United States
Department
of Agriculture

Forest Service

MINNIE MINE

MILLSITE

CLEANUP ACTION PLAN

MONITORING REPORT

Okanogan-Wenatchee National Forests
Pacific Northwest Region

Minnie Mine Millsite Cleanup Action Plan Monitoring Report

Okanogan-Wenatchee National Forests
Okanogan County, Washington

Submitted to:

Washington State
Department of Ecology

Prepared by:

U.S. Department of Agriculture
U.S. Forest Service
Okanogan-Wenatchee National Forests
215 Melody Lane
Wenatchee, WA 98801

October 2003

USDA Forest Service

TABLE OF CONTENTS

1.0 INTRODUCTION……..... 1

2.0 GENERAL MONITORING OBSERVATIONS…….……..……. 1
2.1 MOISTURE BLOCK SENSITIVITY…….... 1
2.2 SUCTION LYSIMETERS……...…… 2
2.3 CORRELATION OF SITE GROUND WATER LEVELS……. 2
2.4 TURBIDITY IN MONITORING WELL SAMPLES……... 3

3.0 MONITORING RESULTS……. 3
3.1 CAP INTEGRITY AND MAINTENANCE…….. 3
3.2 GROUND WATER MONITORING……. 3
3.2.1 Sample Data…….. 3
3.2.2 Arsenic Trends in Down-Gradient Lysimeter L-4 Water Samples……. 4
3.2.3 Correlation of Arsenic in L-1 (Background) and L-4 Lysimeters……..…….. 4
3.2.4 Statistical Analyses…….…… 5
3.2.5 Barnett Well…….. 5
3.2.6 Compliance……. 6

4.0 DISCUSSION……..... 7

5.0 PROPOSAL FOR CONTINUED MONITORING……... 7

6.0 REFERENCES……... 8

TABLES

Table 1 Minnie Mine Millsite Groundwater Sampling Data
Table 2 Minnie Mine Water Samples
Table 3 Statistical Summary of Minnie Mine Water Samples

FIGURES

Figure 1 Location Map
Figure 2 Minnie Mine Site Map
Figure 3 North-South Cross-Section Through Cap Areas, Minnie Mine Millsite
Figure 4 Comparison of Minnie Mine Ground Water Levels With Lysimeter Status and Winter (Oct-Apr) Precipitation
Figure 5a Flood deposits up gradient from Site; looking SW, June 23, 1999.
5b Storm runoff erosion in diversion channel, looking E; note exposed bedrock; June 23, 1999.
Figure 6a Panorama of Minnie Mine Millsite, looking SSW; note basin at right is dry; May 25, 2001
6b Cap vegetation, looking North; May 23, 2001.
6c Cap at L-2, looking West; May 23, 2001.
Figure 7. Arsenic Trends in Lysimeter L-4, Soil Pore Water.
Figure 8. Correlation of Arsenic Values in Lysimeters L-1 and L-4.

APPENDICES

Appendix A Laboratory Certificates
Appendix B MTCAStat Statistical Reports

1.0 INTRODUCTION

This monitoring report is prepared in compliance with the Cleanup Action Plan (CAP) for the Minnie Mine Millsite (Site) and in accordance with State of Washington Department of Ecology (Ecology) Enforcement Order No. DE 94TC-C433 by the United States Deportment of Agriculture Forest Service (USFS).

The Minnie Mine Millsite is located near Carlton, Washington (See Figures 1 & 2) and is owned and controlled by the USFS. The millsite was operated by Cordilleran Development, Inc. using a cyanide heap leaching gold extraction process. Cordilleran Development defaulted on their reclamation bond in 1986 leaving the USFS responsible for site cleanup and reclamation.

The purpose of this report is to describe Site monitoring results since the date of the Cleanup Action Plan Report and propose future action. Monitoring work included:

- Observations of the physical condition of the soil cap;
- Sampling of soil moisture monitoring equipment;
- Sampling of ground water monitoring wells;
- Monitoring of water levels in monitoring wells; and
- Monitoring of Site precipitation.

Olympus Environmental, Inc. and the USFS completed capping and sampling activities at the Site between April 8 and April 14, 1995. Ground and soil pore water monitoring and sampling was initiated immediately thereafter.

Early sampling results were described and evaluated in the Minnie Mine Millsite Construction Report dated October 26, 1995. Preliminary analysis indicated background arsenic soil moisture concentrations greater than the Site cleanup criterion of 5.0 ug/L (MTCA Method A)--11.35 ug/L. Limited sampling data for down gradient suction lysimeters and ground water monitoring wells indicated qualitatively, arsenic concentrations less than the apparent background of 11.35 ug/L. Because arsenic was elevated in cap lysimeter L-4 monitoring was to continue until a statistical comparison could be made between the arsenic data from the down-gradient compliance monitoring wells and suction lysimeters could be compared to background concentrations. Monitoring of the Barnett well, a domestic well at the mouth of Leecher Canyon (Figure 1), was discontinued after approximately two years because of low arsenic values in that well and in monitoring wells closer to the site.

2.0 GENERAL MONITORING OBSERVATIONS

2.1 Moisture Block Sensitivity

Two gypsum soil moisture blocks were installed with each suction lysimeter. The purpose of these blocks was to help identify when adequate soil moisture was present for sample collection. However, in practice, soil moisture readings were consistently in the 90-97 percent range whether or not soil moisture samples could be drawn from the lysimeters. Lower moisture readings were not obtained until June, 2000 and may be due to moisture block deterioration rather than actual changes in soil moisture (life expectancy is advertised at 3-5 years under irrigated soil conditions).

2.2 Suction lysimeters

Soil pore water samples were collected from the suction lysimeters by first applying a vacuum to draw a water sample into the lysimeter cup and then applying pressure with a hand pump to force a sample to the surface. Adequate water from the suction lysimeters was generally only available for sampling when soil surrounding the lysimeter cups was saturated. This resulted in water infiltrating and filling the cup's inner chamber. Samplers were never able to draw adequate water volume from the lysimeters using the vacuum procedures when lysimeter cups were found to be dry.

A comparison of water availability in the suction lysimeters L-1 through L-4 and water levels in MW-1, 2 & 3 indicates that the former was directly related to ground water level (Figure 4). For example, when the water depth in MW-2 falls below about 4 feet, water was not recoverable from L-4, even in early spring when soil moisture is high. Conversely, water was available from L-1 during late summer and fall (1995 & 1998), a time when minimal soil moisture is expected, but only during times of high ground water levels. Finally water was available for sampling on only one occasion from L-2, and never from L-3. The elevation of both of these lysimeter cups are well above that of L-4 (Figure 3). The inference from these observations is that the wetting front originating from spring snow melt moves rapidly through the soil profiles and that L-4 samples represent ground water which is locally influenced by surface water percolating vertically through the soil profile.

