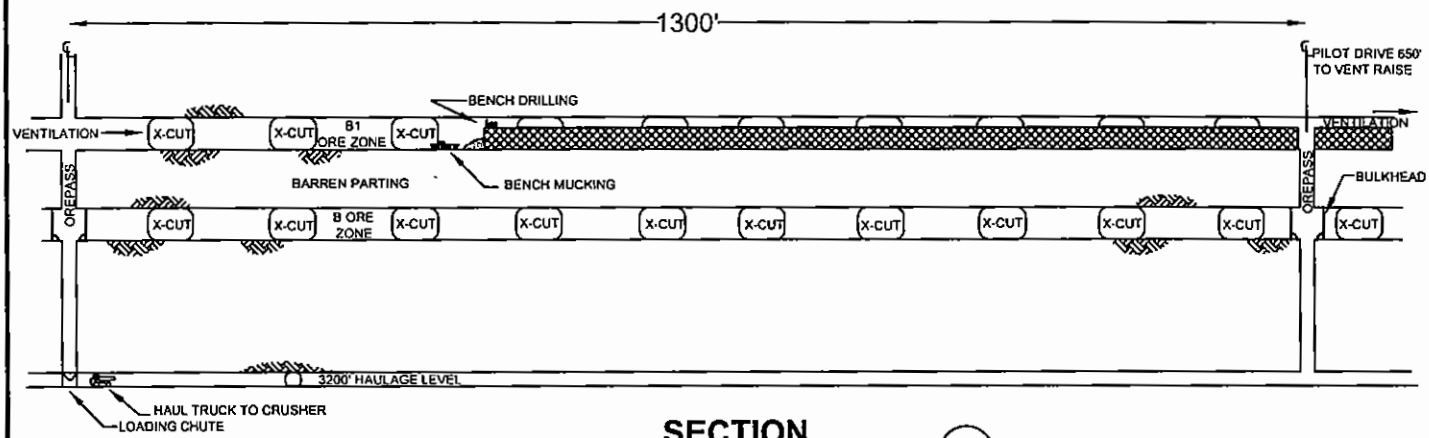
SOURCES: MONTANORE PROJECT DATA

MINES MANAGEMENT, INC.	***FIGURE 20***
	SCALE: 1"=200' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

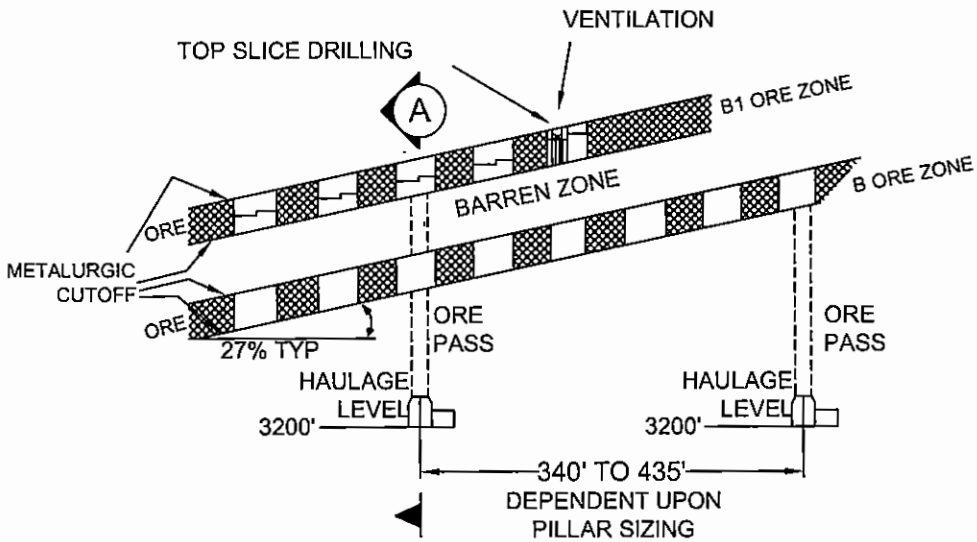
REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

ROOM-AND-PILLAR MINING

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



SECTION A
SCALE: 1"=200'



SECTION B
SCALE: 1"=200'

SOURCES: MONTANORE PROJECT DATA

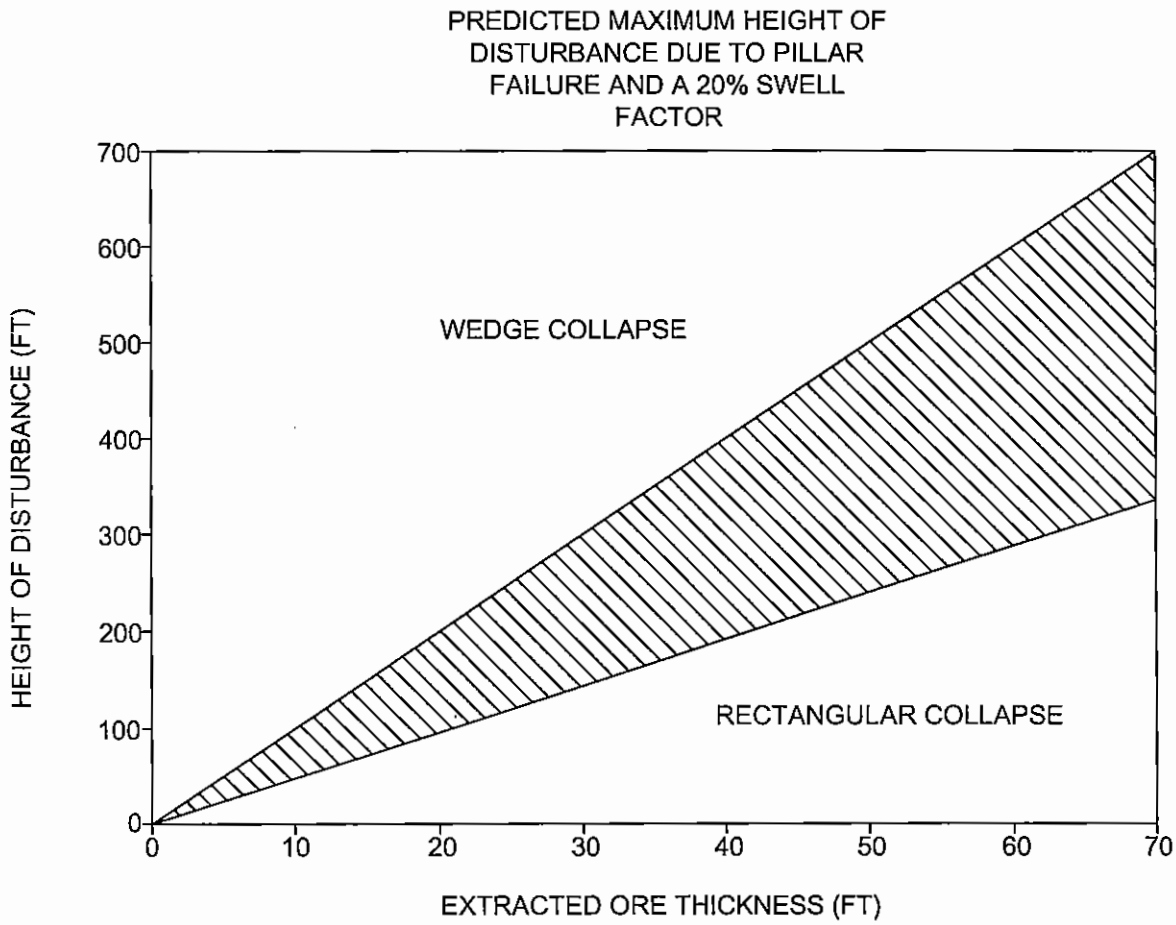
0 200 FT

MINES MANAGEMENT, INC.	*FIGURE 21*
	SCALE: 1"=200' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

MINING METHOD

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



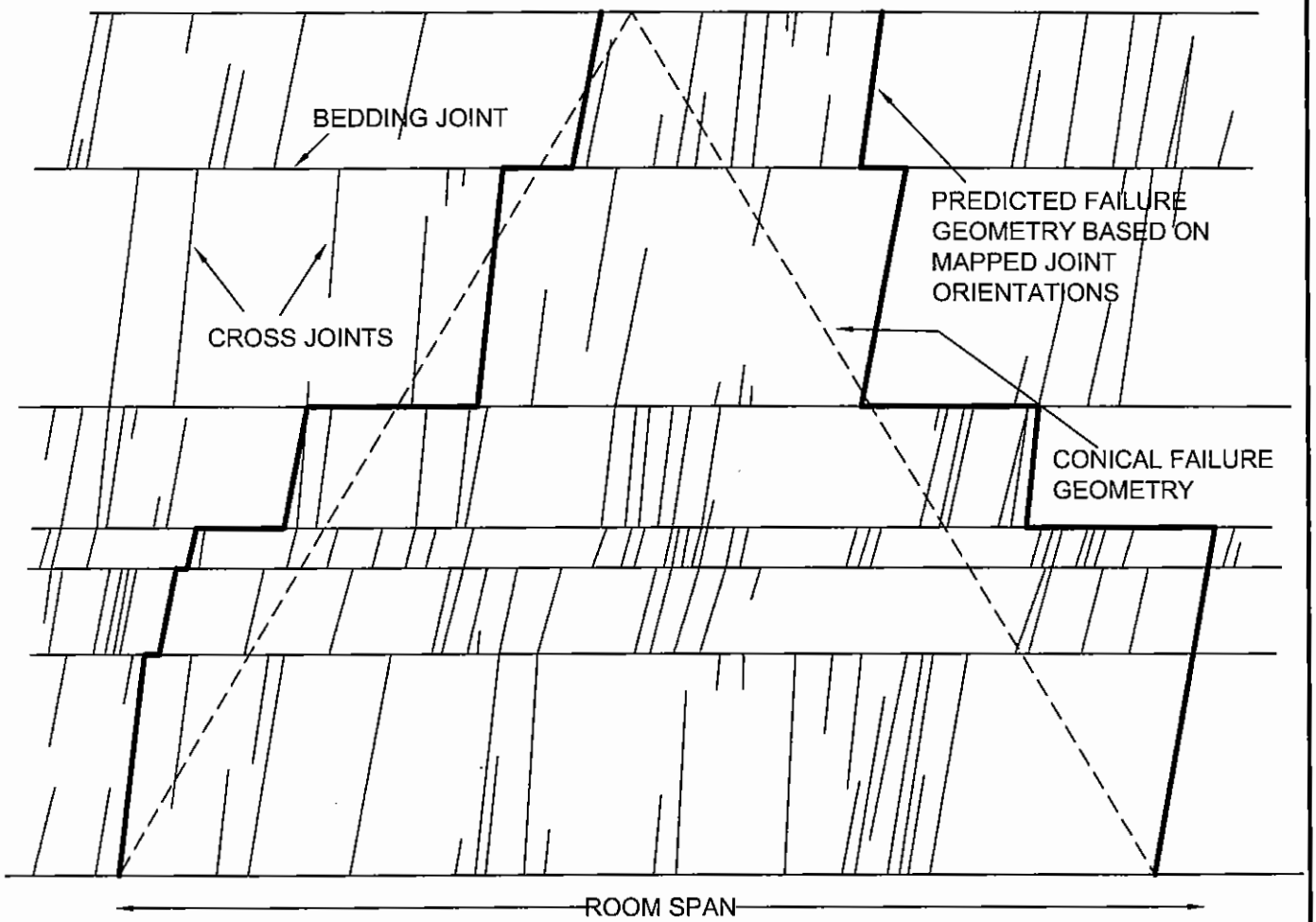
SOURCES: MONTANORE PROJECT DATA

MINES MANAGEMENT, INC.	**FIGURE 22**
	SCALE: NTS / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

PREDICTED MAXIMUM HEIGHT OF DISTURBANCE

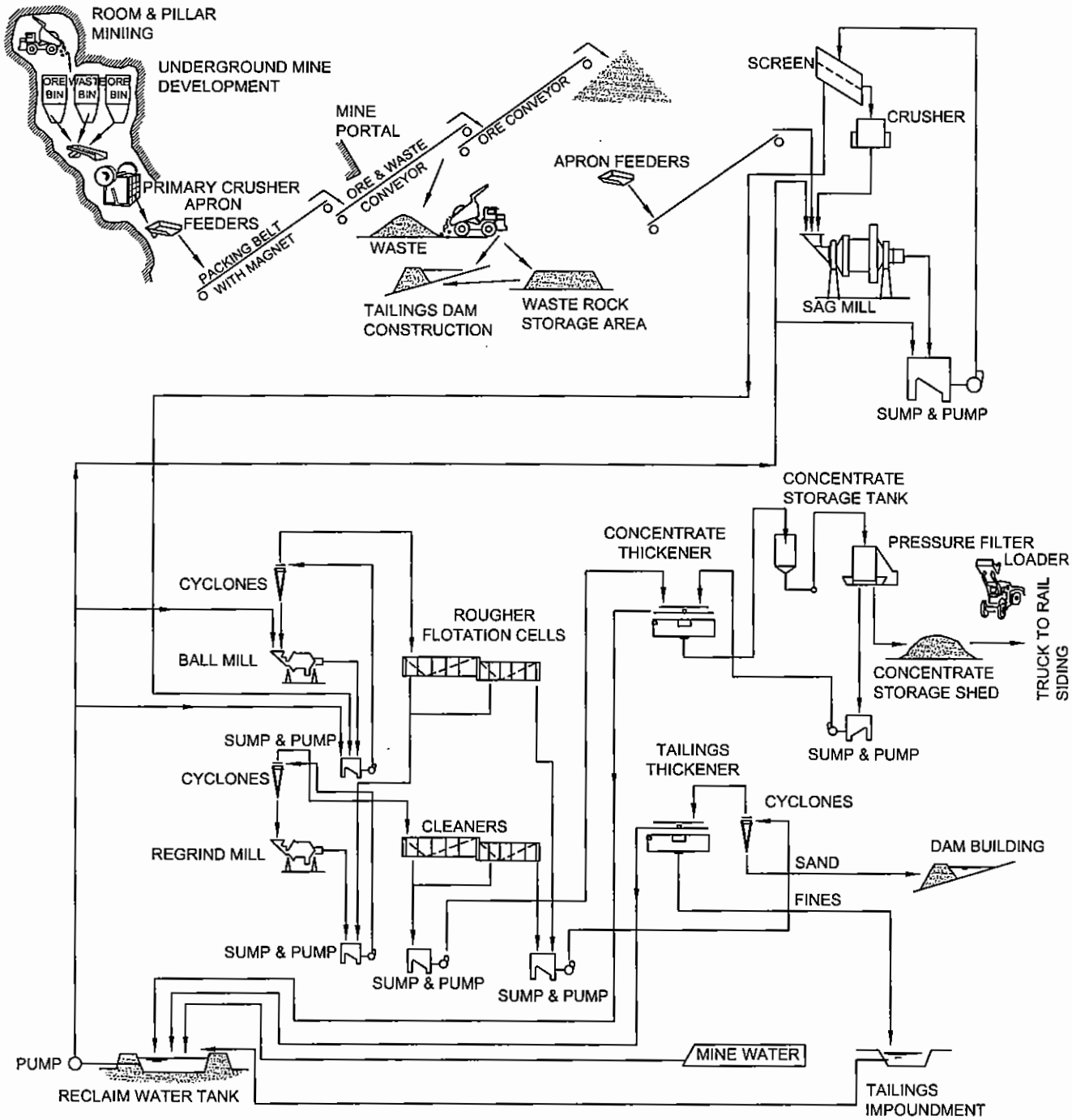
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



