Tailings Facility Groundwater

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Presentation Outline

- Groundwater sampling and well locations
- Characteristics
- Tailings facility and reference chemistry
- Seepage Interception System
- Nature and extent
- Summary

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Questions Being Asked by RI/FS

- Groundwater Data Quality Objectives (DQOs)
  - Concentrations > RBSLs?
  - Concentrations > State Groundwater Standards and MCLs?
  - Adequately determined the nature and extent of concentrations > RBSLs?

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Groundwater Sampling

- Quarterly events (all wells and springs):
  - Completed: Fall 2002; January, April, July, and October 2003; and January 2004
  - Planned: April 2004
- Monthly events (select wells and springs):
  - Completed: December 2002; February, March, May, June, August, September, November, and December 2003
  - No monthly sampling planned for 2004

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Monitoring Wells Installed at the Tailings Facility During the RI

Well ID	Location	Completion or Target Zone	Completion or Target Lithology	Borehole Depth (ft, bgs)	Screened Interval (ft,bgs)
MW-16	Western abutment of Dam No. 4	Basal Aquifer	Basalt	437	No Well
MW-17	South of Dry Maintenance area	Upper Aquifer	sandy gravel	162	135 to 155
MW-18	North/upgradient of Tailings	Basal Aquifer	Basalt	309	No Well
MW-19	North/upgradient of Tailings	Upper Aquifer	Upper Aqufier		No Well
MW-20	North of Tailings - Reference	Basal Aquifer	sandy gravel	296	269 to 289
MW-21	North of Tailings - Reference	Upper Aquifer	sandy gravel	142	117 to 137
MW-22	West of Tailings - Reference	Basal Aquifer	Andesite	445	420 to 440
MW-23	West Tailings/North of Dam No. 5	Basal Aquifer	basalt	460	370 to 400
MW-24 (TPZ-8)	East of Dam No. 2A	Basal Aquifer	sandy gravel	265	235 to 255
MW-25	South of Dam No. 1	Basal Aquifer	Basalt	188	160 to 180
MW-26	South of Dam No. 1	Upper Aquifer	Basalt	48	25 to 45
MW-27	South of Dam No. 1	Basal Aquifer	Andesite	198	164 to 184
MW-28	South of Dam No. 1	Upper Aquifer	clayey sand	65	58 to 63
MW-29	South of Dam No. 1	Upper Aquifer	sandy gravel	42	35 to 40
Confirm. Boring	South of Dam No. 1	Upper Aquifer	Basalt	80	No Well

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Piezometers Installed at the Tailings Facility During the RI

Well ID	Location	Completion or Target Zone	Completion or Target Lithology	Borehole Depth (ft, bgs)	Screened Interval (ft,bgs)
TPZ-1	Southeast of Dam No. 4	Basal Aquifer	basalt/andesite	315	282 to 292
TPZ-2	Southeast of Dam No. 4	Basal Aquifer	basalt	320	295 to 305
TPZ-3	Replaced by MW-25 and MW-26	Basal Aquifer			
TPZ-4U	South of Dam No. 1	Upper Aquifer	sandy gravel	158	33 to 38
TPZ-4L	South of Dam No. 1	Basal Aquifer	sandy gravel	158	50 to 55
TPZ-4B	South of Dam No. 1	Basal Aquifer	andesite	158	153 to 158
TPZ-5U	South of Dam No. 1 near 002	Upper Aquifer	sandy gravel	89	15 to 20
TPZ-5B	South of Dam No. 1 near 002	Basal Aquifer	andesite	89	84 to 89
TPZ-6U	Southeast of Dam No. 1B	Upper Aquifer	sandy gravel	239	25 to 30
TPZ-6L	Southeast of Dam No. 1B	Basal Aquifer	sandy gravel	239	137 to 142
TPZ-7U	Southeast of Dam No. 1B	Upper Aquifer	sandy gravel	265	87 to 92
TPZ-7L	Southeast of Dam No. 1B	Basal Aquifer	sandy gravel	265	255 to 260

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Tailings Facility Characteristics

Where Does Groundwater Occur?

- Aquifers:
  - Upper (alluvial sand/gravel/clay)
  - Basal (alluvium and volcanics)

- Greater clay content south of Dam Nos. 1A
- Greater gravel content east of the tailings facility