2.3 Correlation of Site Ground Water Levels

Ground water levels were monitored regularly in six wells above and below the Site since 1995. These included MW-1 through MW-5 and a deeper, steel-cased piezometer located below MW-1 at the mouth of this small tributary drainage to Leecher Canyon (See Figure 2). The later was installed by a previous mineral operator to ascertain water depth in July, 1981. The piezometer consists of a well point fastened to a 2-in. diameter steel pipe and driven to refusal, a depth of 32.8 feet below surface. Widely-spaced observations of this "Wellpoint" piezometer showed water absent at the time of its installation through May, 1995. MW-1 through MW-5 were installed by backhoe excavation to refusal (believed to be bedrock) in October, 1991. Documented observations in these wells are sporadic prior to 1995 but are consistent with anecdotal information from USFS employees and local land owners.

Figure 4 summarizes water levels over the time period of documented observations. The condition ("wet" or "dry") of lysimeters L-1 (back ground) and L-4 is shown for comparison. Total winter precipitation from the nearest climatological station (Methow 2 S) and the Site (1995-present) is also displayed.

Surface water first appeared in the "Minnie Mine" tributary drainage in spring of 1995. This was the first observation of surface water by USFS personnel since minerals activities administration began in earnest at the Site in 1981 and by the adjacent land owner since 1956 (Personal communication, Gene Vinton, 1995). Changes in surface and groundwater manifestations were associated with unusually heavy winter (1994-95) precipitation. This was also the first heavy precipitation year since the upper part of the drainage was denuded of timber by an August, 1985 wild land fire. This suggests ground water flow rates on or above bedrock of 6-8 m/day.

The appearance of surface flow in the lower part of this tributary triggered additional monitoring of the USFS wells. Comparison of water depth in the monitoring wells indicates a strong correlation between the sites. By the time surface water appeared in the drainage in 1995, ground water had apparently peaked within 3.8 feet of the surface at back ground well MW-5. Twelve hundred feet down gradient, water levels in MW-1 through MW-3 and the Wellpoint peaked some 45 days later. Succeeding seasons revealed a 45- to 60-day lag between MW-5 and the other wells.

Water was never observed in MW-4. This station is located in the existing drainage bottom above the millsite (Figure 2). Because bedrock is exposed in the diversion channel down stream of MW-4 and ground water seepage has been observed at the surface above the station, it is not likely that the well bottomed in false bedrock. It is more probable that the monitoring well is located on the north slope of a buried paleochannel which underlies glacio-alluvial deposits south of the existing valley. This inference is consistent with the growth of volunteer willows in the soil-borrow excavation east of L-4 (See Figure 2).

2.4 Turbidity in Monitoring Well Samples

Ground water samples were collected from MW monitoring wells using disposable bailers. Excessive turbidity was a problem in some monitoring well samples, especially those from MW-3. This was due in part to low water levels during sampling. Early results showed wide variation of total arsenic in the turbid water samples. Sound Analytical Laboratory suggested that effects of turbidity could be ameliorated by eliminating acid preservation in the field and filtering the turbid samples in the laboratory. Several sample pairs were collected in 1996 to compare the standard and Sound Analytical's modified procedure (MW3-9a & b, MW3-10a & b, MW3-11 and 11a, and MW2-9a & b). Analysis of these samples shows a marked reduction of total arsenic in the samples using the modified technique (See Table 1). However, it is possible that adsorption of dissolved arsenic onto detrital particles might have biased these results. For this reason data from excessively turbid samples were not included in the statistical analyses.

3.0 MONITORING RESULTS

3.1 Cap Integrity and Maintenance

Approximately eight years of monitoring (1995- present) have detected no visible evidence of structural failure or significant erosion of the soil cap. A large, summer storm event occurred in June, 1998 which tested the up-stream diversion channel (Figures 5a & b). This event caused deepening of the channel but did not compromise the integrity of the armored channel berm.

Revegetation of the soil cap and surrounding area was accomplished early and is successfully propagating (Figures 6a-c). Relief of the CAP requirement to limit deep-rooted vegetation on the soil cap was provided by Ecology in 2001 (Personal Communication, Rick Roeder, 2001). Mowing of cap vegetation was therefore discontinued and sage brush has become a significant component of the cap plant community.

3.2 Ground Water Monitoring

3.2.1 Sample Data

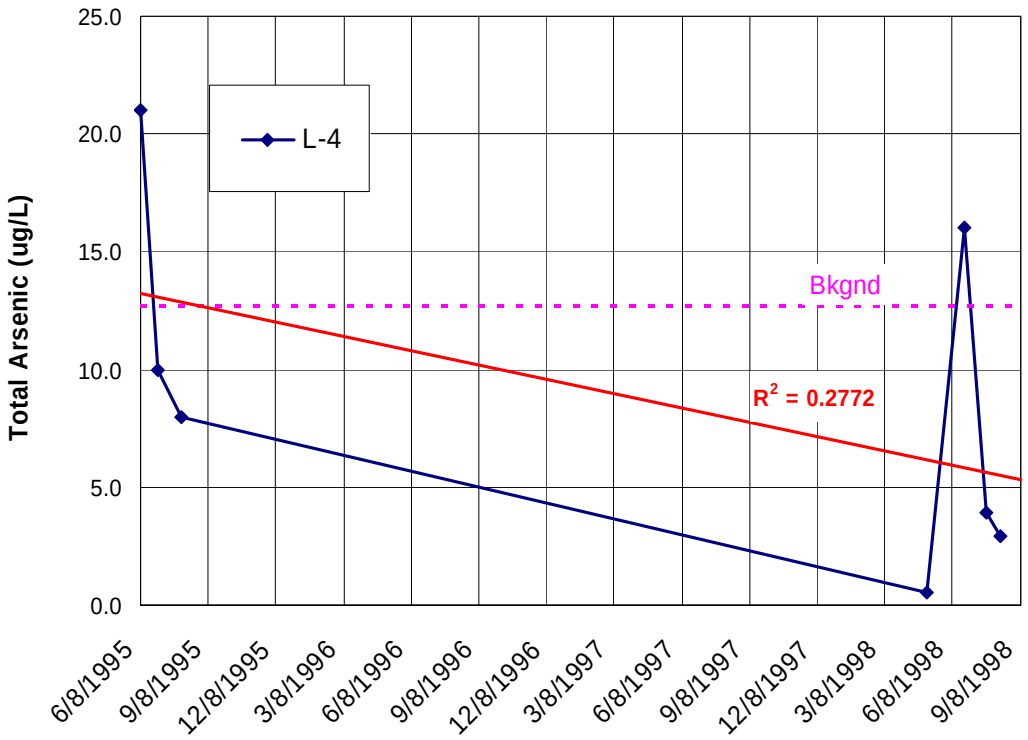
The USFS has conducted ground water monitoring at the Site since 1995, approximately eight years. However, due to falling groundwater levels and the unavailability of water in the suction lysimeters the last water sampling was accomplished in April, 1999.