GENERALIZED CROSS-SECTION PERPENDICULAR TO THE STRIKE OF THE BEDDING

MINES MANAGEMENT, INC.	FIGURE 23	
	SCALE: NTS	DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS	
REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN		
GENERALIZED CROSS SECTION		
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA		

SOURCES: MONTANORE PROJECT DATA



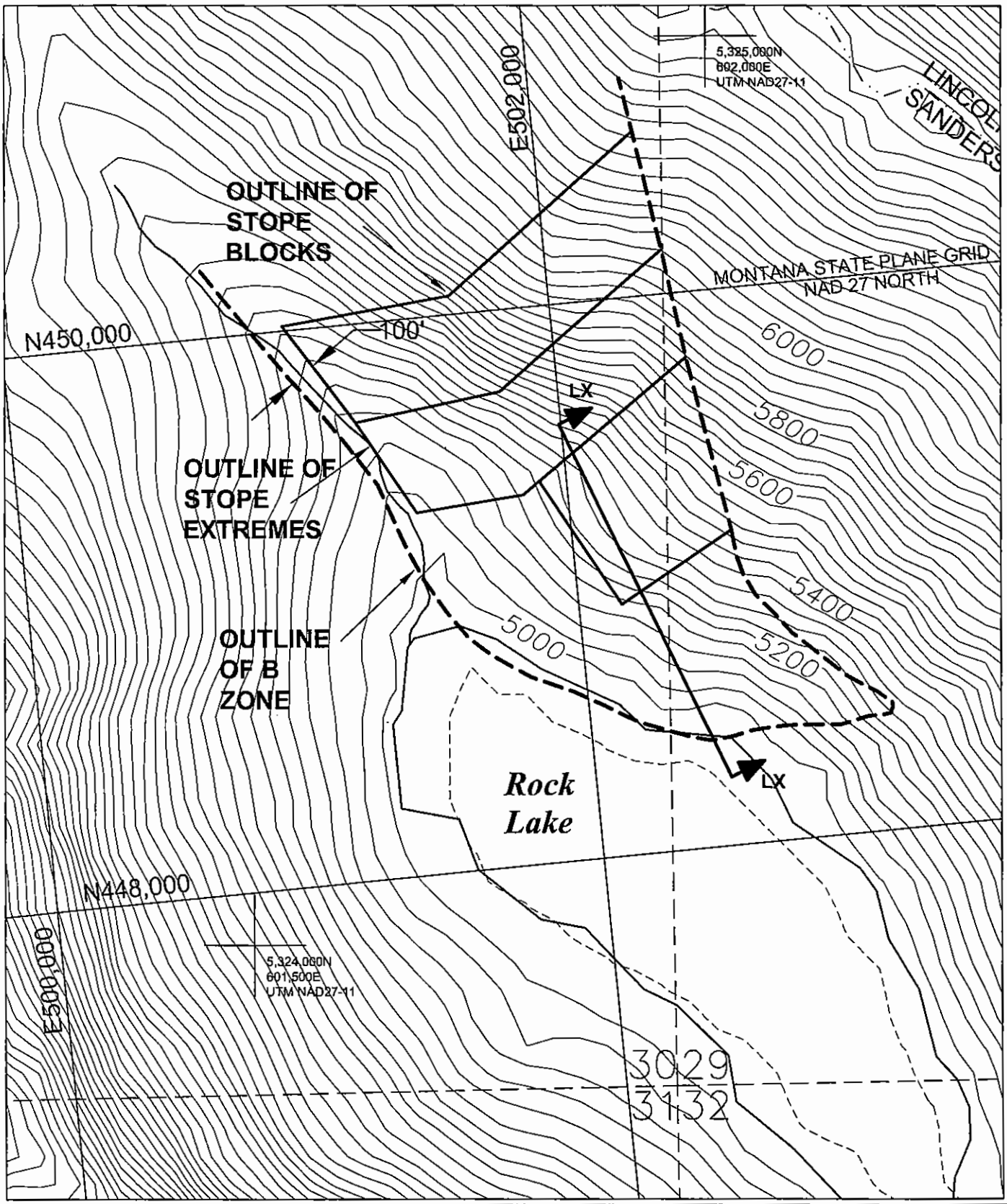
MINES MANAGEMENT, INC.	FIGURE 24
	SCALE: NTS / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

MINING & MILLING FLOW SHEET

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

SOURCES: MONTANORE PROJECT DATA



SOURCES:
USFS, USGS, MONTANORE PROJECT DATA

N
W E
S

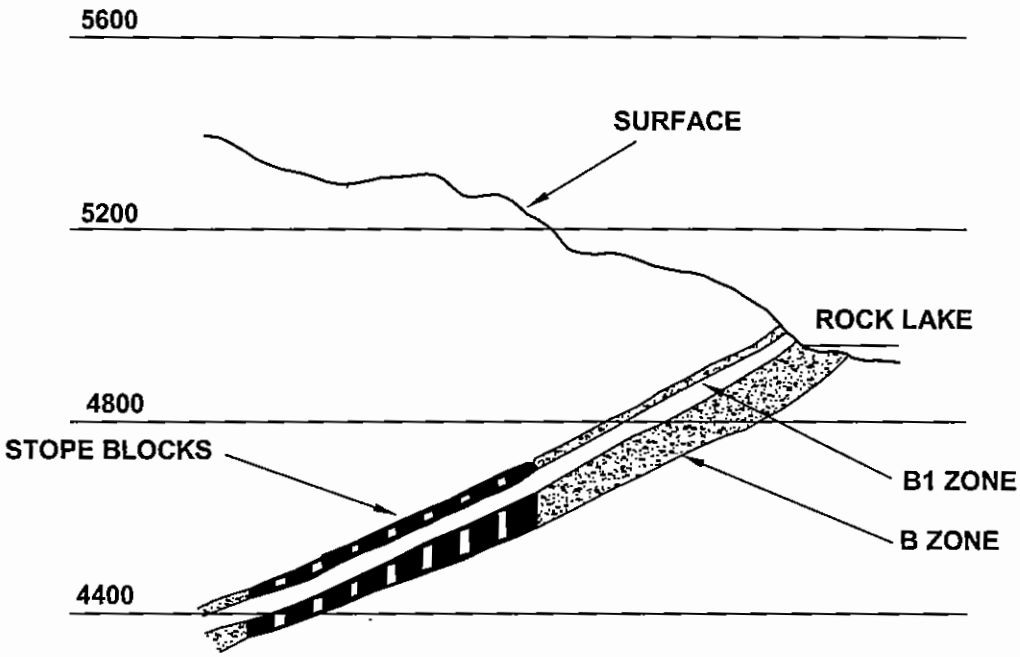
0 500 FT

MINES MANAGEMENT, INC.	FIGURE 25
	SCALE: 1"= 500' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

PLAN OF MINING LIMITS AT ROCK LAKE

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



SECTION LX-LX

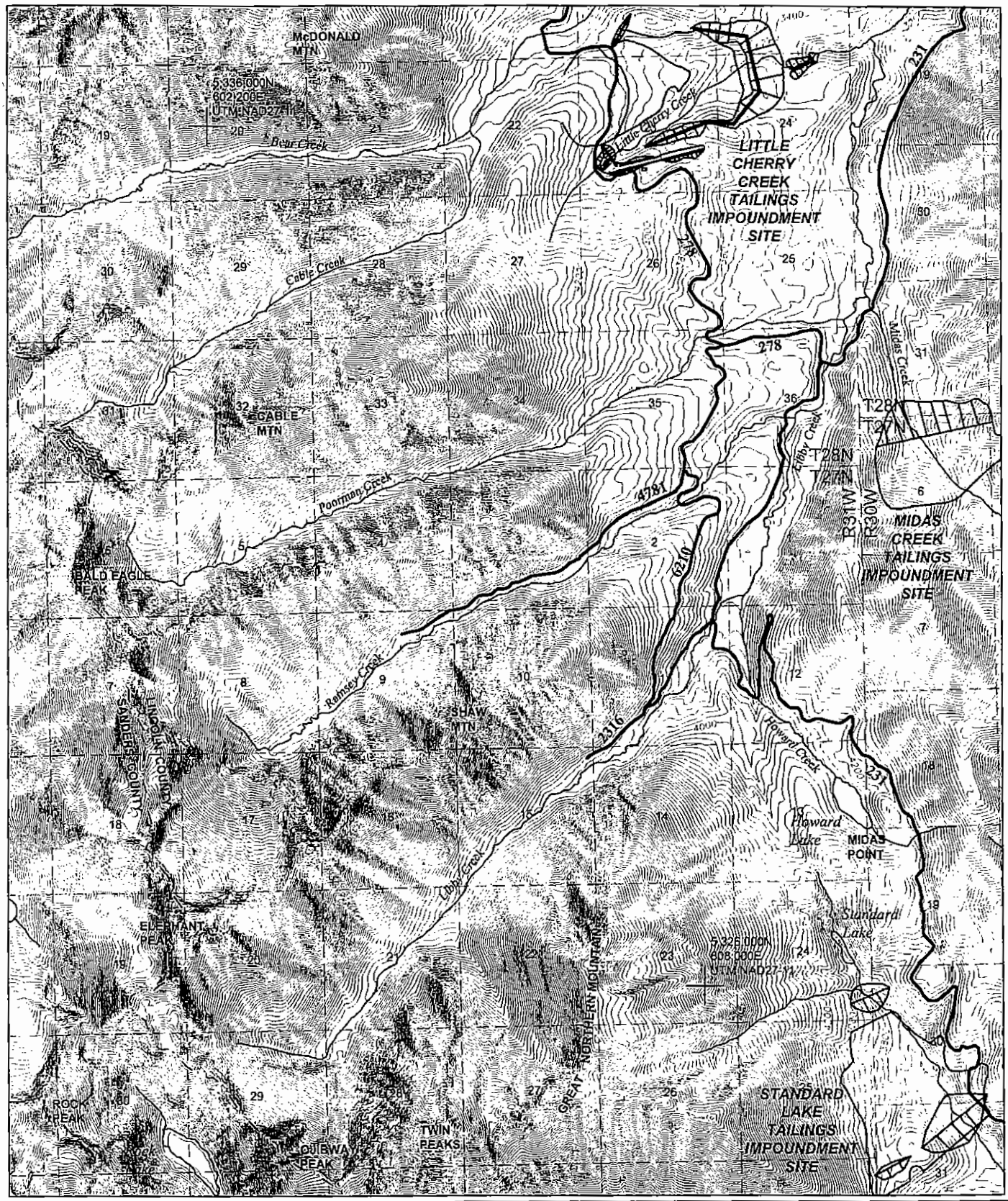
MINES MANAGEMENT, INC.	FIGURE 26
	SCALE: 1"=400' / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

SECTION OF MINING LIMITS AT ROCK LAKE

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

SOURCES: MONTANORE PROJECT DATA



N
W E
S

SOURCES:
USFS, USGS, MONTANORE PROJECT DATA

0 1 MILE

MINES MANAGEMENT, INC.