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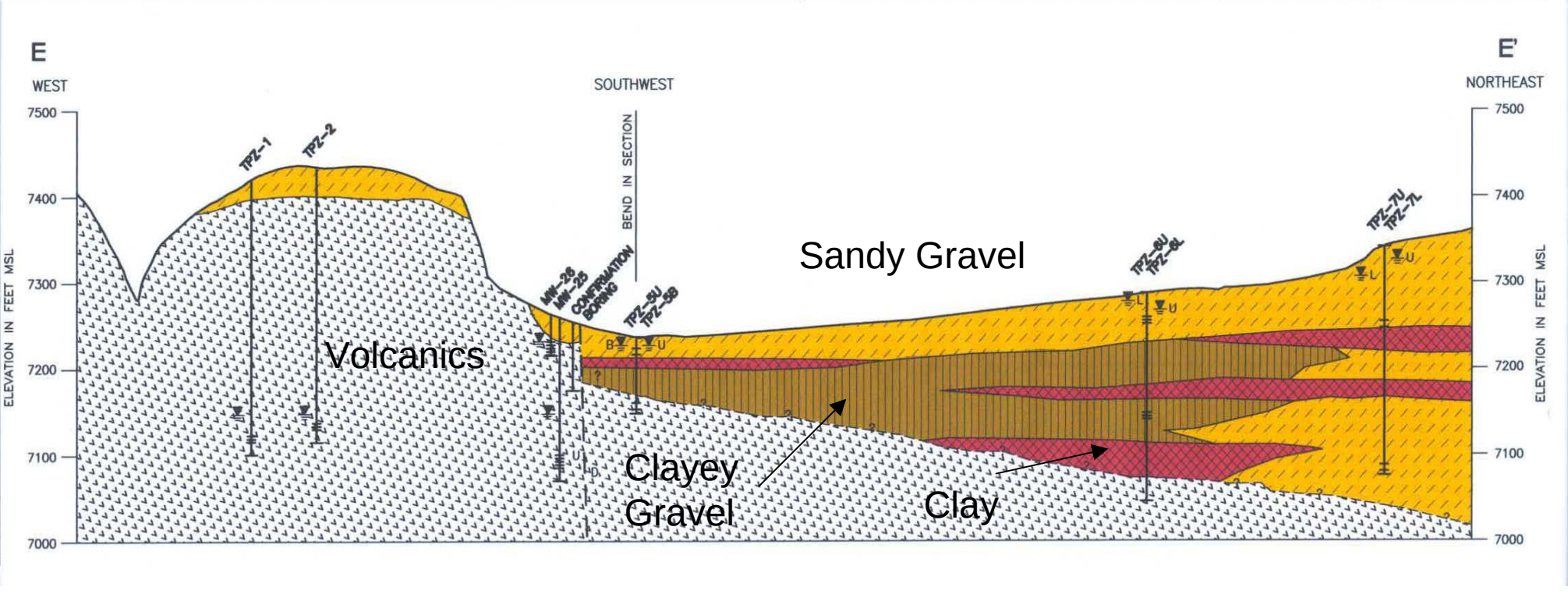
East-West Geologic Cross Section South of Tailings Facility



Hydraulic Conductivity

- Upper and Basal alluvial aquifers
  - 0.01 to 10 feet/day
  - Variability depends on amount of clay content
- Basal volcanic aquifer
  - 100 to 1000's feet/day

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Groundwater Flow Direction

- Horizontal groundwater gradients:
  - Upper aquifer is south/southwest
  - Basal aquifer is south/southwest
  - Both aquifers are influenced locally by extraction system near Dam No.1A

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Potentiometric Surface Maps

- Two potentiometric surface maps (.PDF):
  - Upper aquifer
  - Basal aquifer
  - Based on October 2003 groundwater elevations

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Groundwater Chemistry

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Reference Monitoring Wells

- MW-20: Basal alluvial aquifer (289 feet deep)
- MW-21: Upper alluvial aquifer (139 feet deep)
- MW-22: Basal volcanic aquifer (440 feet deep)