Minnie Mine Millsite groundwater sample results and field data are listed in Table 1. Total arsenic was determined by Sound Analytical Services, Inc. (see Appendix A for laboratory certificates). The number of samples from each of the monitoring stations is summarized in Table 2. As noted in Section 2.3 above, turbid MW water samples were not considered usable.

3.2.2 Arsenic Trends in Down-Gradient Lysimeter L-4 Water Samples

Trends in the data are not apparent except for arsenic concentrations in lysimeter L-4 soil pore water samples. L-4 arsenic values indicate both seasonal and long-term trends (Figure 7). Seasonal arsenic values in L-4 correlate with peaking ground water levels and infiltration of spring snow melt. Arsenic

Figure 7. Arsenic Trends in Lysimeter L-4, Soil Pore water



concentrations are elevated shortly after ground water levels peak in early June and fall rapidly in the months following. Winter snows at the site are typically melted before April 1.

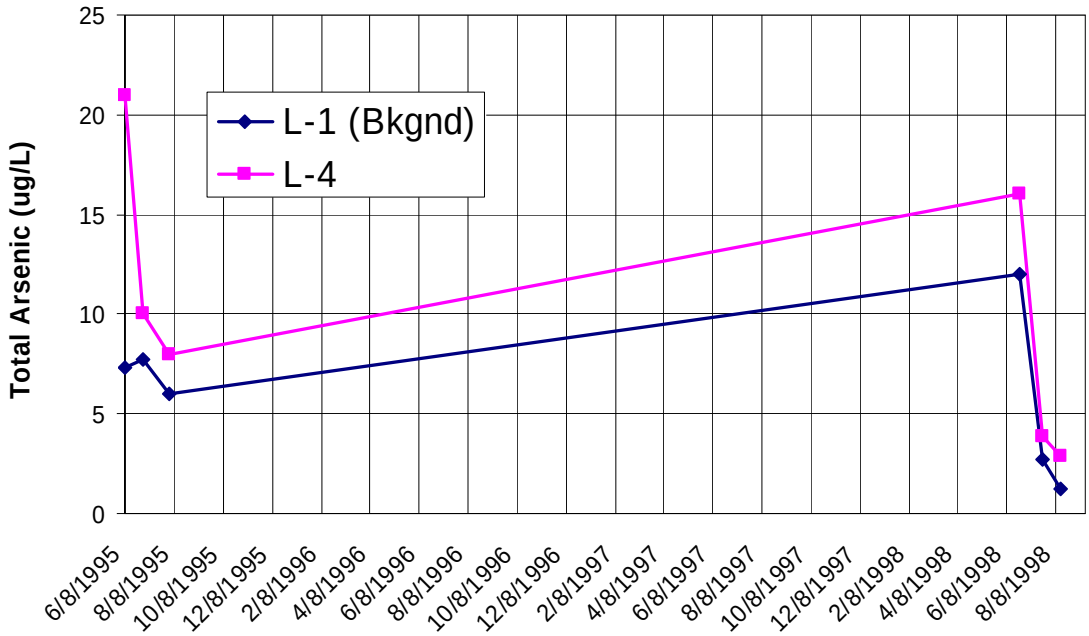
The data also indicate *decreasing* arsenic concentrations in L-4 samples over time. Unprocessed ore which had been stock piled on site was moved, placed and capped at L-4 (*Minnie Mine Millsite Cleanup Action Plan Construction Report,* 1995). The above soil pore water trend indicates that soluble arsenic compounds flushed from these ore materials during spring snow melt and infiltration are diminishing with time.

3.2.3 Correlation of Arsenic in L-1 (Background) and L-4 Lysimeters

Figure 8 compares total arsenic concentrations in concurrent soil pore water samples taken from suction lysimeters L-1 (background) and L-4. The graph shows good correlation between these data sets: When

arsenic values are low in background they are also low in L-4; and likewise, when arsenic values are high in background they are also high in L-4. This suggests that a significant portion of the arsenic in L-4 pore water can be attributed to background arsenic levels.

Figure 8. Correlation of Arsenic Values in Lysimeters L-1 and L-4



3.2.4 Statistical Analysis

The intent of the USFS monitoring program was to obtain sufficient data to make a statistical comparison between background concentrations of arsenic and arsenic concentrations in down-gradient monitoring wells and suction lysimeters (Minnie Mine Millsite CAP Construction Report, 1995). Statistical analyses of background and site compliance data were performed using the following Ecology Guidance documents:

Statistical Guidance for Ecology Site Managers. August, 1992, Publication No. 92-54 (Includes loose leaf Supplement S-6.) [REF 1]

Guidance on Sampling and Data Analysis Methods. January, 1995, Publication No. 94-49 [REF 2]

Supplement to Statistical Guidance for Ecology Site Managers. February 19, 1998 Memorandum [REF 3]

MTCAStat, A Statistical Package for Statistical Guidance for Ecology Site Manager, 1993 [REF 4]

Relevant statistical parameters for the background and site data are described in Table 3. MTCAStat reports displaying this information are provided in Appendix B.

3.2.5 Barnett Well

Four samples were available for statistical analysis. Both the normal and lognormal distributions are rejected by the MTCAStat compliance calculator. The lognormal mean for arsenic in Barnett well samples is 1.40 ug/L. No sample values exceeded background. The upper confidence limit, is determined using the data set's maximum value, 1.70 ug/L, as per recommendations in Reference 3, Case 2, Part III. The UCL is falls below the current state drinking water standard (10 ug/L) and the site's background value (see below).

3.2.6 Compliance

Statistical analysis of 21 background samples gives a Site background value (90th percentile) for arsenic in soil pore water of 12.69 ug/L. MTCA allows the use of natural background in place of the Method A cleanup standard (WAC 173-340-700(4)(d)).

Compliance success requires that, for each well or monitoring point, the 95th percent confidence interval on the 50th percentile is less than the background standard; that no sample exceeds twice the background concentration and that fewer than 10 percent of the samples exceed the cleanup standard (REF 1, p. 61).

Suction lysimeters L-2 and L-3 can not be tested statistically for compliance due to the lack of available soil pore water samples from these down gradient points. One or no samples were collected from these stations, respectively. The single sample from L-2 showed arsenic concentrations of <1 ug/L. The apparent lack of soil moisture at these lysimeters implies compliance with soil pore water standards.

Down gradient compliance points statistically evaluated, include L-4, MW-1, MW-2 and MW-3.