FIGURE 27

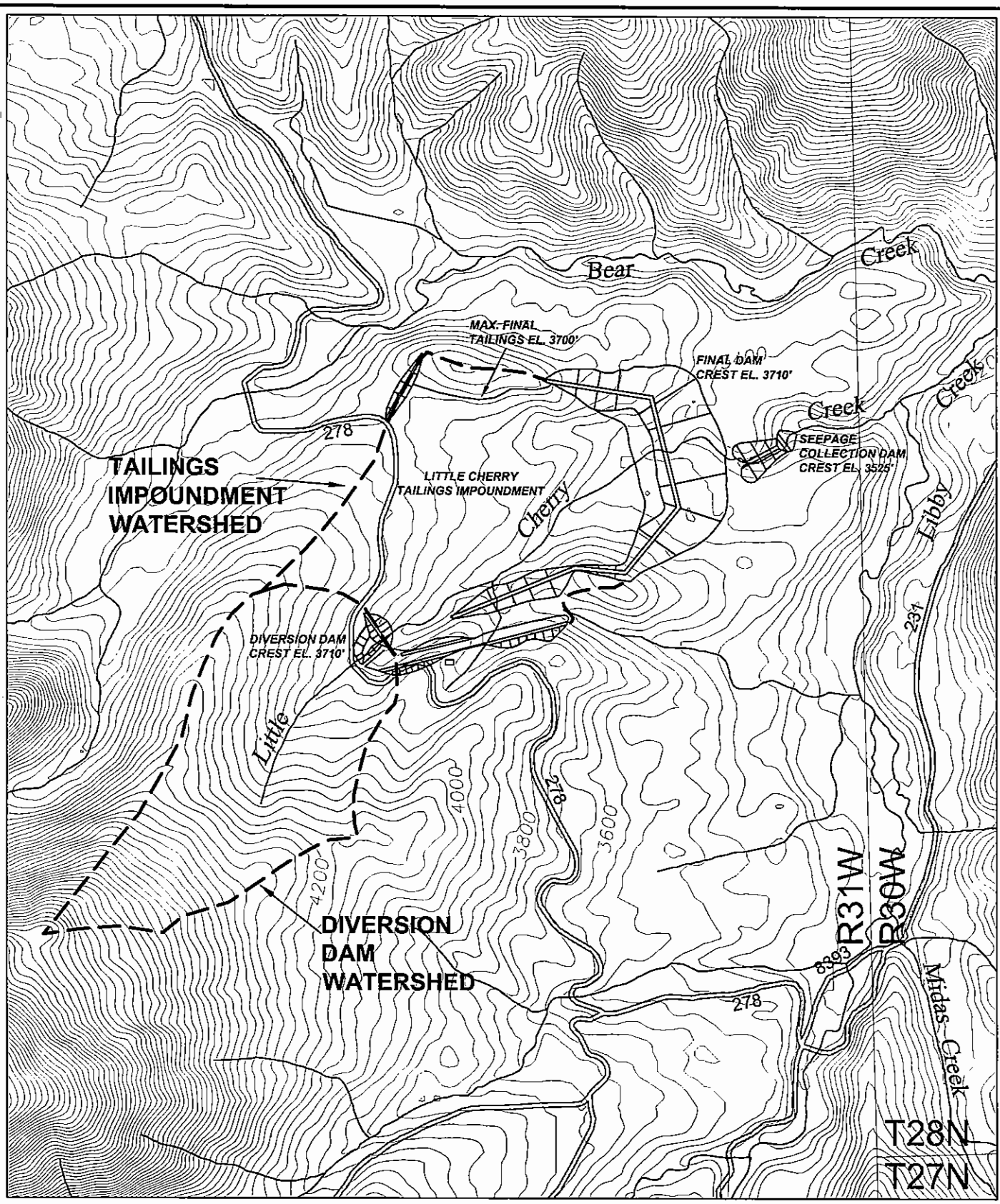
SCALE: 1"= 1 MILE | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

ALTERNATIVE TAILINGS IMPOUNDMENT SITES

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

SOURCES: USFS, USGS & MONTANORE PROJECT DATA

0 3000 FT

0 1 MILE

MINES MANAGEMENT, INC.

FIGURE 28

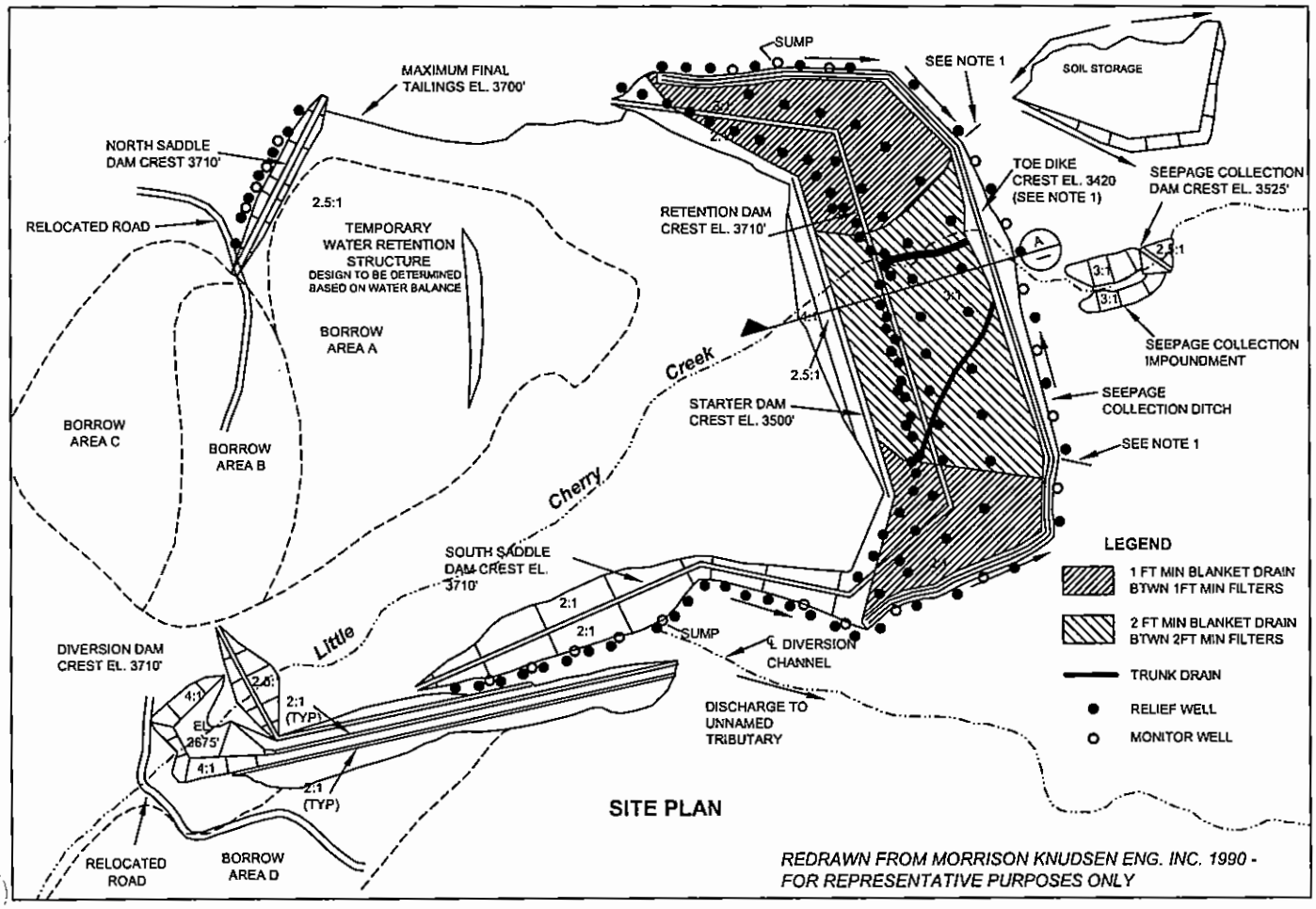
SCALE: 1"=½ MILE | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

IMPOUNDMENT WATERSHED AREAS

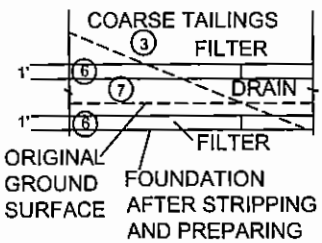
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

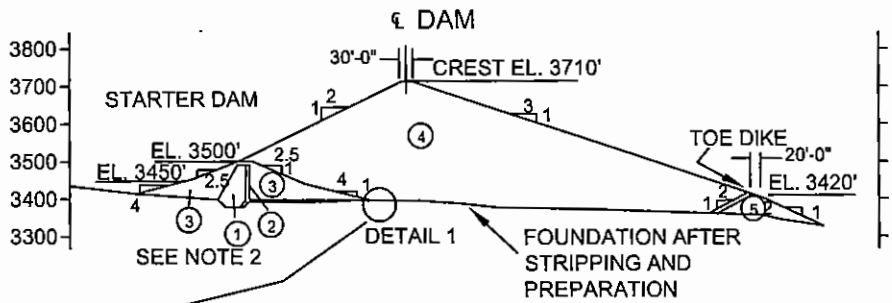


N W E S

0 1500 FT

0 1/4 MILE





DETAIL 1

CROSS-SECTION A

NOTE:
1. ABOVE EL 3405' TOE DIKE CREST IS 15'0" ABOVE FOUNDATION
2. SURFACE TO BE SEEDED WITH GRASS

LEGEND
ZONE -- DESCRIPTION

1. GRAVELLY SANDY CLAY OR SANDY CLAYEY SILT
2. SILTY SANDY GRAVEL AND COBBLES
3. WEATHERED BEDROCK, MIXTURE OF COBBLES, GRAVEL, SAND CLAYEY SOIL
4. CYCLONED TAILINGS SAND
5. RUN OF MINE WASTE ROCK
6. SAND FILTER
7. GRAVEL DRAIN

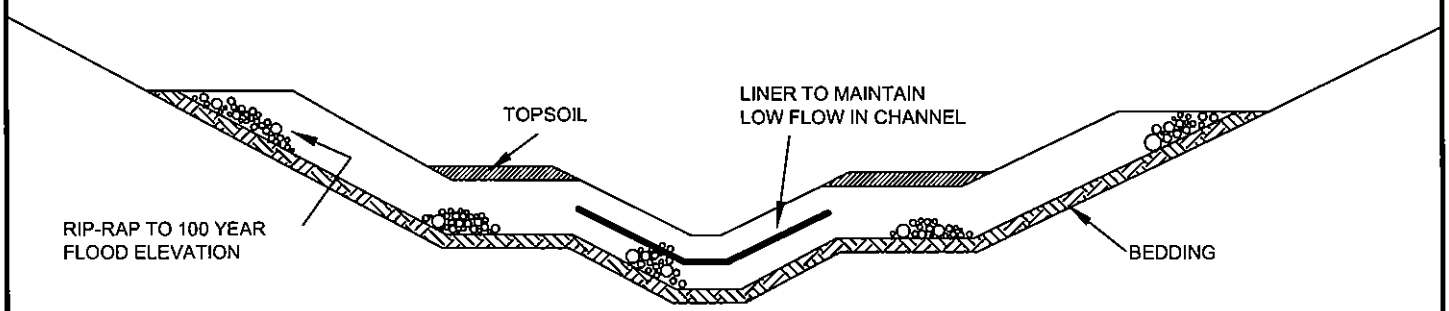
SOURCES: USFS, MONTANORE PROJECT 1992 EIS

MINES MANAGEMENT, INC.	**FIGURE 29**
	SCALE: 1"= 1,500' DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

TAILINGS IMPOUNDMENT SITE

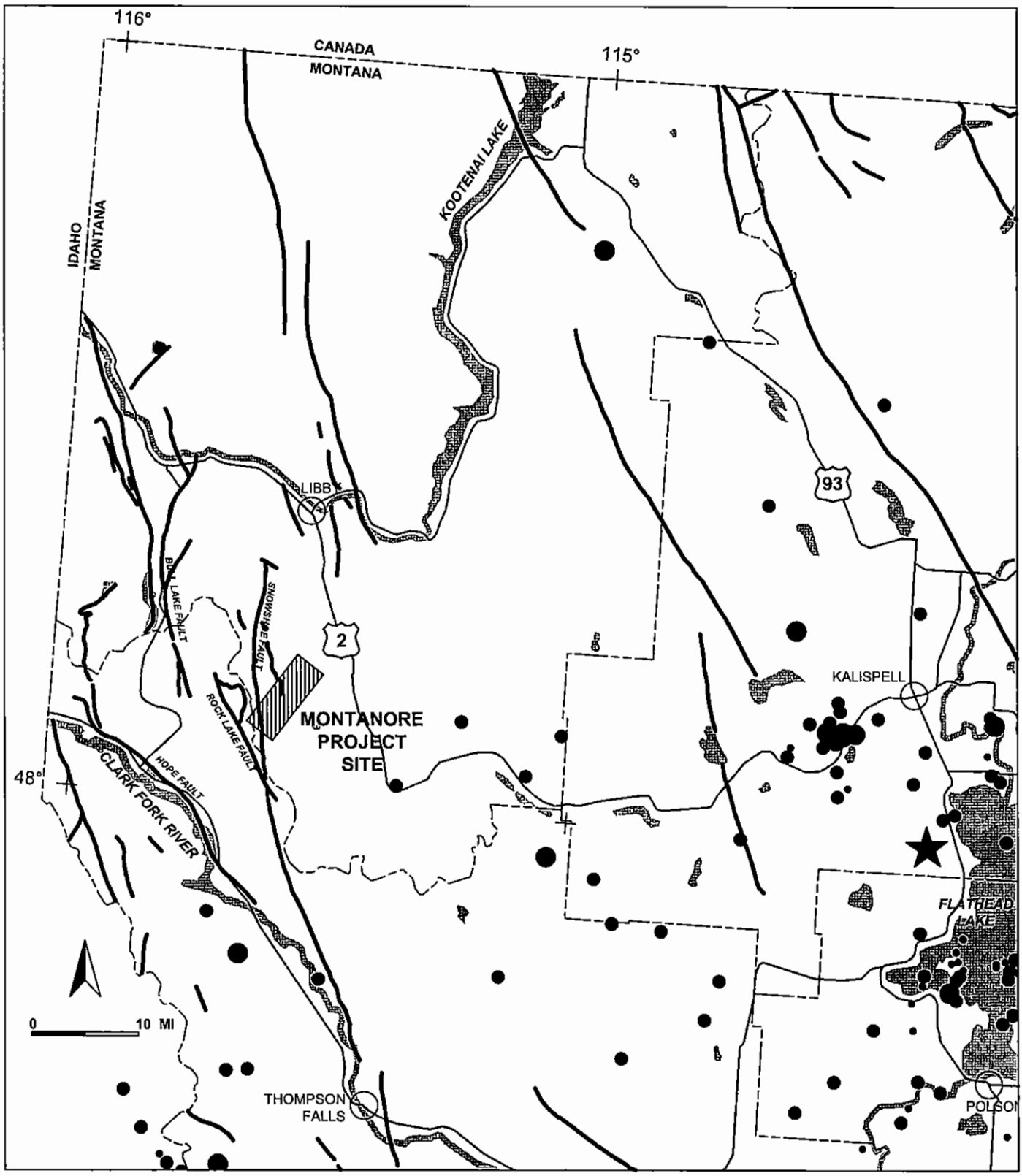
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



TYPICAL CROSS-SECTION OF TAILINGS IMPOUNDMENT DIVERSION CHANNEL

MINES MANAGEMENT, INC.	FIGURE 30
	SCALE: NTS / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS
REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN	
TYPICAL CROSS-SECTION OF DIVERSION CHANNEL	
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA	

SOURCES: MONTANORE PROJECT DATA



★ EPICENTERS OF POST 1900 EARTHQUAKES HAVING MAGNITUDES OF 5.5 OR LARGER

● EARTHQUAKE EPICENTERS LOCATED BY MBMG SINCE 1982 (MAGNITUDES LESS THAN 5.5; SYMBOL SCALED TO MAGNITUDE)