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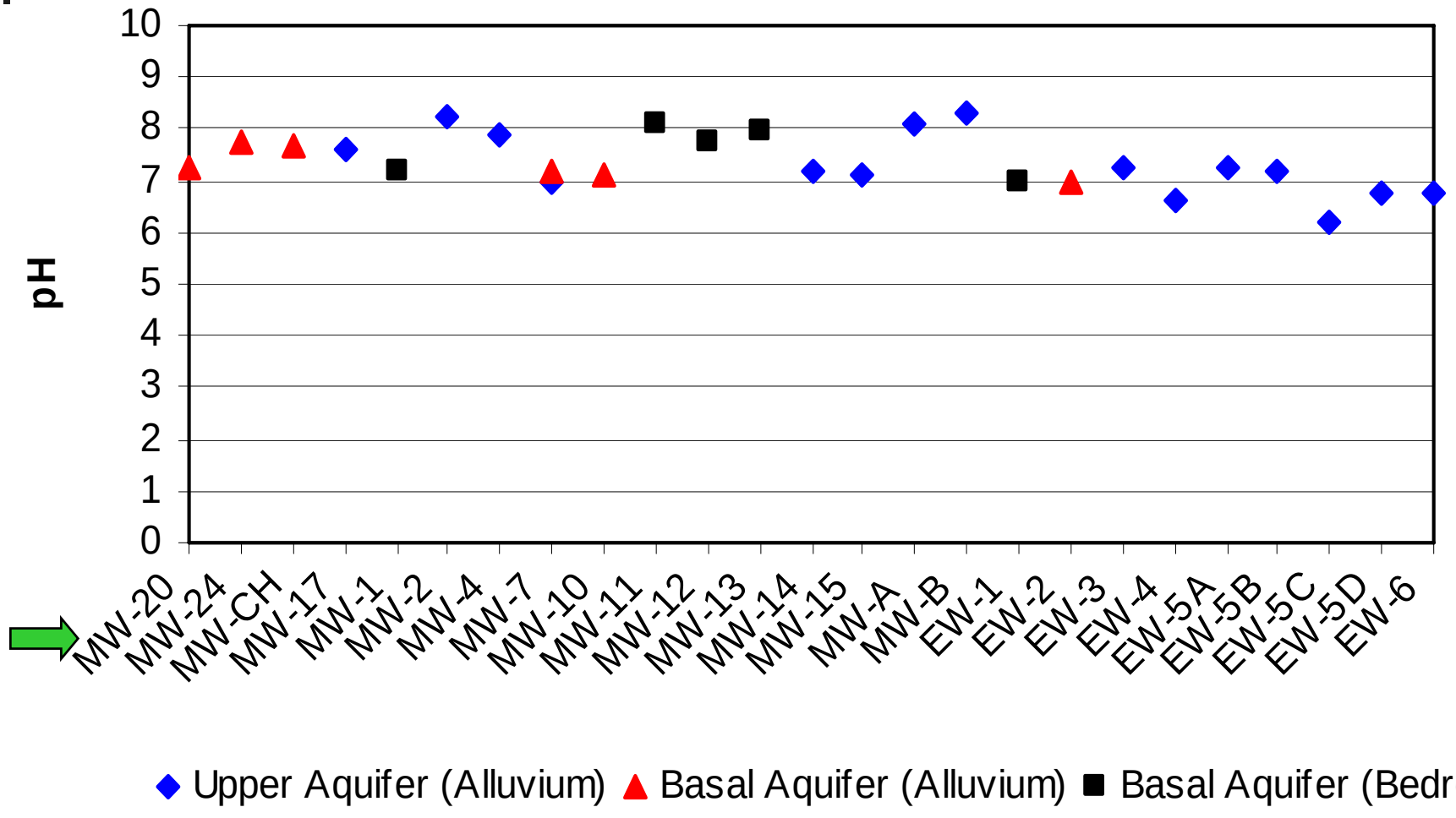
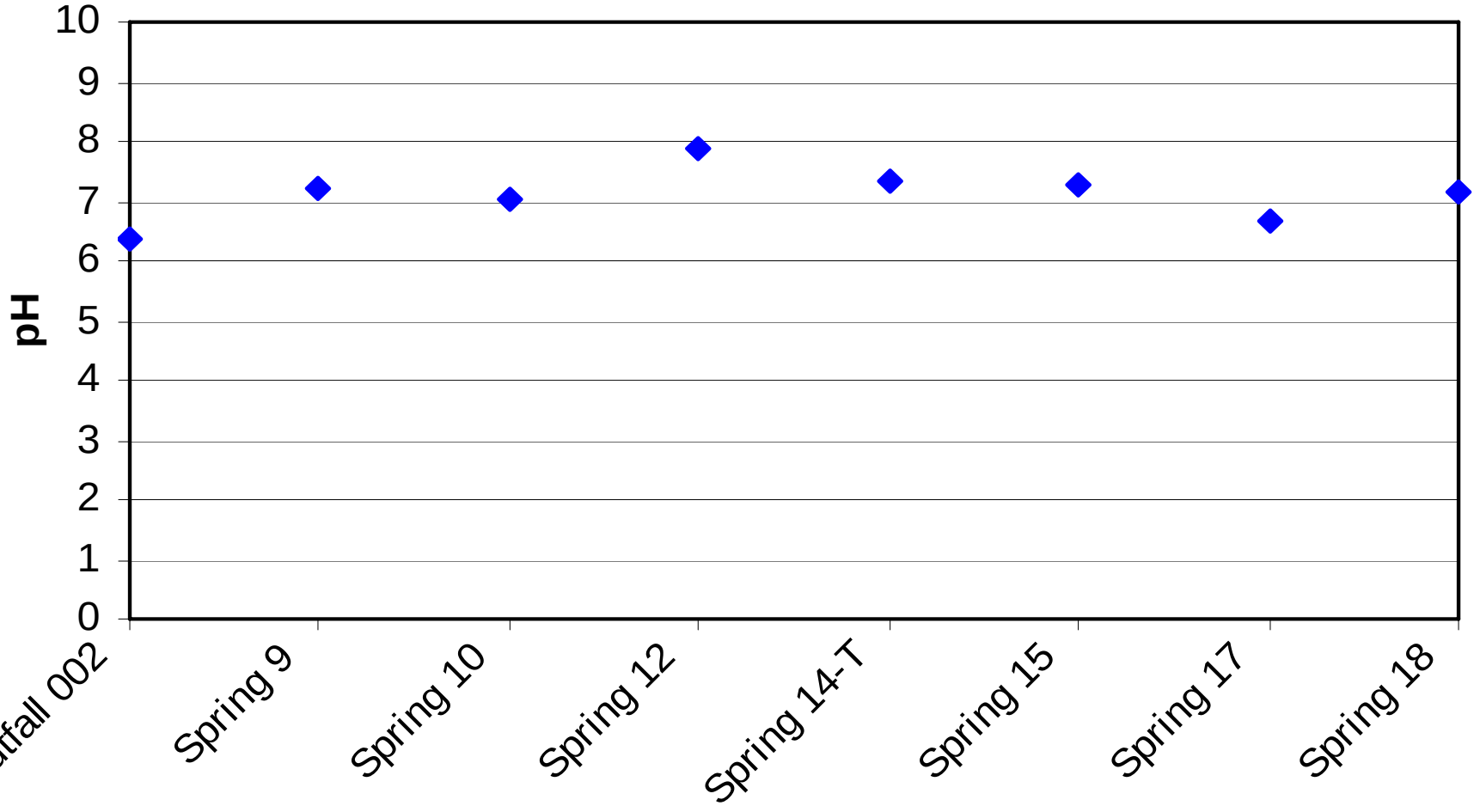
pH in Monitoring Wells