Lysimeter L-4

Only 7 soil pore water samples were available from lysimeter L-4. The statistical distribution of the data is lognormal and the lognormal mean, 11.07 ug/L, is below the background standard of 12.69 ug/L. However, due to the value range and small number of samples MTCAStat calculated a 95th percentile of 57.9. None of the sample values exceeded twice the background standard (25.38), but two of the seven or 29 percent exceeded background. MTCAStat estimates that some 226 samples would be necessary to obtain an upper confidence limit (UCL) of 12.5 ug/L (below background). Based upon sample availability during the past eight years this would amount to many decades of additional monitoring.

Monitoring Well MW-1

Twenty two ground water sample values were analyzed from MW-1. Both the normal and lognormal distributions are rejected by the MTCAStat compliance calculator. Follow-up distributional analysis using the MTCAStat background calculator (MTCAStat Case 2, Method B(2)) recommends use of a lognormal distribution. The lognormal mean for arsenic in MW-1 samples is 1.65 ug/L, well below background. No sample values exceeded background. The upper confidence limit, as calculated using Land's method, is 2.55 ug/L, also well below the background standard.

Monitoring Well MW-2

Twenty one ground water sample values were analyzed from MW-2. Both the normal and lognormal distributions are rejected by the MTCAStat compliance calculator. Follow-up distributional analysis using the MTCAStat background calculator (MTCAStat Case 2, Method B(2)) recommends use of a lognormal distribution. The lognormal mean for arsenic in MW-2 samples is 1.47 ug/L, well below background. No sample values exceeded background. The upper confidence limit, as calculated using Land's method, is 2.10 ug/L, also well below the background standard.

Monitoring Well MW-3

Eight ground water samples values were analyzed from MW -3. The statistical distribution of the data is lognormal and the lognormal mean, 2.33 ug/L, is well below the background standard. No sample values exceeded background. The upper confidence limit, as calculated using Cohen's method, is 4.33 ug/L, also below the background standard.

4.0 DISCUSSION

Except for suction lysimeter L-4 arsenic in all down-gradient ground water monitoring stations complies with the background standard of 12.69 ug/L. The lognormal mean of arsenic concentrations in L-4 samples is below the background standard, but over two hundred additional samples would be needed to obtain a UCL below the compliance value. Lysimeter L-4 has been dry since late 1999, and inference from past ground and surface water observations suggests that it could be many years before sampling opportunities are again available from that lysimeter.

Several other factors have been considered in developing the proposal for continued monitoring:

- Correlation of piezometric levels in the monitoring wells and sample availability in the suction lysimeters demonstrate a direct relationship between the availability of soil pore water at L-4 and ground water in the monitoring wells (See Section 3.2);
- A comparison of arsenic concentrations in L-4 soil pore water and that from down gradient wells MW-1, 2 & 3 (Table 3), even when sampled contemporaneously (Table 1), indicate that L-4 arsenic concentrations that exceed background are not reflected in the down gradient wells.
- Despite arsenic spikes in soil pore water from lysimeter L-4 arsenic concentrations in all down-gradient monitoring wells have lognormal means of 1.47 to 2.33 ug/L and comply with site background and the new 10 ug/L drinking water standards (See Section 3.2.5);
- Arsenic in L-4 soil pore water is decreasing, indicating diminishing availability of soluble metal in the capped material (See Section 3.3.2);
- A substantial portion of arsenic in the L-4 soil pore water can be attributed to background levels (See Section 3.3.3);
- The up-drainage watershed area and its contribution to ground water flow beneath the site is very large relative to the capped areas and the respective volume of water filtering through the ore materials;
- If arsenic is being mobilized down gradient of L-4 there is no indication that it has reached the nearest monitoring well, MW-2 (100 feet down gradient), after 8 years of unusually high groundwater flows (Figure 4); and
- The return to normally low ground flows in the drainage should reduce potential metal transport substantially relative to the previous monitoring period (1995-2003).

5.0 PROPOSAL FOR CONTINUED MONITORING

The Forest Service proposes to discontinue regular soil pore water monitoring at the Site on the basis of sampling data and analysis collected to date. Future monitoring will include an annual site inspection to be accomplished during the month of May. USFS personnel will:

1. Visually inspect the cap for:
    - Surface erosion;
    - General vegetation condition;
    - Deterioration of the diversion berm and ditch; and
    - Deterioration of fences;

2. For two (2) years, visually inspect for surface water adjacent monitoring well MW-1 and measure the water level in MW-2.

The integrity of the soil cap and facilities will also be inspected after large storm events that may impact the site area.

If surface water is present adjacent MW-1 or the water level in MW-2 is within four (4) feet of the surface (5.1 feet below the top of the casing) suction lysimeter L-4 will be tested for soil pore water. If present, a water sample will be drawn and analyzed for arsenic. Samples will be drawn and analyzed from L-4 each month thereafter until water is no longer available.

If samples from L-4 have been collected, data will be analyzed and the monitoring plan reevaluated. If, after two years, no samples have been available from L-4, Monitoring Item 2 above, will be discontinued.

The Forest Service believes that this monitoring plan will protect the health and safety of humans and the environment in the vicinity of and down gradient of the Minnie Mine Millsite. It is our goal to be able to remove the site from the MTCA Hazardous waste list. We expect to develop appropriate institutional controls for the site at a later date.

6.0 REFERENCES

Ecology, 1992, Statistical Guidance for Ecology Site Managers. August, 1992, Publication No. 92-54 (Includes loose leaf Supplement S-6.)

Ecology, 1993, MTCAStat, A Statistical Package for Statistical Guidance for Ecology Site Manager (software available at www.wa.gov/Ecology/tcp/mtcastat.html)

Ecology, 1995, Guidance on Sampling and Data Analysis Methods. January, 1995, Publication No. 94-49

Ecology, 1998, Supplement to Statistical Guidance for Ecology Site Managers. February 19, 1998 Ecology Memorandum

USFS, 1994, Minnie Mine Millsite Cleanup Action Plan Engineering Report, November, 1994.

USFS, 1995, Minnie Mine Millsite Cleanup Action Plan Construction Report, October, 1995.

Rodney T. Lentz, L.G.