FAULTS

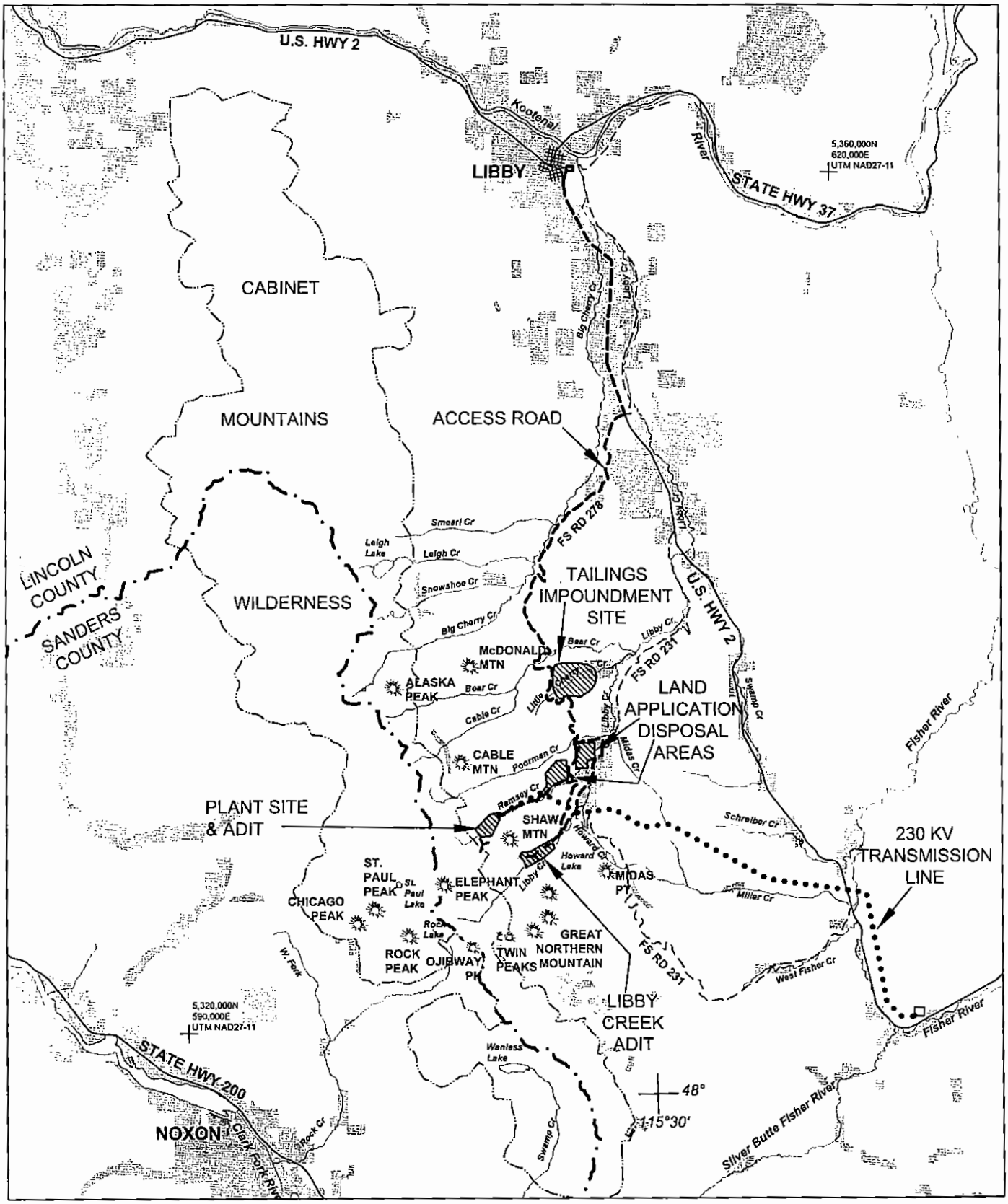
SOURCES:
EARTHQUAKES: MONTANA BUREAU OF MINES & GEOLOGY SPECIAL PUBLICATION No. 114, STICKNEY et. al. 2000
FAULTS: MONTANA STATE GIS LAYER USING USGS DATA

MINES MANAGEMENT, INC.	*FIGURE 31*
	SCALE: AS SHOWN / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

HISTORICAL EARTHQUAKES IN MONTANA 1900-2000

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

PRIVATE LAND

SOURCES: USFS, MONTANORE PROJECT 1992 EIS

0 20,000 FT

0 4 MILES

MINES MANAGEMENT, INC.

FIGURE 32

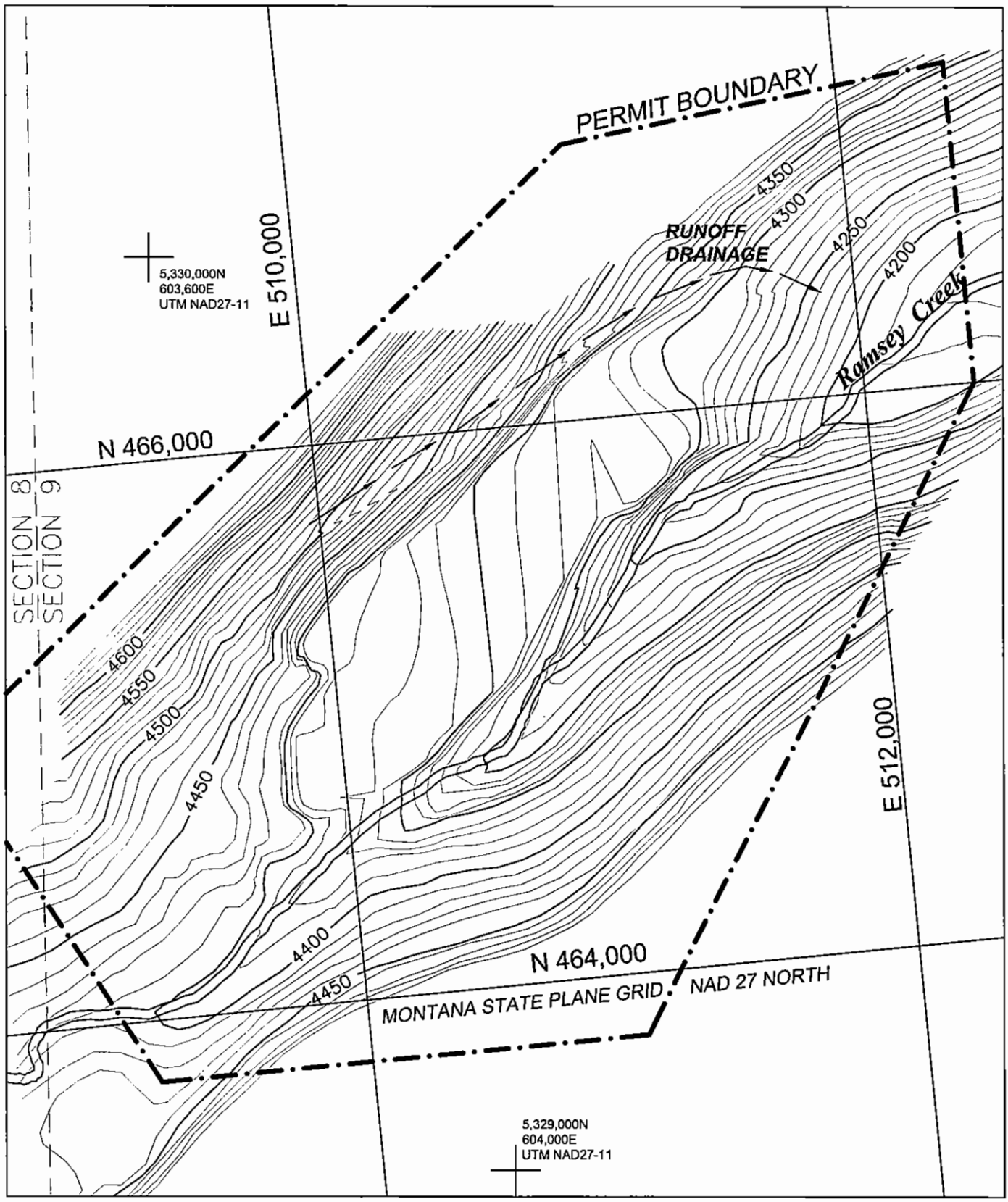
SCALE: 1"=4 MILES | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

LAND OWNERSHIP MAP

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



SOURCES: USFS, USGS, MONTANORE PROJECT DATA

N W E S

0 500 FT

MINES MANAGEMENT, INC.

FIGURE 33

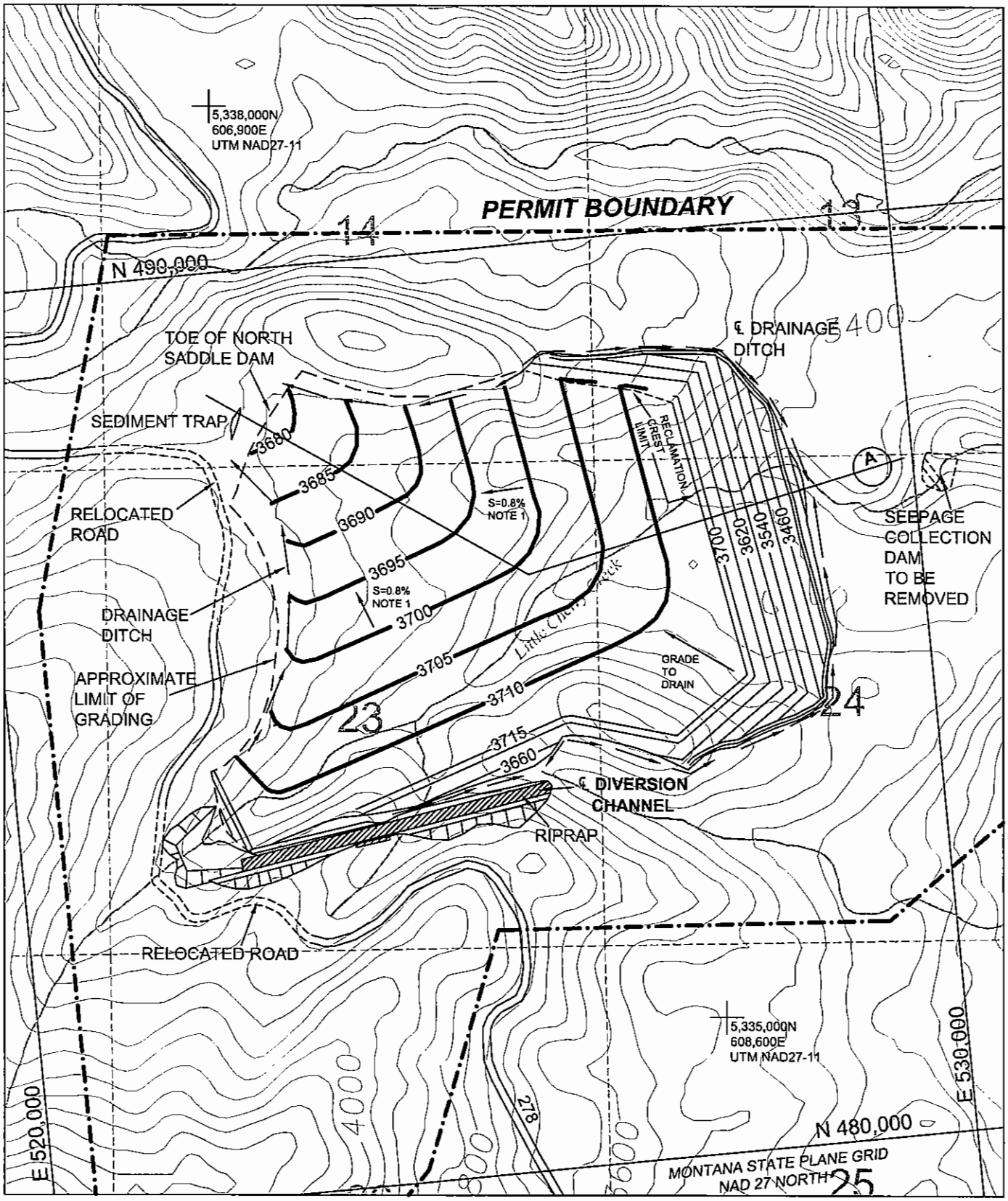
SCALE: 1"=500' | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

RAMSEY CREEK RECLAMATION PLAN

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



N
W E
S

SOURCES: USFS, USGS, MONTANORE PROJECT DATA

NOTE 1:
FINAL SLOPES MAY VARY BETWEEM 0.5% AND 1.0%, TO BE DETERMIINED DURING RECLAMATION DESIGN.

0 1500 FT

MINES MANAGEMENT, INC.