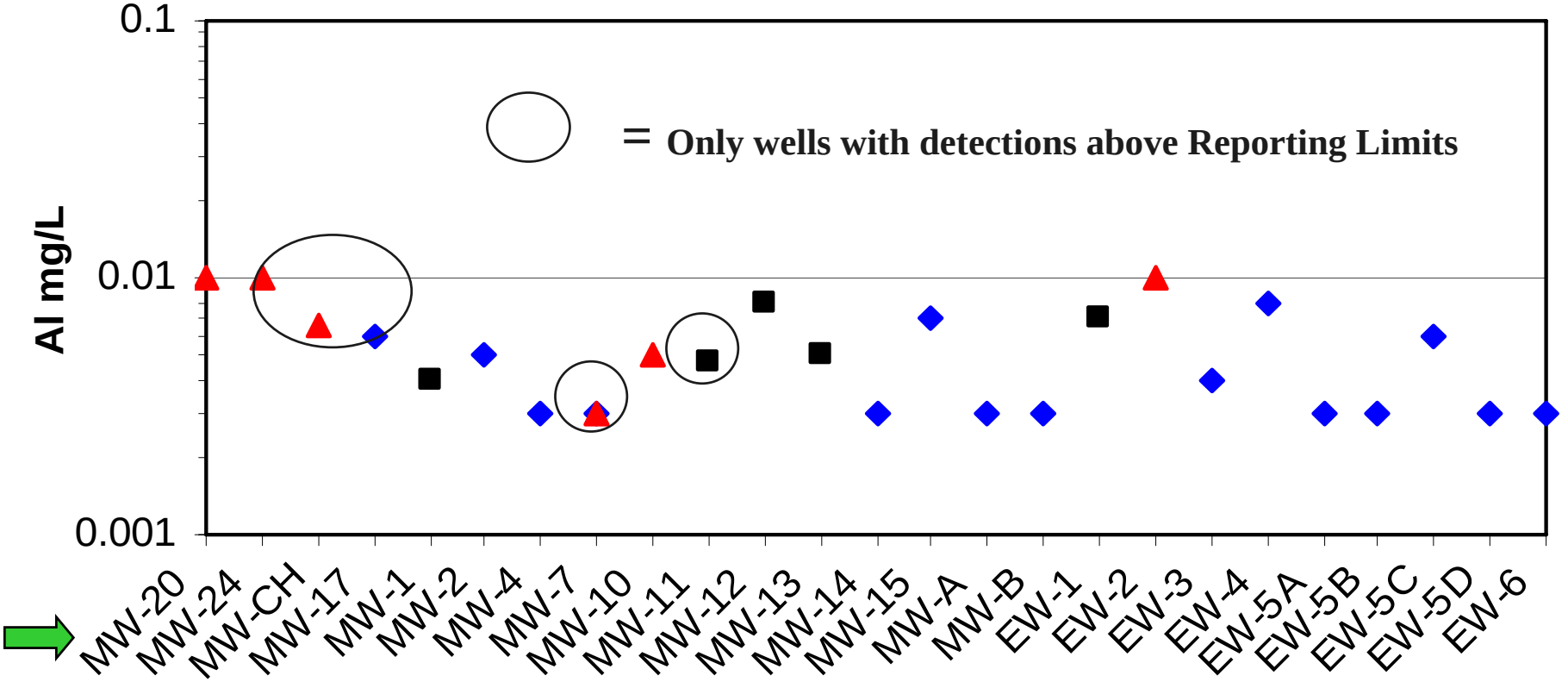
Fall 2002 data

pH in Springs and Seeps



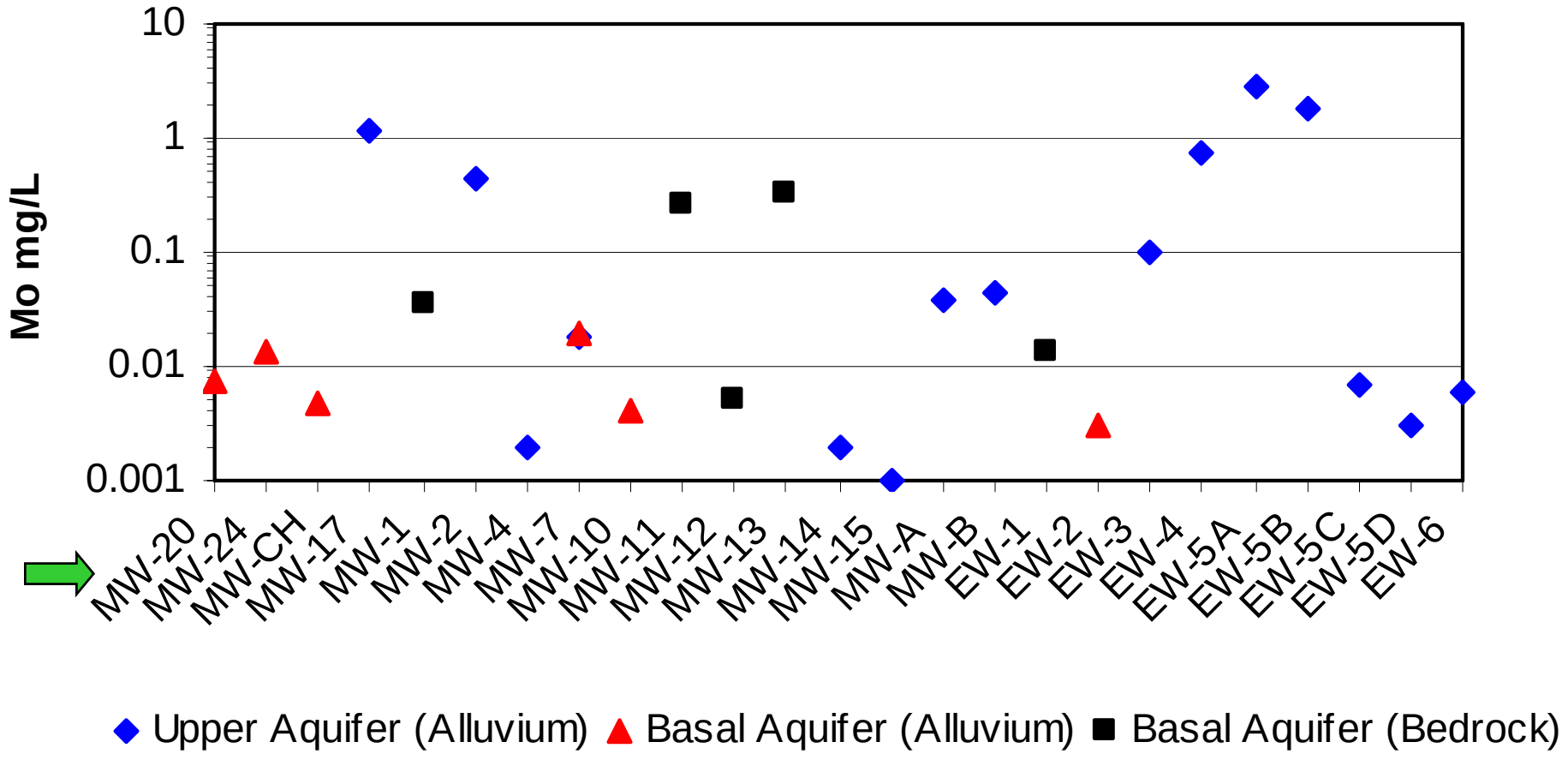
Fall 2002 data

Aluminum



Fall 2002 data

Molybdenum



Fall 2002 data

Comparison of All July 2003 Groundwater Results to SLC

Metal (total, mg/L)	EPA Human Health Tap Water SLC (HQ=1)	Maximum Concentration from July 2003	Location of Maximum Concentration
Aluminum	37	5.4	003 West Seep
Antimony	0.015	<0.001	--
Arsenic	0.01	0.0022	MW-11
Barium	2.6	0.11	MW-23
Beryllium	0.073	<0.00045	--
Boron	3.3	0.2	MW-CH
Cadmium	0.018	<0.0006	--
Chromium	0.11	0.0082	MW-22
Copper	1.4	0.0049	EW-4
Cyanide	0.73	0.019	003 East Seep
Fluoride	2.2	2.1	MW-25
Iron	11	7.8	MW-B
Lead	0.015	0.0048	003 West Seep
Manganese	1.7	2.2	MW-A
Mercury	0.011	<0.00017	--
Molybdenum	0.18	3	EW-5A
Nickel	0.73	0.035	MW-25
Nitrate	10	8.5	MW-21
Nitrite	1	0.052	MW-21
Selenium	0.18	0.0098	MW-21
Silver	0.18	<0.0002	--
Thallium	0.0026	<0.0002	--
Vanadium	0.26	0.0092	Spring 15-T
Zinc	11	0.74	MW-CH