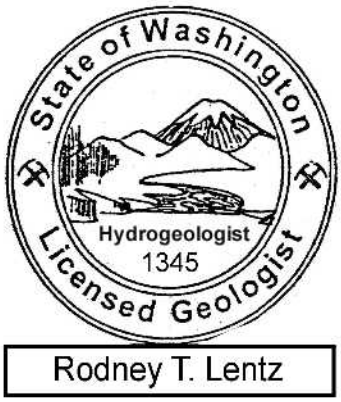


Table 2. Minnie Mine Water Samples

Station	Total	Usable	Censored	Percent Censored
Background				
L-1	19	19	0	0
MW-5	3	2	0	0
Site				
L-2	1	1	1	100
L-3	0	0	0	0
L-4	7	7	1	14
MW-1	22	22	11	50
MW-2	23	21	9	43
MW-3	22	8	3	30
MW-4	0	0	0	0
Barnett Well				
WW	4	4	2	50

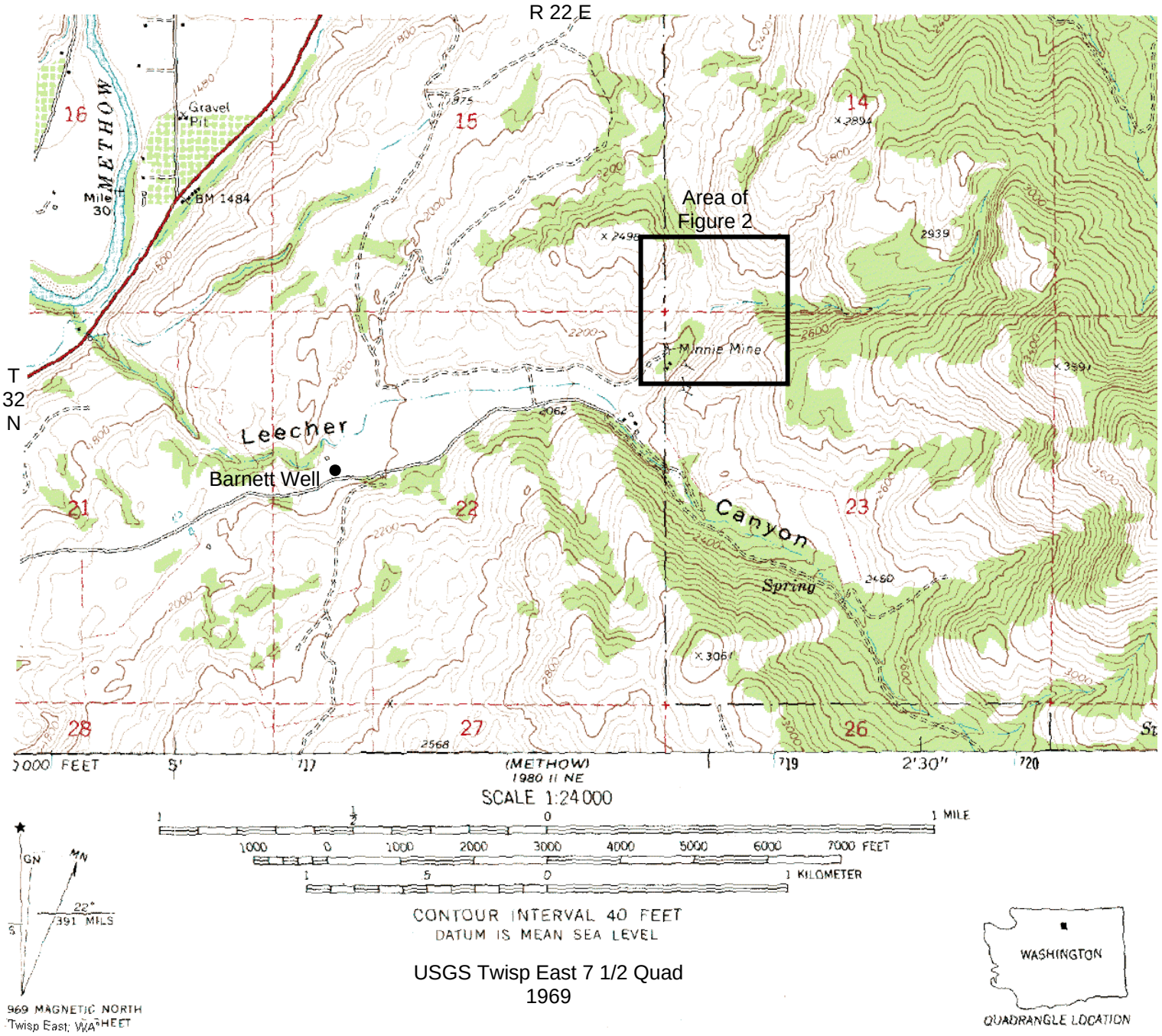
Table 3. Statistical Summary of Minnie Mine Water Samples (values in ug/L)

Station	n*	Mean	Lognormal Mean	Std. Deviation	Median	UCL (95th Percentile)	Appropriate Distribution	Notes
Background	21	6.03	6.22	3.98	5	12.69**	Lognormal	REF 3 (p. 10, Case 4)
Down Gradient								
L-2	1	NA	NA	NA	NA	NA	NA	Too few samples for analysis
L-3	0	NA	NA	NA	NA	NA	NA	Too few samples for analysis
L-4	7	10.30	11.07	7.04	9	57.9	Lognormal	MTCAStat Case 1; MTCAStat estimates 226 additional samples needed to attain 95th Percentile at 12.5;REF3
MW-1	22	1.73	1.65	2.01	1	2.55	Lognormal	MTCAStat Case 2, Method B(2)
MW-2	21	1.46	1.47	1.09	1	2.10	Lognormal	MTCAStat Case 2, Method B(2)
MW-3	8	2.28	2.33	1.58	2	4.33	Lognormal	MTCAStat Case 2
MW-4	0	NA	NA	NA	NA	NA	NA	NA
Barnett Well	4	1.35	1.40	0.50	1.35	1.7 =highest value	Neither	REF 3 (p. 8, Case 2, Part III)