FIGURE 34

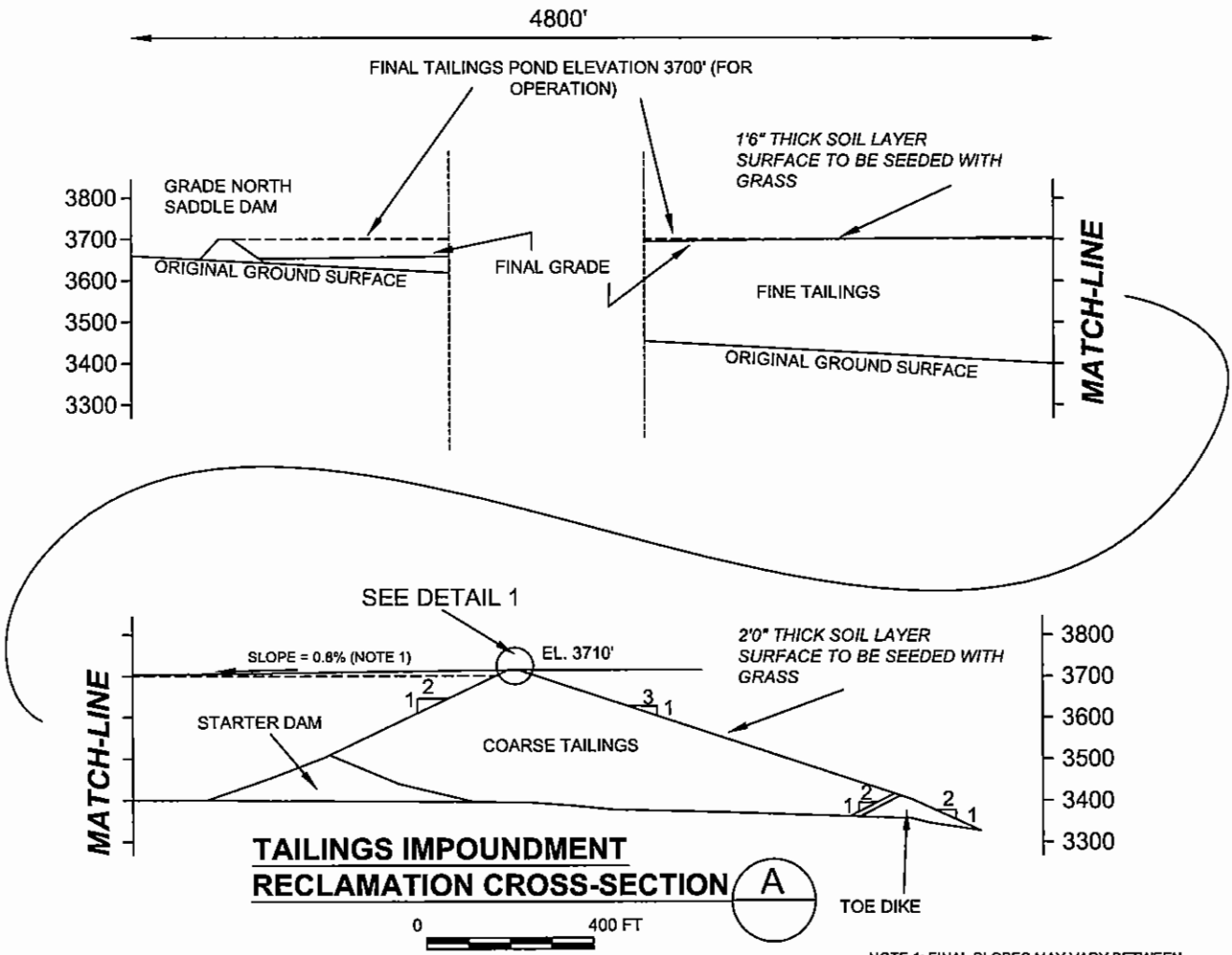
SCALE: 1"=1,500' | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

LITTLE CHERRY IMPOUNDMENT RECLAMATION PLAN

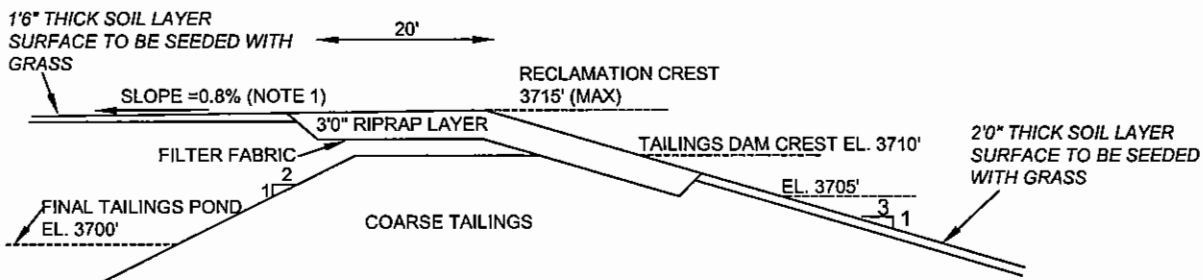
MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



TAILINGS IMPOUNDMENT RECLAMATION CROSS-SECTION A

0 400 FT

NOTE 1: FINAL SLOPES MAY VARY BETWEEN 0.5% AND 1.0%, TO BE DETERMINED DURING RECLAMATION DESIGN.



NOTE 1: FINAL SLOPES MAY VARY BETWEEN 0.5% AND 1.0%, TO BE DETERMINED DURING RECLAMATION DESIGN.

TAILINGS DAM CREST AFTER RECLAMATION DETAIL 1

0 20 FT

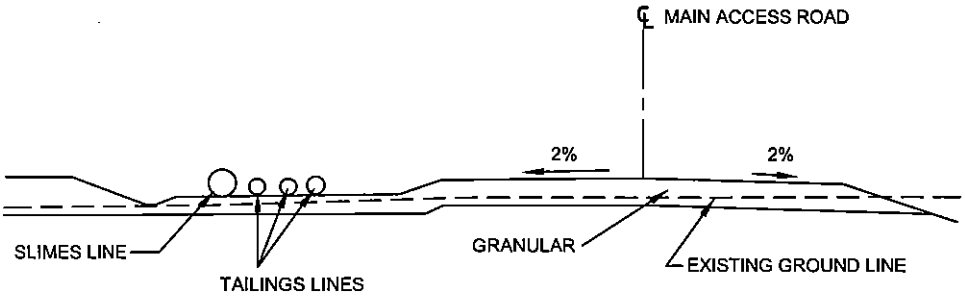
SOURCES: MONTANORE PROJECT DATA

MINES MANAGEMENT, INC.	FIGURE 35
	SCALE: AS SHOWN / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

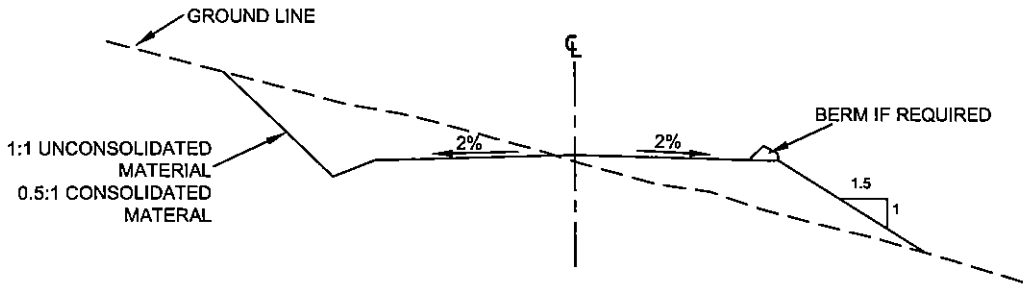
LITTLE CHERRY IMPOUNDMENT-RECLAIMED SECTIONS

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



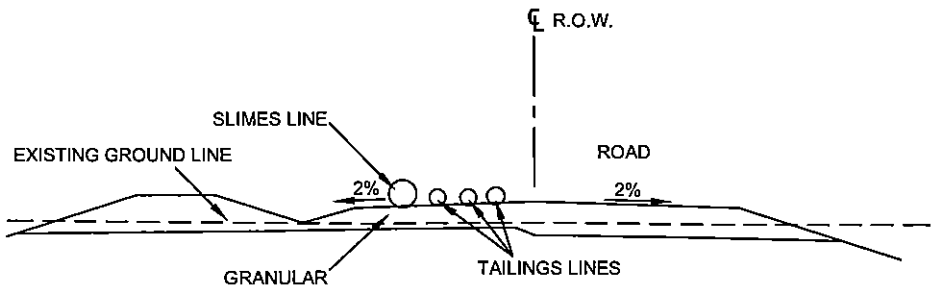
TYPICAL PIPE PLATFORM & MAIN ACCESS ROAD CROSS-SECTION

0 10 FT



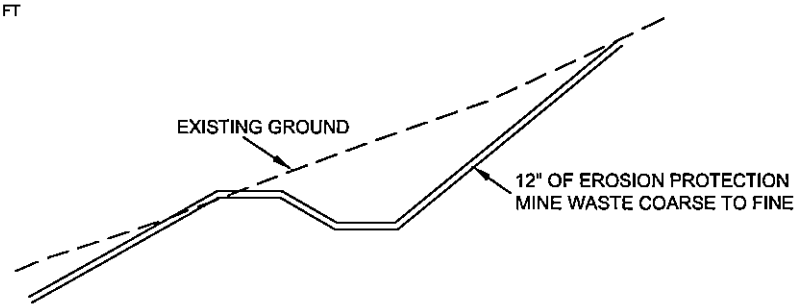
MAIN ACCESS ROAD CROSS-SECTION

0 10 FT



TAILINGS LINE ROAD & PIPE PLATFORM CROSS-SECTION

0 10 FT



PLANT SITE INTERCEPTOR CHANNEL AT DOWNSTREAM END

0 20 FT

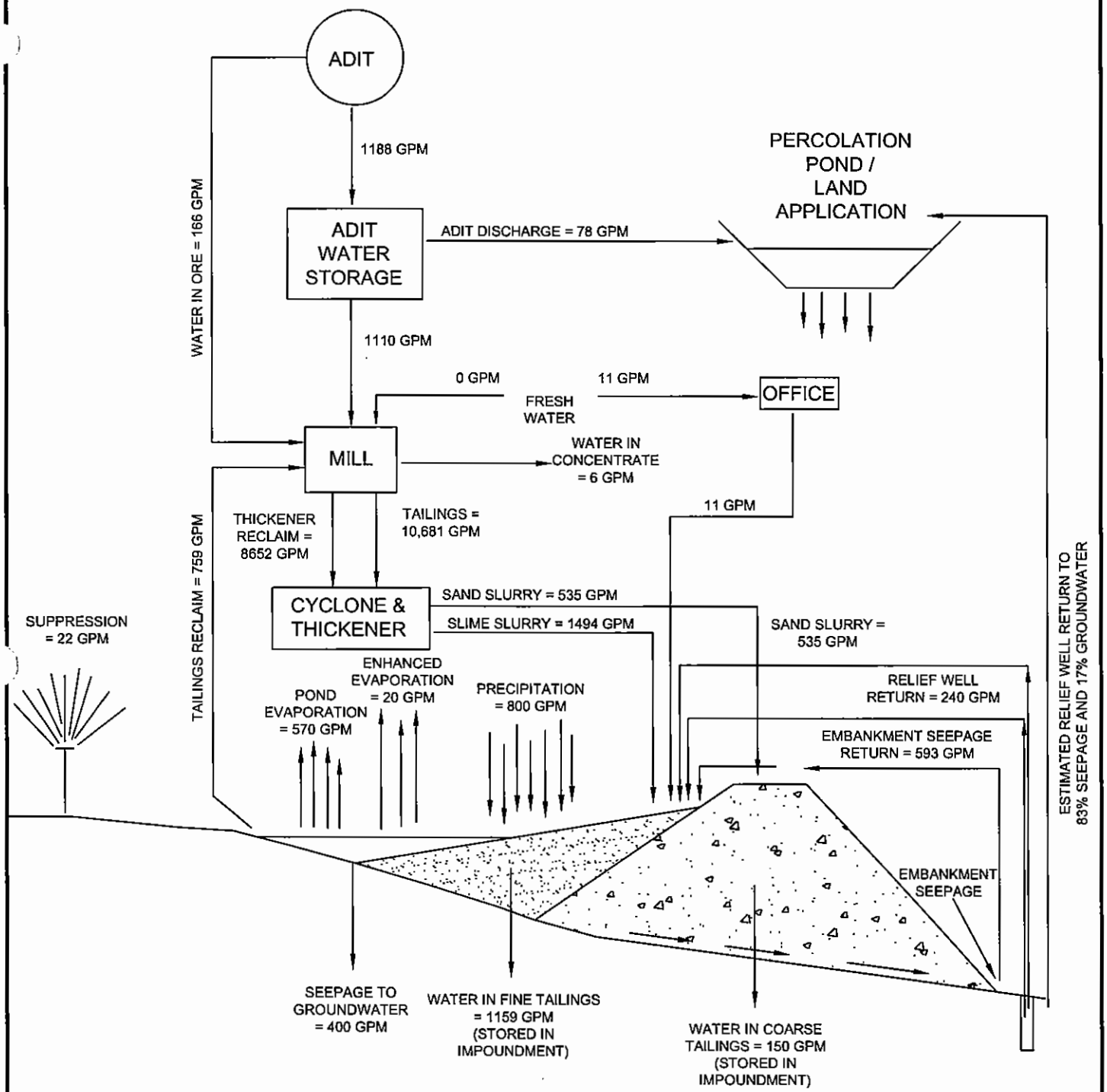
SOURCES: MONTANORE PROJECT DATA

MINES MANAGEMENT, INC.	***FIGURE 36***
	SCALE: AS SHOWN / DATE: DEC. 2004
	DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

MILL TAILINGS LINES DETAILS

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA



MINES MANAGEMENT, INC.