Note: Used all groundwater data including springs

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Tailing Water Sample Results

Parameter	Total Concentration (mg/L)
Aluminum	<0.63
Arsenic	<0.0004
Cadmium	<0.0003
Chromium	<0.0006
Copper	<0.0017
Fluoride	5.1
Iron	<0.67
Lead	0.00027
Manganese	1.4
Mercury	<0.0001
Molybdenum	2.5
Nickel	0.012
Selenium	0.004
Sulfate	1610
Zinc	<0.058
pH (su)	7.7

July 2003 data

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002 Outfall Sample Results

mg/L	002	
	Total	Dissolved
Aluminum	0.02	<0.006
Arsenic	0.0005	0.0005
Barium	0.0288	0.0282
Boron	0.0351	0.0337
Iron	0.0254	<0.0226
Manganese	0.675	0.657
Nickel	0.002	0.0024
Selenium	0.0008	0.0011
Molybdenum	1.24	1.21
Alkalinity	156	
Fluoride	1.1	
Sulfate	989	
pH (su)	7	
TDS	1,460	

Fall 2002 data

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Organic Compound Sampling

- Wells were tested for organic compounds in the only area of the tailings facility where use of organic compounds may have occurred
- This included testing of MW-17 and MW-CH for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) (November 2002 through March 2003)
- No VOCs or SVOCs were detected other than low concentrations of lab contaminants

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Seepage Interception System

Seepage Interception System

- Consists of seepage barriers, rock-fill drains and extraction wells
- Regulated by NMED under DP-933 February 1997; requirements:
  - Extract groundwater from shallow array of wells and discharge to outfall 002
  - Install additional seepage barrier downgradient of Dam 1A
  - Re-evaluate the system after first year and modify as necessary

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Chronology of Seepage Interception System

1. Western Rock Drains (1975) - keyed into a clay layer; collects seepage from Dam No. 4 tailings; flows by gravity
2. Dam 1A Toe Drain (1975) – pipe within the dam's engineered gravel blanket toe drain; flows by gravity
3. Upper Seepage Barrier (1975) – 200' x 14' x 20'; perforated drain with backfill; flows by gravity
4. 003 Seepage Barriers (late 1970s) – 50' x 10' x 20'; perforated drains with backfill; western drain flows, eastern drain does not; flows by gravity; pipeline break in the late 1980s

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Chronology of Seepage Interception System (cont.)

5. Extraction Wells (1994) – EW-1 through EW-4 installed; EW-1 and EW-2 were completed in the Basal Aquifer; EW-3 and EW-4 were completed in the Upper Aquifer
6. Lower Seepage Barrier (1996) – 80’ x 10’ x 20’; perforated drain keyed into clay layer; water is pumped to manhole; observed to be dry recently
7. Extraction Wells (1997) – EW-5A, -5B, 5C, and 5D installed into the Upper Aquifer at toe of Dam No. 1A with input from NMED
8. Extraction Well EW-6 (2000) – MW-3 was converted to extraction well

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Chronology of Seepage Interception System (cont.)

9. Pumpback system (January 2004):

- Objective: to reduce manganese load from Outfall 002
- Installed a new sump near manhole of upper seepage barrier
- Water from EW-5 series, Dam No. 1A toe drain and western rock-filled drains is diverted to the new sump
- Water is pumped (75 gpm) 6,000 ft to Dam No. 5A pond area
- Manganese load from Outfall 002 should be reduced by approximately 50 percent