*number of samples

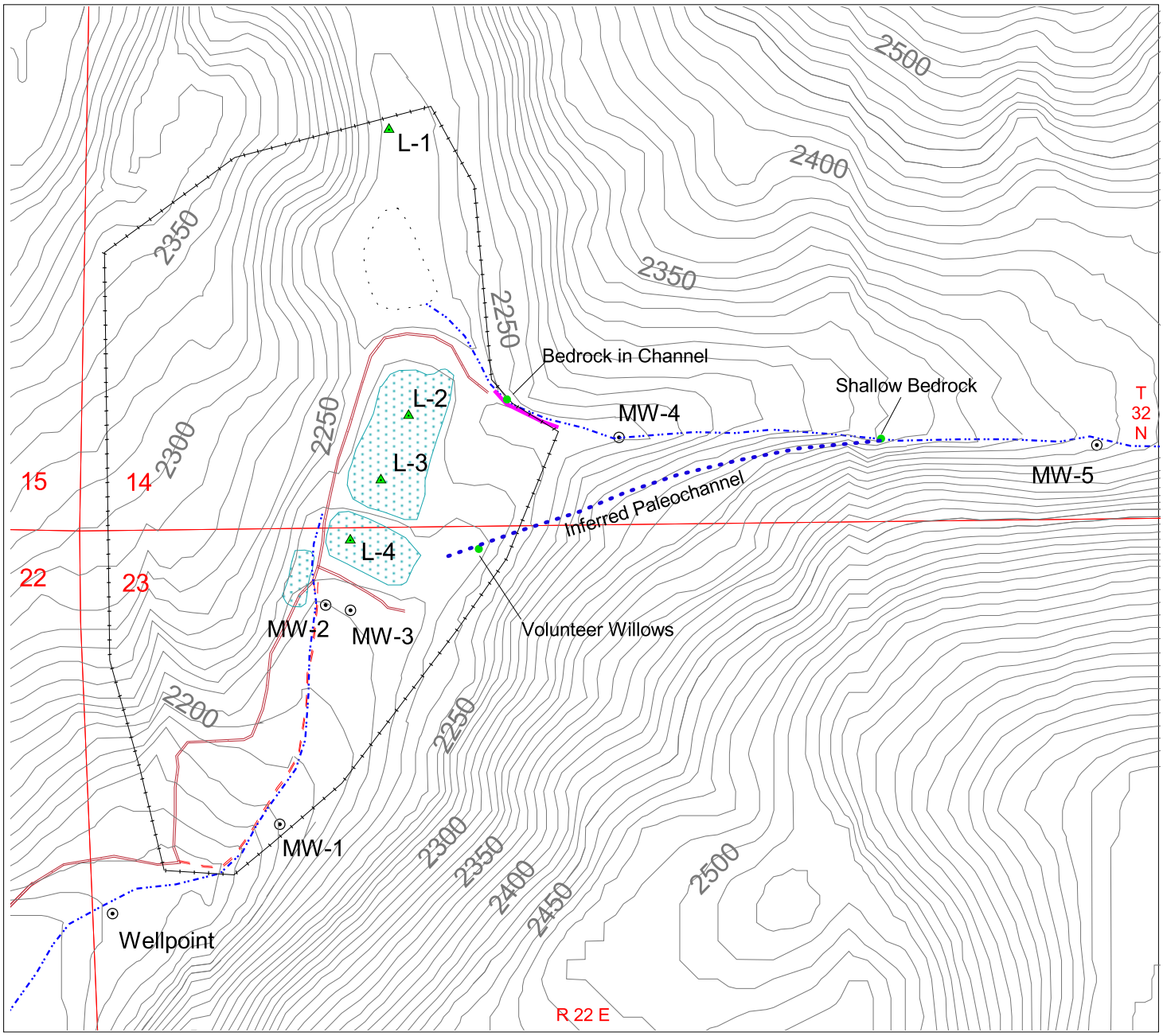
**Background value based upon 90th percentile concentration (REF 1, p. 45)

Figure 1. Location Map



USGS Twisp East 7 1/2 Quad
1969

Figure 2. Minnie Mine Site Map



N

200 0 200 Feet

Contour Interval = 10 ft

LEGEND

▲	Suction Lysimeters		Cattle Fence
⊙	Monitoring Wells		Drainage
	Cap Areas		Roads
	Diversion berm.shp		