FIGURE 37

SCALE: NTS | DATE: DEC. 2004

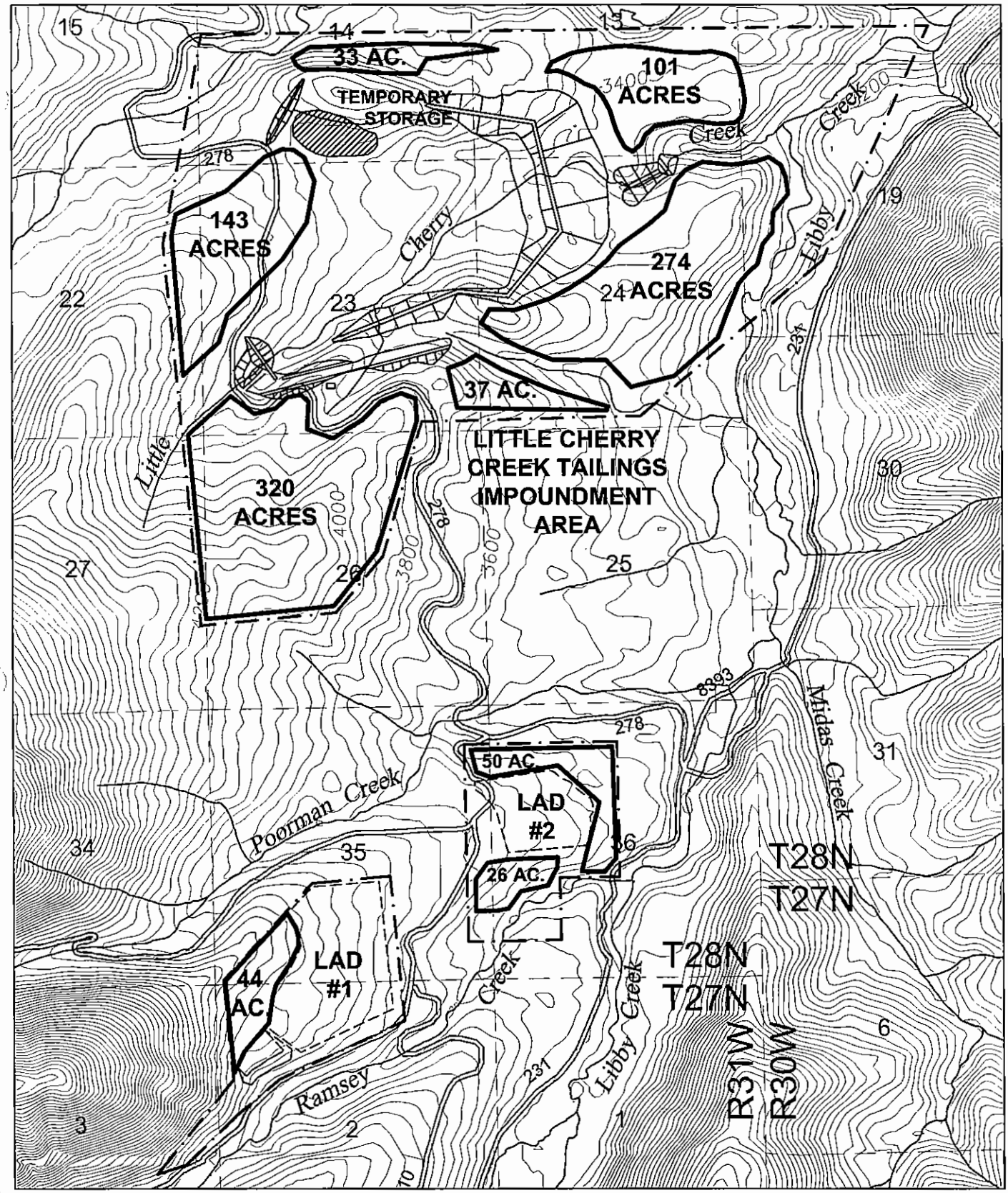
DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

WATER BALANCE YEAR 10 (20,000TPD 1992 EIS)

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

SOURCES: MONTANORE PROJECT DATA



SOURCES: USFS, USGS & MONTANORE PROJECT DATA

N W E S

0 3000 FT

0 1 MILE

MINES MANAGEMENT, INC.

FIGURE 38

SCALE: 1"=½ MILE | DATE: DEC. 2004

DRAWN: JASPER GEOGRAPHICS

REVISED APPLICATION FOR HARD ROCK OPERATING PERMIT & PROPOSED OPERATING PLAN

SUPPLEMENTAL LAND APPLICTION SITES

MONTANORE PROJECT - LINCOLN COUNTY, MONTANA

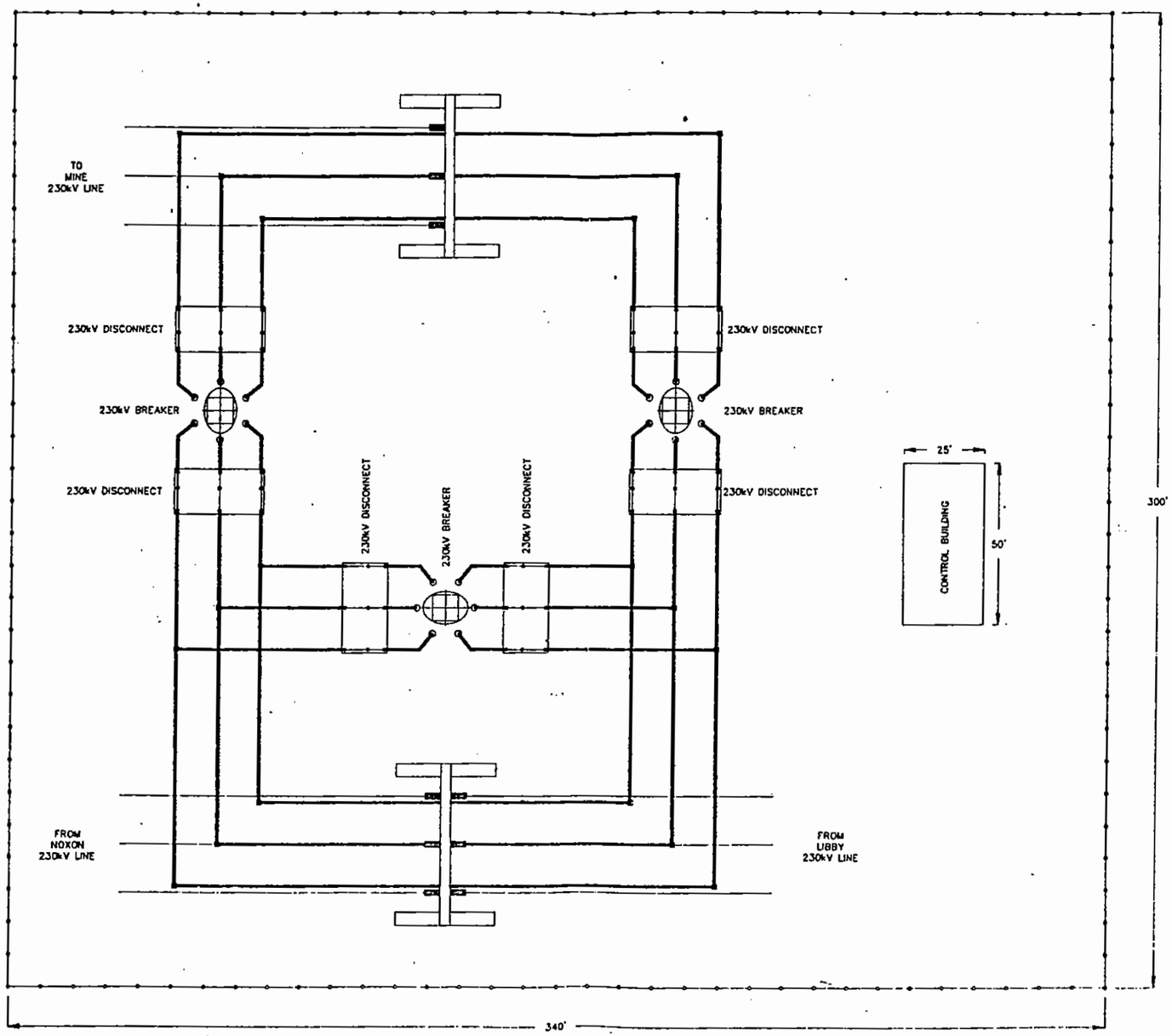


FIG. 39

Mines Management, Inc.
Montanore Project

Pleasant Valley 230kV Switchyard/Substation General Arrangement

DWG. NO.	REFERENCE DRAWINGS	NO.	REVISION	DATE	BY	DSGN ENG	PROJ MGR
		F					
		E					
		D					

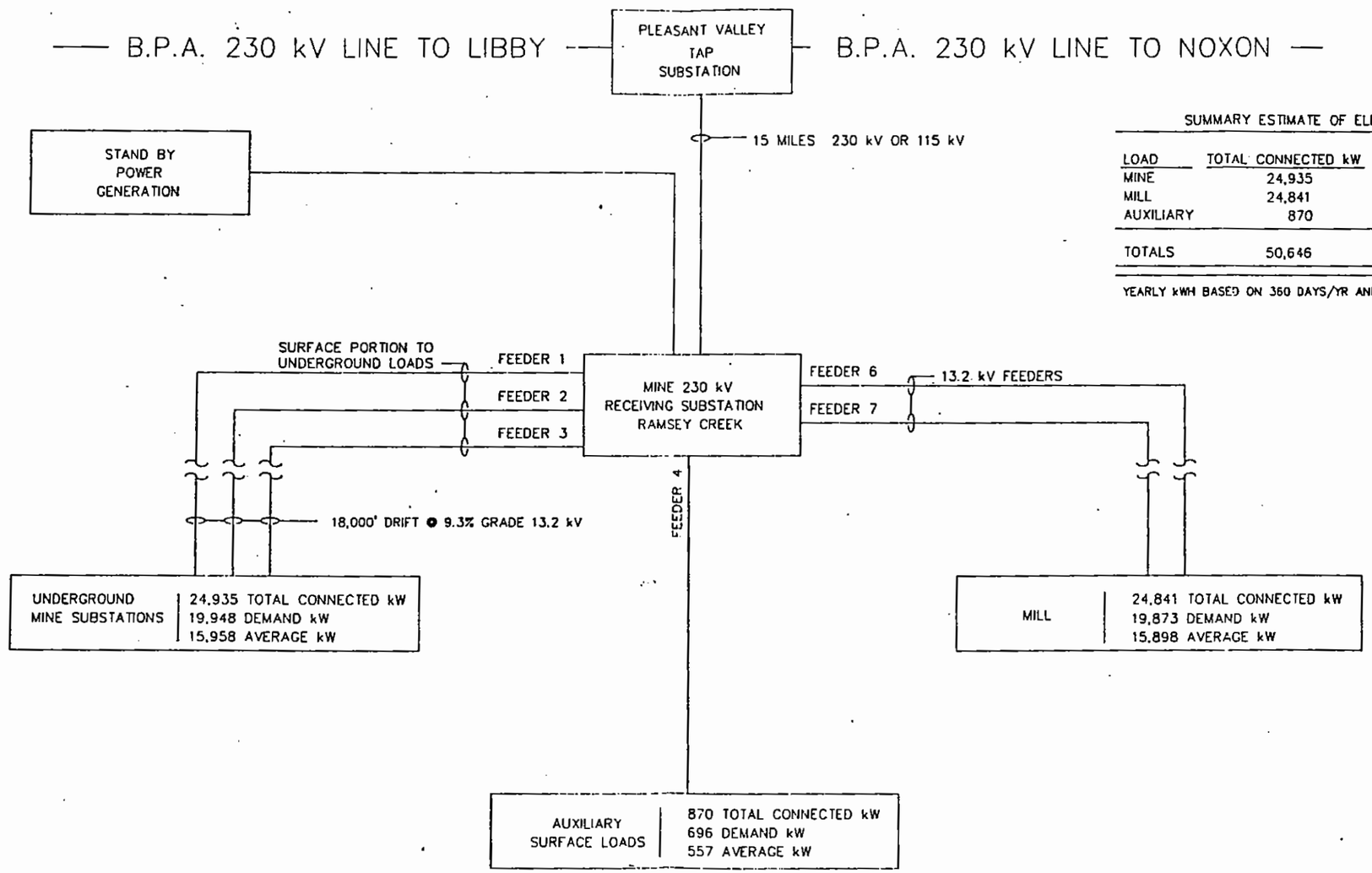
NO.	REVISIONS	DATE	BY	DSGN ENG	PROJ MGR
C	REVISION OF SWITCHYARD LAYOUT	7-6-89	PME		
B	RECONSTRUCTION OF SWITCHYARD	6-13-89	PME		
A	REVISION OF DIMENSIONS	1-18-89	TCM		

B.P.A. PLEASANT VALLEY 230kV SWITCHYARD/SUBSTATION GENERAL ARRANGEMENT HARD ROCK MINING PERMIT APPLICATION

238-02-E-801

C

...NORE PROJECT



SUMMARY ESTIMATE OF ELECTRICAL REQUIREMENTS

LOAD	TOTAL CONNECTED kW	DEMAND kW	AVERAGE kW
MINE	24,935	19,948	15,958
MILL	24,841	19,873	15,898
AUXILIARY	870	696	557
TOTALS	50,646	40,517	32,413

YEARLY kWH BASED ON 360 DAYS/YR AND 24 HRS/DAY = 280,048,320 kWH/YR

NOTE:
SEE FINAL LOAD LIST FOR HP INFORMATION.

FIG 40

Mines Management, Inc.
Montanore Project

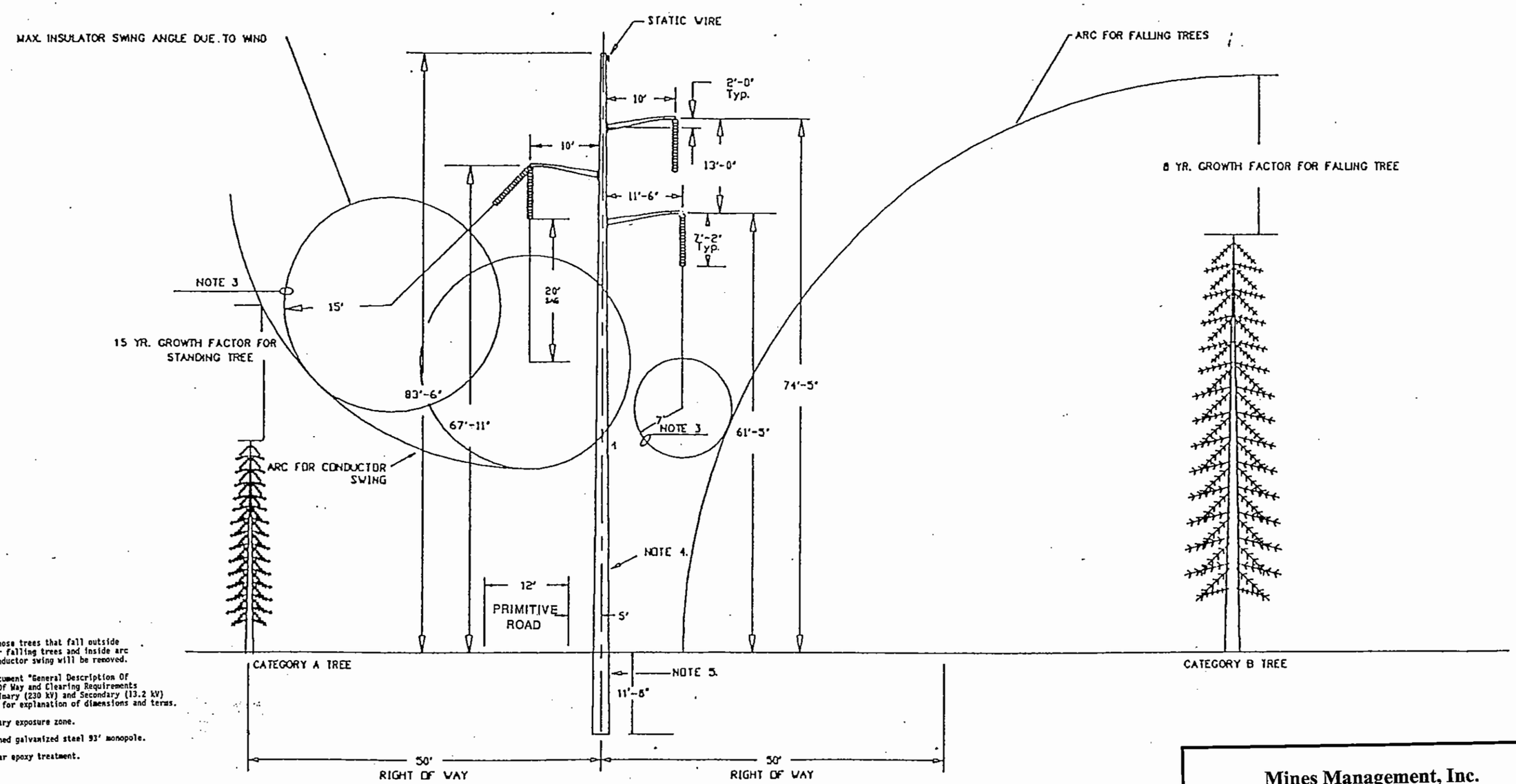
Electrical Power System Block Diagram

238-02-E-805

ELECTRICAL POWER SYSTEM BLOCK DIAGRAM

MONTANORE PROJECT

DWG NO.	REFERENCE DRAWINGS	NO.	REVISION	DATE	BY	NO.	REVISIONS	DATE	BY
		F				C			
		E				B			
		D				A	IN HOUSE REVISIONS	8-17-89	AR S



NOTE 1. Only those trees that fall outside arc for falling trees and inside arc for conductor swing will be removed.