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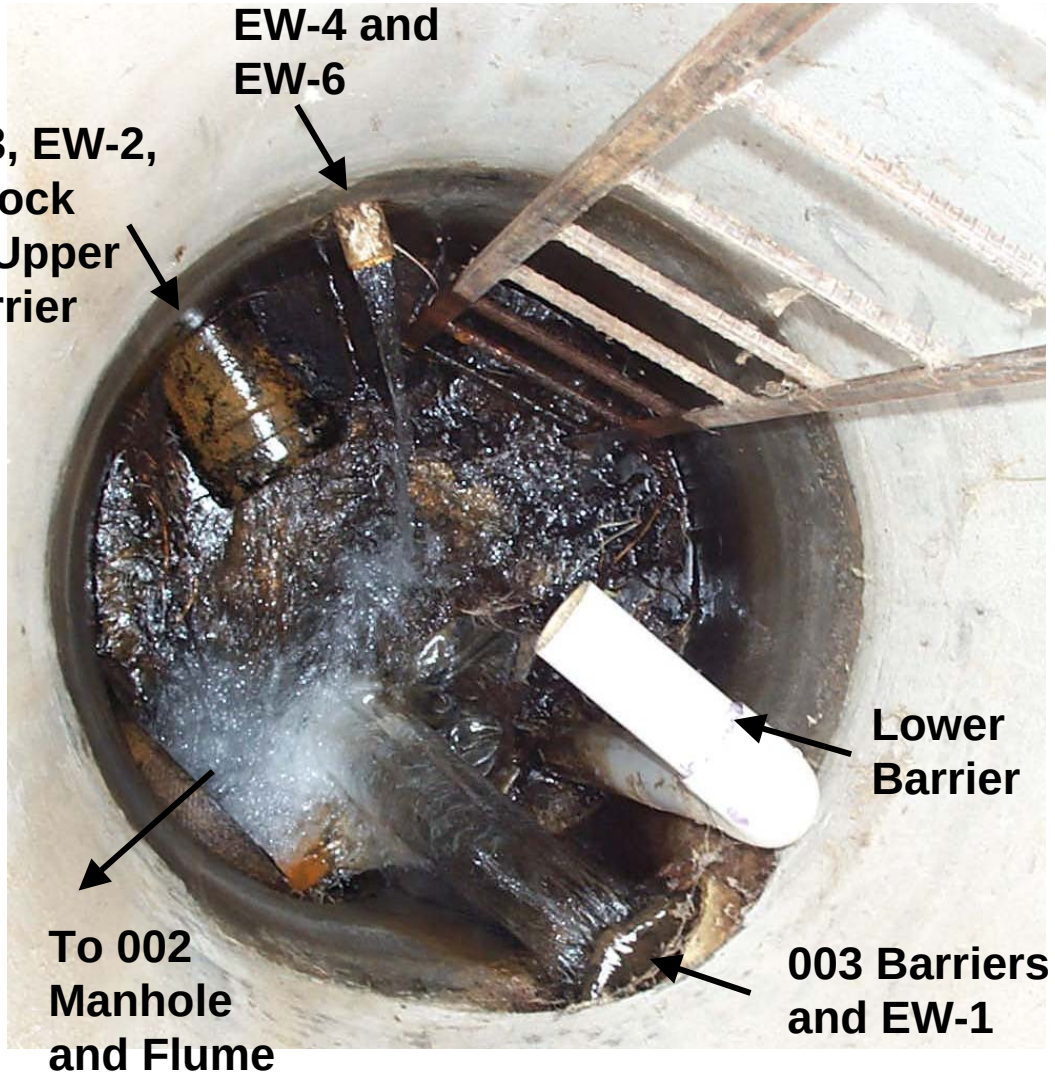
Collection Manhole Next to Outfall 002



Flume at Outfall 002

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Ultrasonic Flow Meter for Flume

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Extraction Well EW-5B

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Evaluation of Seepage Interception System Effectiveness

Comparison of Pre- and Post-Pumping Water Levels for Extraction Wells (SMA 1998)

Extraction Wells				
Well ID	Sept. 1997 Pre-Pumping Elevation (ft)	First Year Average Post-Pumping Elevation (ft)	Drawdown (ft)	First Year Average Pumping Rate (gpm)
EW-1	7229.66	7229.32	-0.34	14
EW-3	7262.67	7249.57	-13.10	8
EW-4	7264.29	7242.86	-21.43	3
EW-5A	7301.53	7289.39	-12.14	7
EW-5B	7302.82	7297.40	-5.42	63
EW-5C	7305.65	7298.68	-6.97	2
EW-5D	7343.66	7338.55	-5.11	3

Note: EW-2 was not included in the analysis because it was not impacted by tailings seepage

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Evaluation of Seepage Interception System Effectiveness

Comparison of Pre- and Post-Pumping Water Levels for Surrounding Monitoring Wells (SMA 1998)

Surrounding Monitoring Wells			
Well ID	Nov 1996 through Sept 1997 Average Pre-Pumping Elevation (ft)	First Year Average Post-Pumping Elevation (ft)	Drawdown (ft)
MW-1	7233.38	7231.18	-2.20
MW-2	7243.15	7240.73	-2.42
MW-3	7278.53	7278.48	-0.05
MW-7A	7260.55	7253.01	-7.54
MW-A	7280.26	7278.80	-1.46
MW-C	7313.81	7314.01	0.20
MW-B	7299.18	7296.82	-2.36