C:\1My Documents\Minnie Mine\Monitoring Report\rpt_document\figure_2

Drawn by: RTL
Date: 5/23/2003

Figure 3. North-South Cross-Section Through Cap Areas
Minnie Mine Millsite

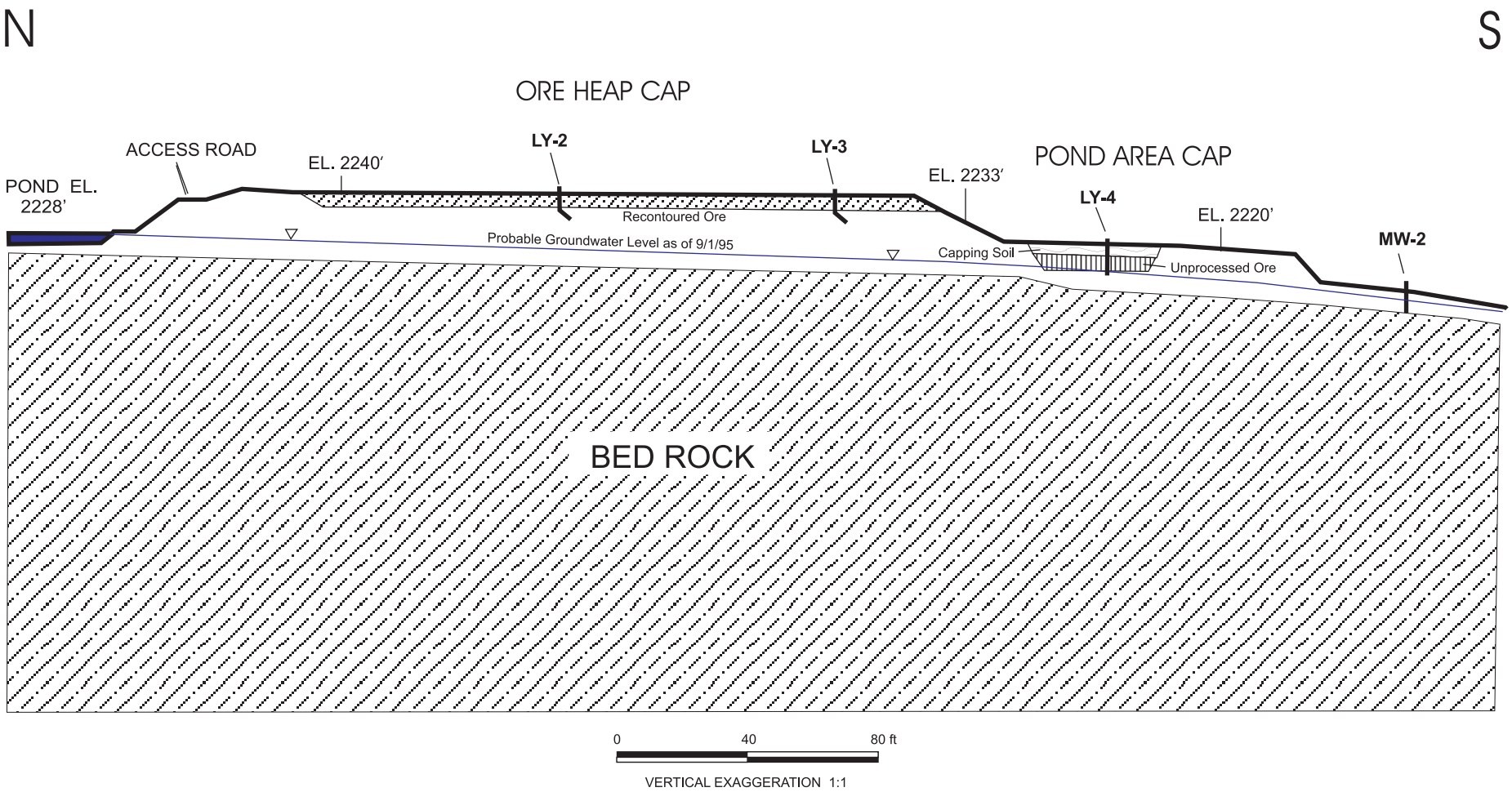
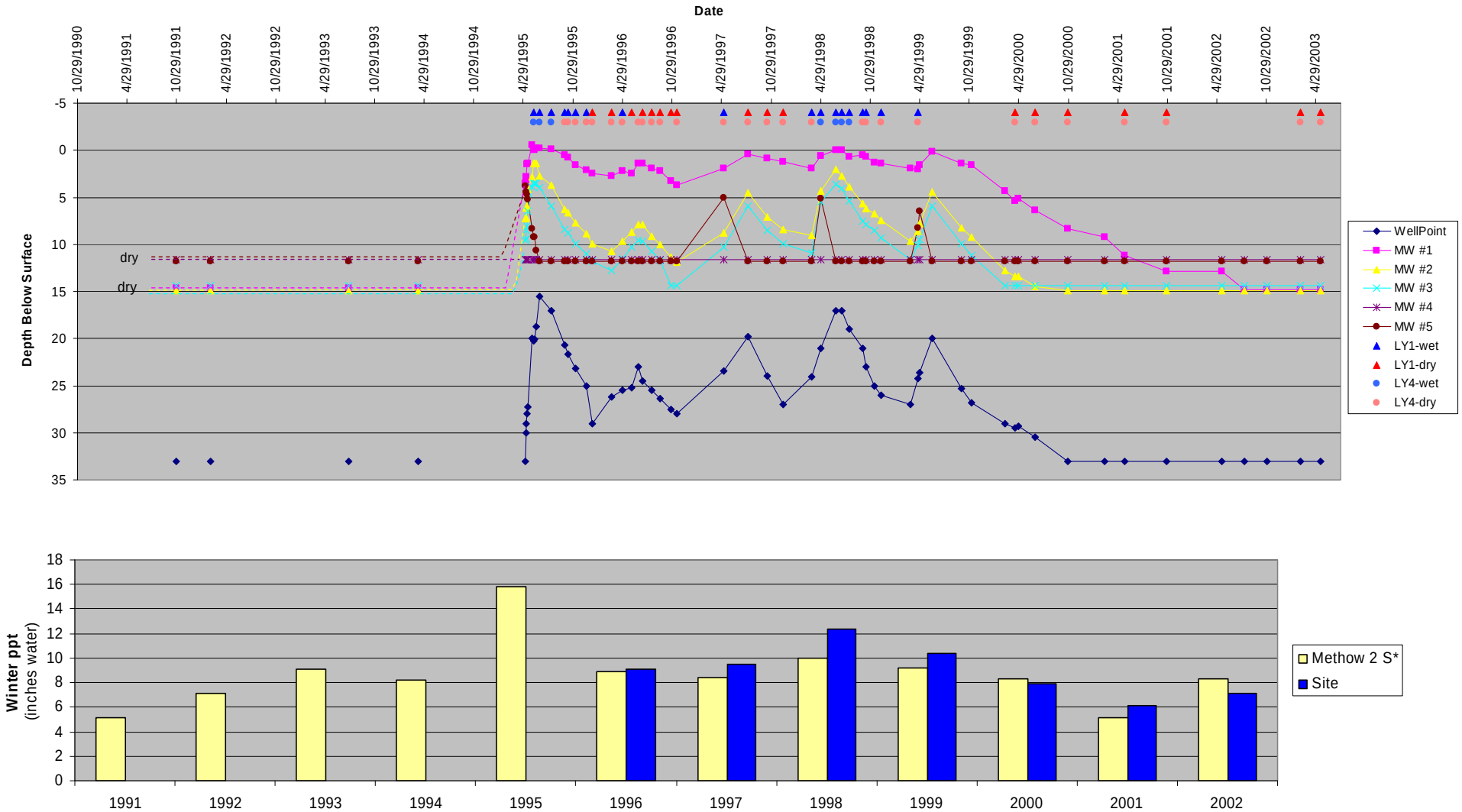


Figure 4. Comparison of Minnie Mine Ground Water Levels With Lysimeter Status and Winter (Oct-Apr) Precipitation



*Station located approximately 11 miles south of the Minnie mine site; lat. 48° 06' N, long. 120° 01' W.

*Station located approximately 11 miles south of the Minnie mine site; lat. 48° 06' N, long. 120° 01' W.

Figure 5a. Flood deposits up gradient from Site; looking SW, June 23, 1999.

Figure 5b. Storm runoff erosion in diversion channel, looking E; note exposed bedrock; June 23, 1999.

Figure 6a. Panarama of Minne Mine Millsite, looking SSW; note basin at right is dry; May 25, 2001.

Figure 6b. Cap vegetation, looking North; May 23, 2001.

Figure 6c. Cap at L-2, looking West; May 23, 2001.

APPENDIX A

LABORATORY CERTIFICATES

Laboratory Certificates are available in the Administrative Record File at the Okanogan & Wenatchee National Forest Okanogan Valley Office, Okanogan, Washington

APPENDIX B

MTCAStat STATISTICAL REPORTS

Appendix B-1

Background Calculations

Arsenic (ug/L)	Sample Number
1.2	LY1-16
1.9	LY1-17
2	LY1-8
2	LY1-12
2.1	LY1-12*
2.7	LY1-15
3	MW5-2
4	LY-9
4.4	LY-1-11
5	LY1-7
5	MW-1
6	LY-6
6	LY-8
7.3	LY-2
7.6	LY1-18
7.7	LY-4
7.7	LY1-13
11	LY1-19
12	LY1-14
13	LY1-20
15	LY-7

Minnie Mine Millsite MTCAStat Summary Statistics for Upgradient (Background)Water Samples

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	6.03
Censored	0	Lognormal mean	6.22
TOTAL	21	Std. devn.	3.98
		Median	5
		Min.	1.2
		Max.	15

Lognormal distribution?		Normal distribution?	
r-squared is:	0.97	r-squared is:	0.92

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	12.69
1 = Lognormal		4.81
2 = Normal	4 X 50th	19.23
3 = Nonparametric method		Coefficient of Variation = 0.88

Compliance Calculations

Arsenic (ug/L)	Sample Number
21	LY-1
10	LY-3
8	LY-5
16	LY4-4
3.9	LY4-5
2.9	LY4-6

Minnie Mine Millsite MTCAStat Summary Statistics for Lysimeter L-4 Water Samples

Number of samples		Uncensored values	
Uncensored	6	Mean	10.30
Censored	1	Lognormal mean	11.07
Detection limit or PQL	1	Std. devn.	7.04386258
Method detection limit	1	Median	9
TOTAL	7	Min.	2.9
		Max.	21

Lognormal distribution?		Normal distribution?	
r-squared is:	0.956	r-squared is:	0.973

Recommendations:

Use lognormal distribution.