NOTE 2. See document "General Description Of Right Of Way and Clearing Requirements for Primary (230 kV) and Secondary (13.2 kV) Lines" for explanation of dimensions and terms.

NOTE 3. Momentary exposure zone.

NOTE 4. Blackened galvanized steel 93' monopole.

NOTE 5. Coal tar epoxy treatment.

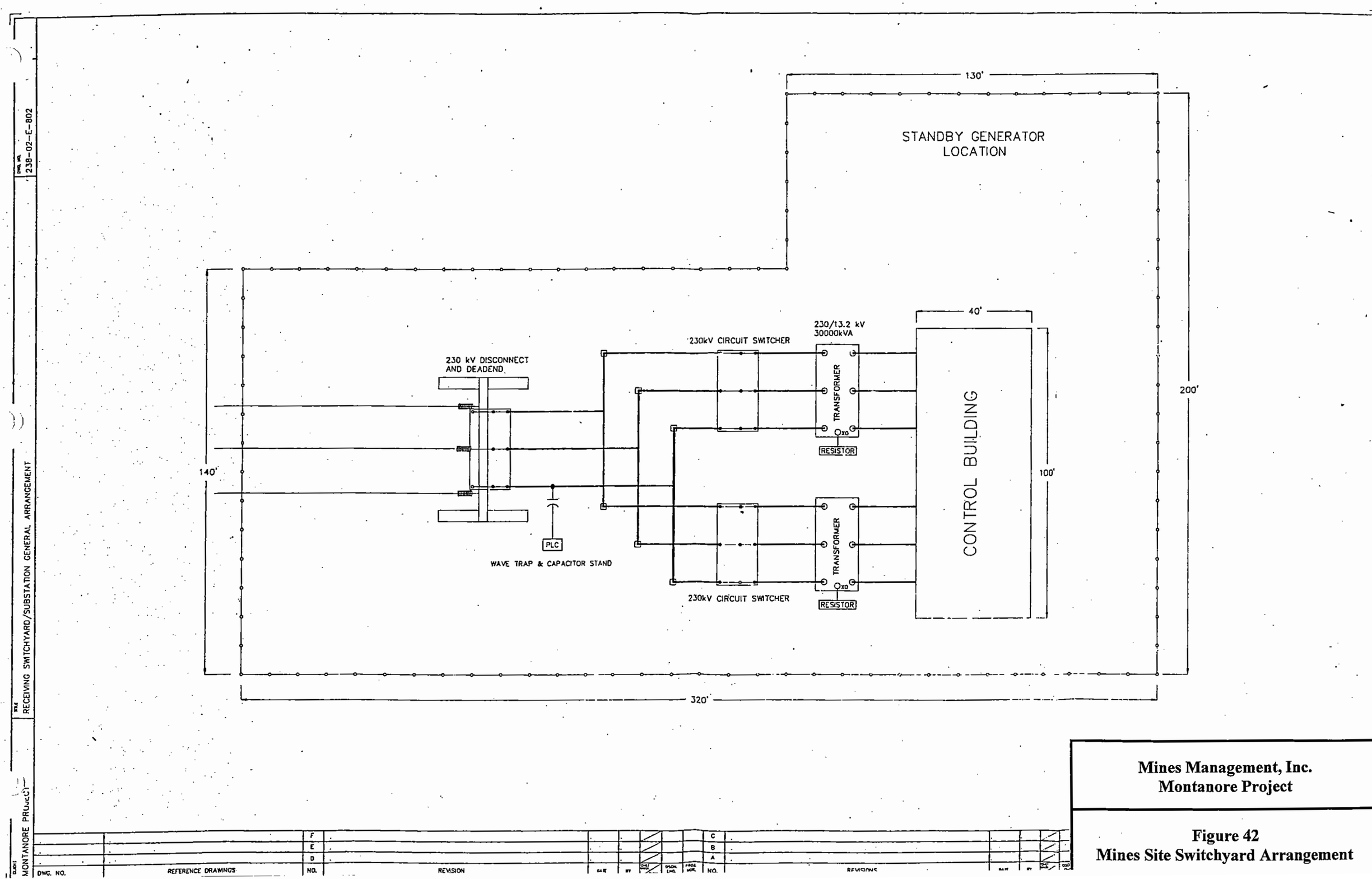
TYPICAL DRAWING FOR RIGHT OF WAY AND CLEARING REQUIREMENTS FOR 230 kV PRIMARY POWER LINE

DWG. NO.	REFERENCE DRAWINGS	NO.	REVISION	DATE	BY				NO.	REVISIONS	DATE	BY		
		F							C	MODIFIED STRUCTURE TO REFLECT MONOPOLE DESIGN	6-10-88	MLS		
		E							B	REVISED RIGHT OF WAY	1-21-88	JCM		
		D	ADDITION OF PRIMITIVE ROAD	8-13-86	MLS			JR	A	REVISED DIMENSIONS	1-15-88	JCM		

Rev. 11/15/89

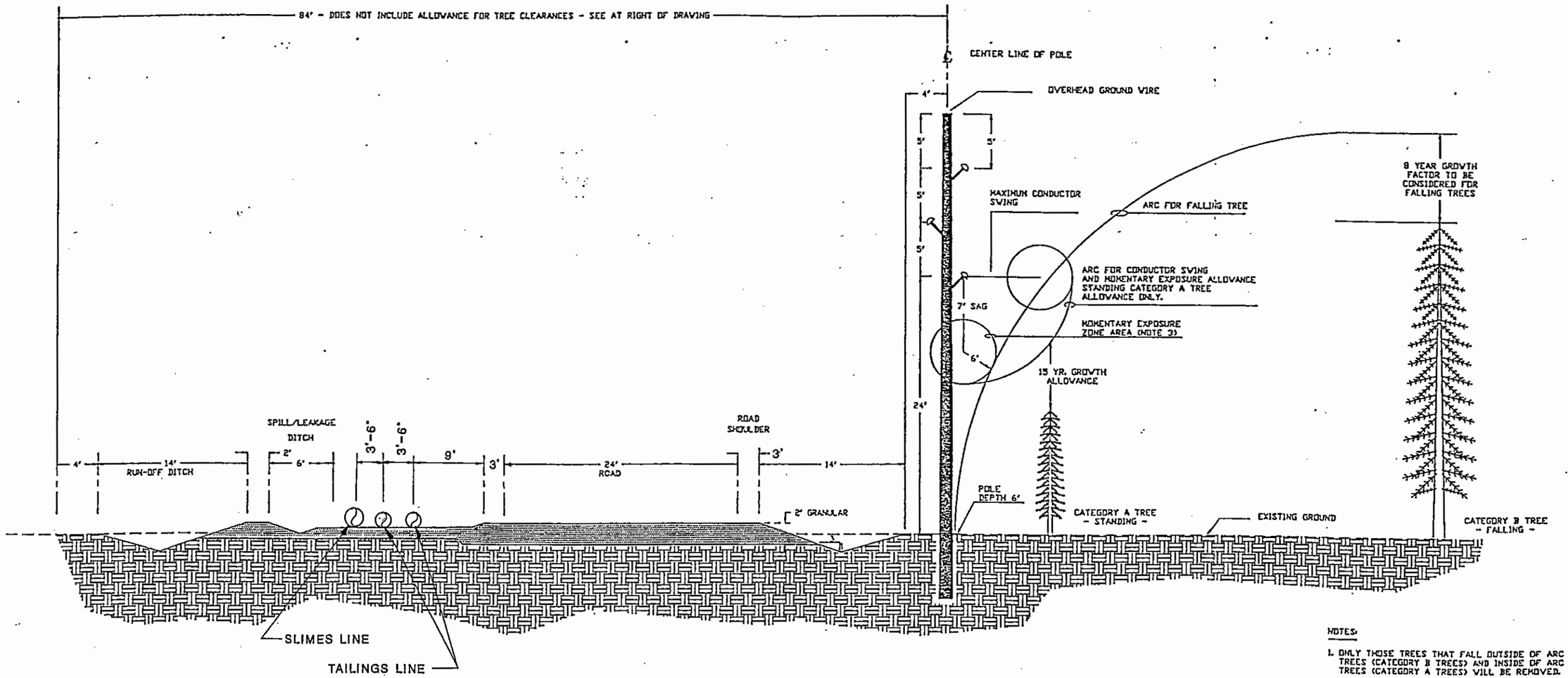
Mines Management, Inc.
Montanore Project

Figure 41
Typical Power Line Arrangement



Mines Management, Inc.
Montanore Project

Figure 42
Mines Site Switchyard Arrangement



NOTE: Additional Reclaim Line may be added if and as needed.

NOTES:

1. ONLY THOSE TREES THAT FALL OUTSIDE OF ARC FOR FALLING TREES (CATEGORY B TREES) AND INSIDE OF ARC FOR STANDING TREES (CATEGORY A TREES) WILL BE REMOVED.
2. SEE DOCUMENT "GENERAL DESCRIPTION OF RIGHT OF WAY AND CLEARING REQUIREMENTS FOR PRIMARY (230 KV) AND SECONDARY (13.2 KV) LINES" FOR EXPLANATION OF DIMENSIONS AND TERMS.
3. MOMENTARY EXPOSURE ZONE.

TYPICAL PIPE PLATFORM AND TAILINGS LINE ROAD SECTION WITH 13.2 kV POWER LINE AND RIGHT OF WAY REQUIREMENTS

Mines Management, Inc.
Montanore Project

Figure 43
Typical General Arrangement
Mine-Tailings – Road/Powerline

Rev. 1

DWG. NO.	REFERENCE DRAWINGS	NO.	REVISION	DATE	BY	NO.	REVISIONS	DATE	BY
		5				2			
		4				1			
		3				0			

MONTANA PROJECT — HARD ROCK MINING PERMIT APPLICATION CONCEPTUAL DRAWING ONLY — 23B-uZ-E-804

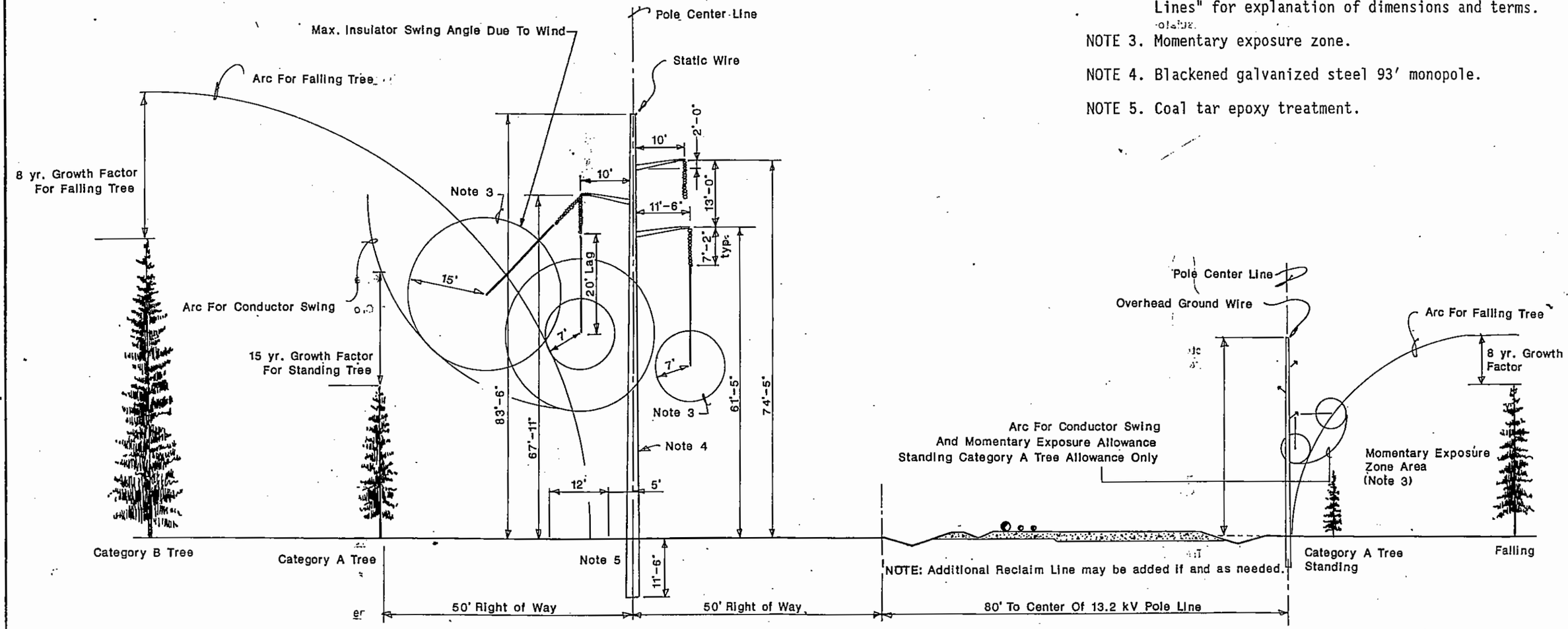
NOTE 1. Only those trees that fall outside arc for falling trees and inside arc for conductor swing will be removed.