UCL (Land's method) is
57.9026831588253

Simple substitution used with censored values.

Notes:

An estimated 22 additional samples are needed to attain 95th Percentile at 15.7 ug/L.

Appendix B-3

Compliance Calculations

Arsenic (ug/L)	Sample Number
0.5	MW-4
1	MW-5
6	MW-7*
1	MW-10
0.5	MW-13
1	MW1-6
0.5	MW1-7
2	MW1-8
3	MW1-9
2	MW1-10
0.5	MW1-11
0.5	MW1-12
0.5	MW1-13
1	MW1-14
1	MW1-15
1	MW2-16
3.1	MW1-16
1.9	MW1-17
0.5	MW1-18
0.5	MW1-19
1.4	MW1-19
8.6	MW1-20

Minnie Mine Millsite MTCAStat Summary Statistics for Monitoring Well MW-1 Water Samples

95th Percentile calculated using Lognormal distribution

Number of samples		Uncensored values	
Uncensored	22	Mean	1.73
Censored	0	Lognormal mean	1.65
Detection limit or PQL		Std. devn.	2.00598671
Method detection limit	1	Median	1
TOTAL	22	Min.	0.5
		Max.	8.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.872	r-squared is:	0.631

Recommendations:

Reject lognormal distribution.

W value is 0.8638. This is less than the tabled value of 0.911

Reject normal distribution.

W value is 0.6438. This is less than the tabled value of 0.911

UCL (Land's method) is 2.55340556565914

Notes:

MTCAStat Case 2, censored data; Method B2, multiple detection limits

W-Test rejected both normal and lognormal distributions

Data was inputed into MTCAStat Background (Appendix 3b) to determine distribution = Lognormal

Appendix B-3.1

Background Calculations

Arsenic (ug/L)	Sample Number
<1	MW-4
<1	MW-13
<1	MW1-7
<1	MW1-11
<1	MW1-12
<1	MW1-13
<1	MW1-18
<1	MW1-19
1	MW-5
1	MW1-6
1	MW2-16
1.4	MW1-19
1.9	MW1-17
2	MW1-8
2	MW1-10
m2	MW1-14
m2	MW1-15
3	MW1-9
3.1	MW1-16
m4	MW-10
6	MW-7*
8.6	MW1-20

Distribution Analysis for
Monitoring Well MW-1 Water Samples
(MTCAStat Method B2)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	11	Mean	2.82
Censored	11	Lognormal mean	2.82
TOTAL	22	Std. devn.	2.40
		Median	2
		Min.	1
		Max.	8.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.97	r-squared is:	0.92

Recommendations:

. Use lognormal distribution

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	95	
1 = Lognormal	50th	
2 = Normal	4 X 50th	
3 = Nonparametric method		

Appendix B-4

Compliance Calculations

Arsenic (ug/L)	Sample Number
2	MW-3
1	MW-6
1	MW-8
4	MW-11
0.5	MW-14
4	MW2-6
1	MW2-7
3	MW2-8
2	MW2-10
2	MW2-11
0.5	MW2-12
1.2	MW2-13
1	MW2-14
2	MW2-15
0.5	MW2-17
1.7	MW2-18
0.5	MW2-19
1.2	MW2-19*
0.5	MW2-21
0.5	MW2-22
0.5	MW2-23

Minnie Mine Millsite MTCAStat Summary Statistics for Monitoring Well MW-2 Water Samples

95th Percentile calculated using Lognormal distribution

Number of samples		Uncensored values	
Uncensored	21	Mean	1.46
Censored	0	Lognormal mean	1.47
Detection limit or PQL	1	Std. devn.	1.09387907
Method detection limit	1	Median	1
TOTAL	21	Min.	0.5
		Max.	4

Lognormal distribution?		Normal distribution?	
r-squared is:	0.903	r-squared is:	0.820

Recommendations:

Use lognormal distribution.

UCL (Land's method) is
2.10067719607663

Notes:
MTCAStat Case 2, censored data; Method B2, multiple detection limits

W-Test rejected both normal and lognormal distributions

Data was inputed into MTCAStat Background (Appendix 3b) to determine distribution = Lognormal

Appendix B-4.1

Background Calculations

Arsenic (ug/L)	Sample Number
<1	MW-14
<1	MW2-12
<1	MW2-17
<1	MW2-19
<1	MW2-21
<1	MW2-22
<1	MW2-23
1	MW-6
1	MW2-7
m1	MW-8
m1	MW2-14
1.2	MW2-13
1.2	MW2-19*
1.7	MW2-18
2	MW-3
2	MW2-10
2	MW2-11
2	MW2-15
3	MW2-8
4	MW-11
4	MW2-6

Distribution Analysis for
Monitoring Well MW-2 Water Samples
(MTCAStat Method B2)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	12	Mean	2.09
Censored	9	Lognormal mean	2.11
TOTAL	21	Std. devn.	1.06
		Median	2
		Min.	1
		Max.	4

Lognormal distribution?		Normal distribution?	
r-squared is:	0.93	r-squared is:	0.90

Recommendations:

. Use lognormal distribution

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	95	
1 = Lognormal	50th	
2 = Normal	4 X 50th	
3 = Nonparametric method		

Compliance Calculations

Arsenic (ug/L)	Sample Number
2	MW-2
1	MW-7
5	MW-9
2	MW3-7
1.4	MW3-13

Minnie Mine Millsite MTCAStat Summary Statistics for Monitoring Well MW-3 Water Samples

Number of samples		Uncensored values	
Uncensored	5	Mean	2.28
Censored	3	Lognormal mean	2.33
Detection limit or PQL	1	Std. devn.	1.57860698
Method detection limit	1	Median	2
TOTAL	8	Min.	1
		Max.	5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.937	r-squared is:	0.845

Recommendations:

Use lognormal distribution.

UCL (Land's method) is 4.327279299913

Cohen's method applied.

Notes:

MTCAStat Case 2 censored data

Compliance Calculations

Arsenic (ug/L)	Sample Number
1	ww-29
1.7	ww-30

Minnie Mine Millsite MTCAStat Summary Statistics for Barnett Well WW Water Samples

Number of samples		Uncensored values	
Uncensored	2	Mean	1.35
Censored	2	Lognormal mean	1.40
Detection limit or PQL	5	Std. devn.	0.49497475
Method detection limit	1	Median	1.35
TOTAL	4	Min.	1
		Max.	1.7

Lognormal distribution?
r-squared is:

Normal distribution?
r-squared is:

Recommendations:
Unable to analyze probability plots.
Consult Statistical Guidance document

Notes:
MTCAStat Case 2 censored data; Part III, Data neither lognormally or normally distributed