NOTE 2. See document "General Description Of Right Of Way and Clearing Requirements for Primary (230 kV) and Secondary (13.2 kV) Lines" for explanation of dimensions and terms.

NOTE 3. Momentary exposure zone.

NOTE 4. Blackened galvanized steel 93′ monopole.

NOTE 5. Coal tar epoxy treatment.



No Scale:

Typical Cross-Section Where Both 230 kV And 13.2 kV Share The Same Right Of Way
This Will Vary Considerably From This Depiction Due To Elevation Differences At The Sides Of The Corridor

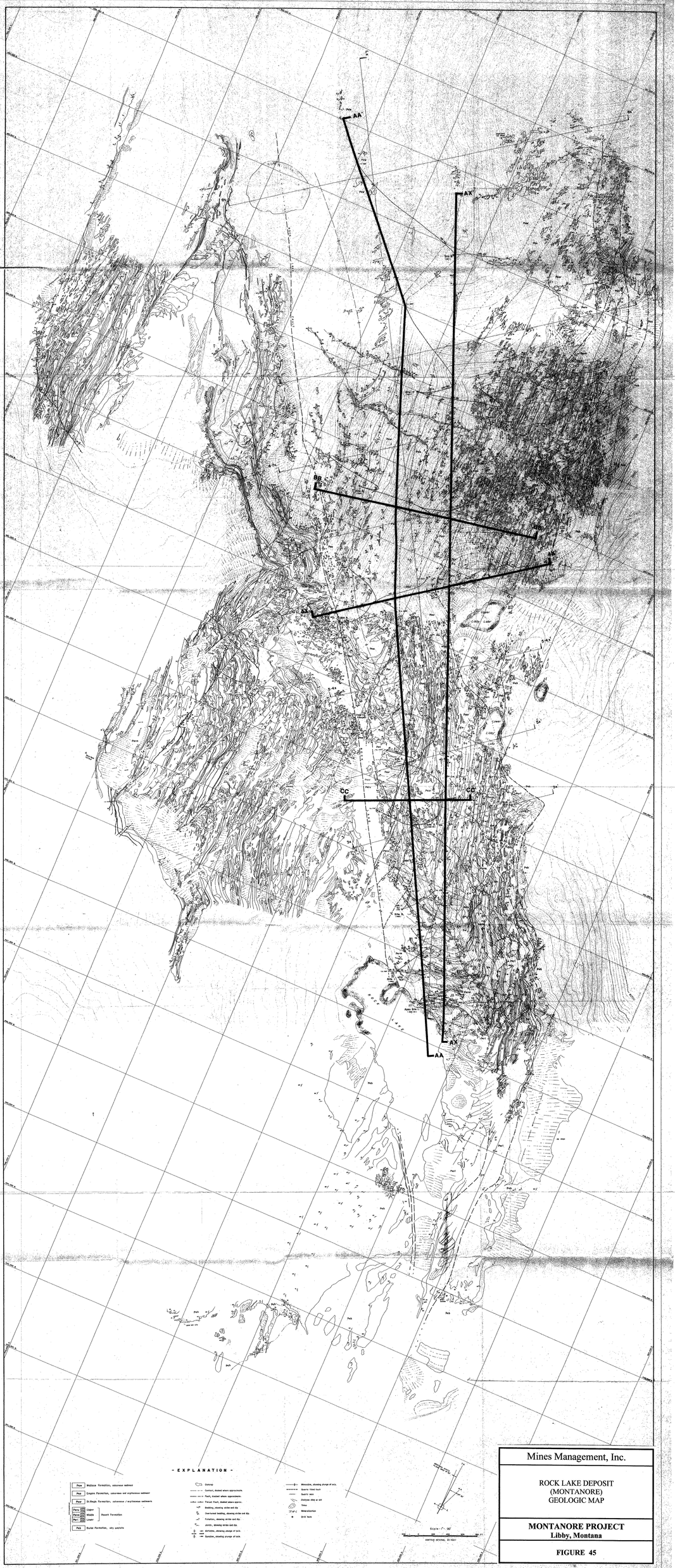
This Drawing Is Intended For General Clarification Only

SOURCE OF INFORMATION: Redpath Engineering Mesa, Arizona, Dwg. No. 238-E-02-8004

Rev. 11/15/89

Mines Management, Inc.
Montanore Project

Figure 44
Typical General Arrangement
Powerlines/Road
Shared Corridor



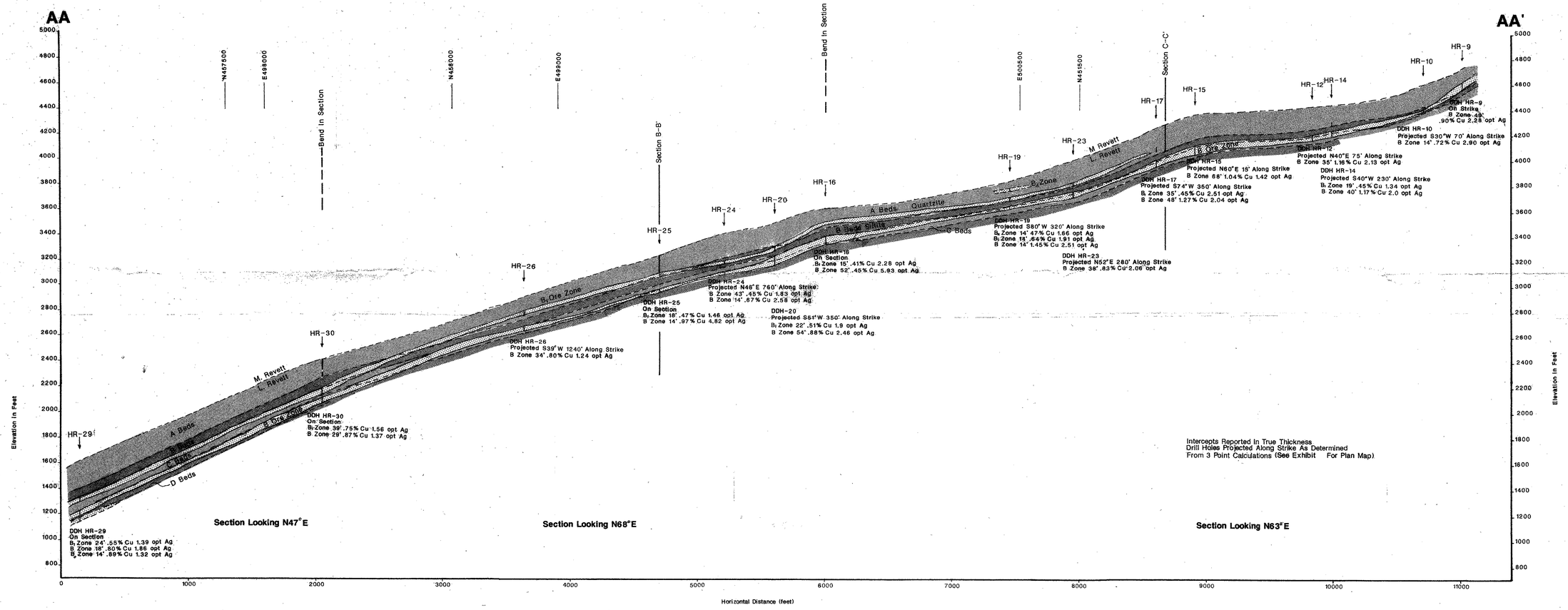
Mines Management, Inc.

ROCK LAKE DEPOSIT
(MONTANORE)
GEOLOGIC MAP

MONTANORE PROJECT
Libby, Montana

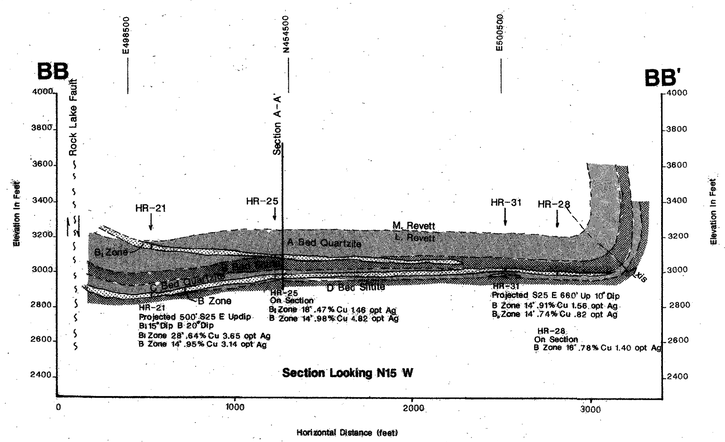
FIGURE 45

1989

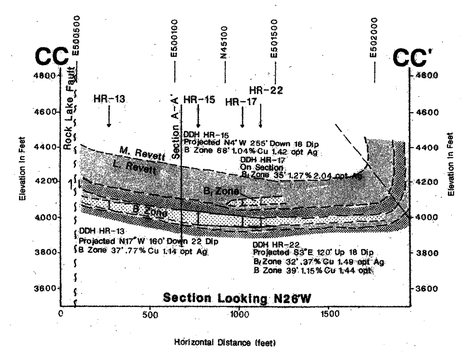


GEOLOGIC SECTION AA-AA'

See Exhibit 1-1 For Cross-Section Locations



GEOLOGIC SECTION BB-BB'



GEOLOGIC SECTION CC-CC'

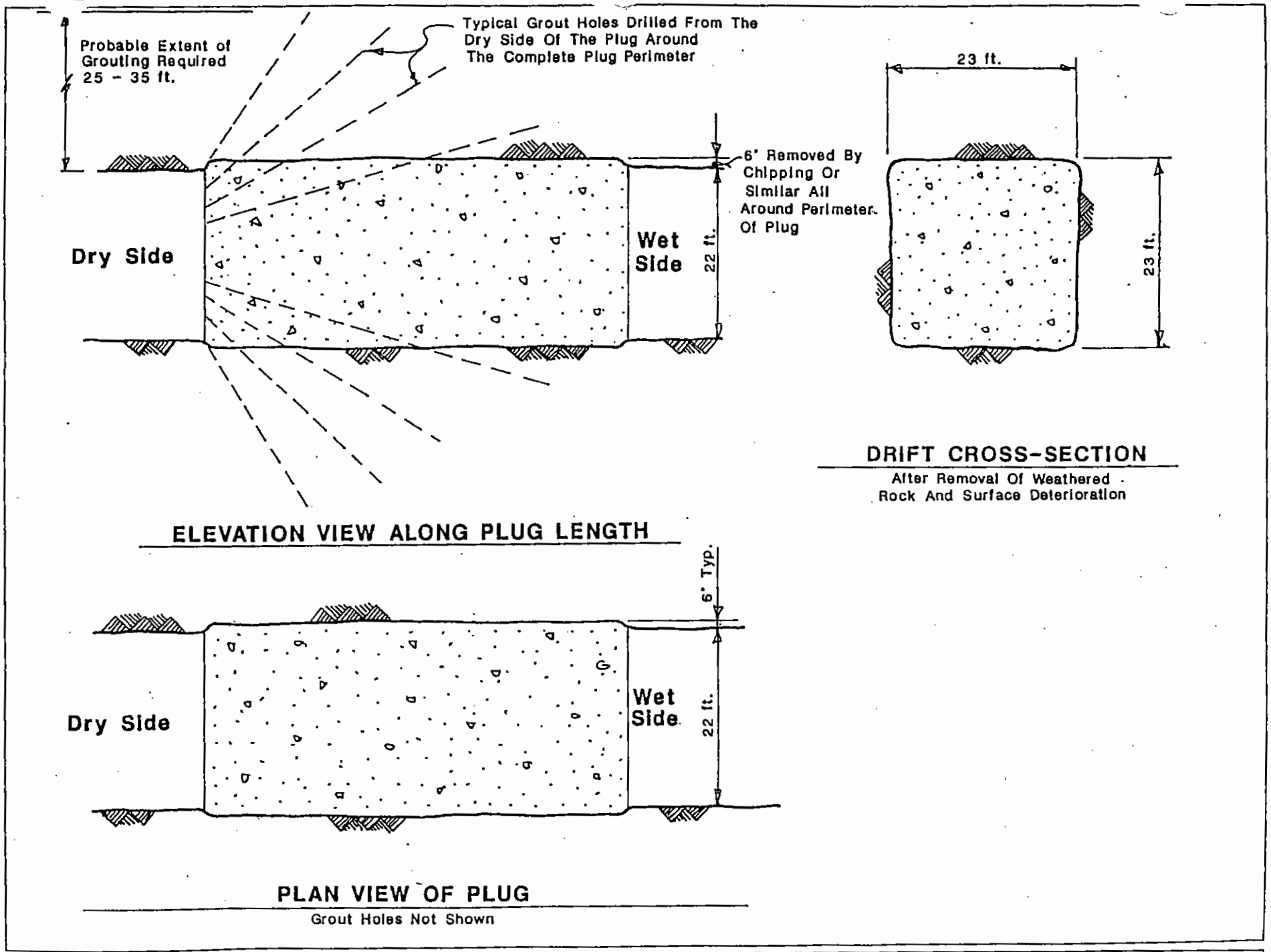
Scale: 1" = 400' Horizontal and Vertical

Mines Management, Inc.

Geologic Longitudinal and
AA-AA'
BB-BB'
&
CC-CC'

MONTANORE PROJECT
Libby, Montana

FIGURE 46



Mines Management, Inc. – Montanore Project
Figure 47 - Conceptual Portal Plug Design