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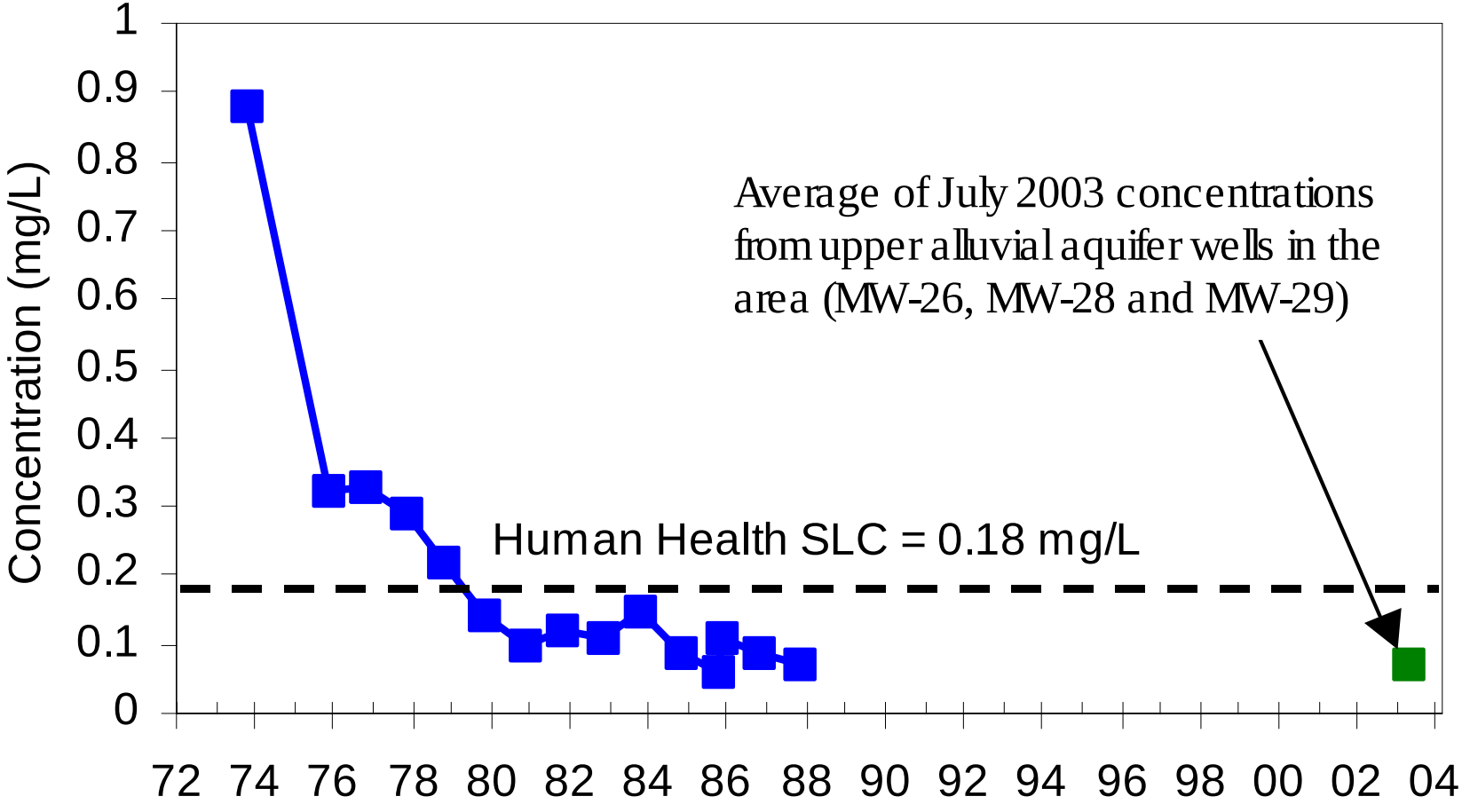
Historical Molybdenum Concentrations in PRW-1 (Private well)



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Recent Status of Seepage Interception System

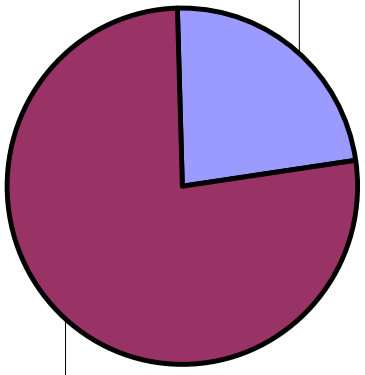
Extraction Well	Pumping Rate (gpm)	Pumping Water Level (ft, bgs)	Pumping Status	Comments
EW-1	26	83	Continuous	
EW-2	21	156	Continuous	
EW-3	0	69	Cycles	Insufficient water to pump to surface
EW-4	0.5	27	Cycles	Evacuates casing and is off for 1 to 2 hours
EW-5A	0.3	19	Cycles	Evacuates casing and is off for 1 to 2 hours
EW-5B	39	21	Continuous	
EW-5C	0.2	30	Cycles	Evacuates casing and is off for 1 to 2 hours
EW-5D	5	32	Continuous	
EW-6	9	26	Continuous	
Total Extraction Wells	**101**			
Total Seepage Barriers and Rock Drains	**338**			
Outfall 002	**439**			

September 2003 data

Breakdown of Flows from Seepage Interception System

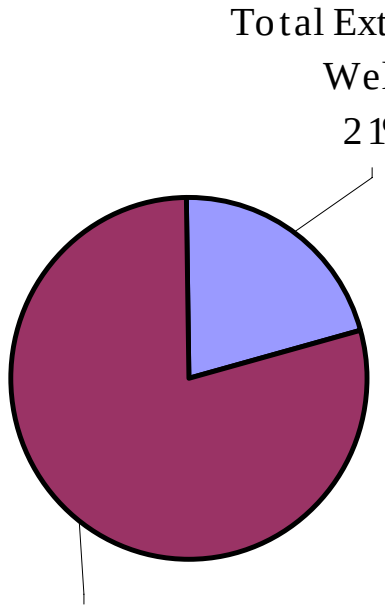
September 2003

439 gpm

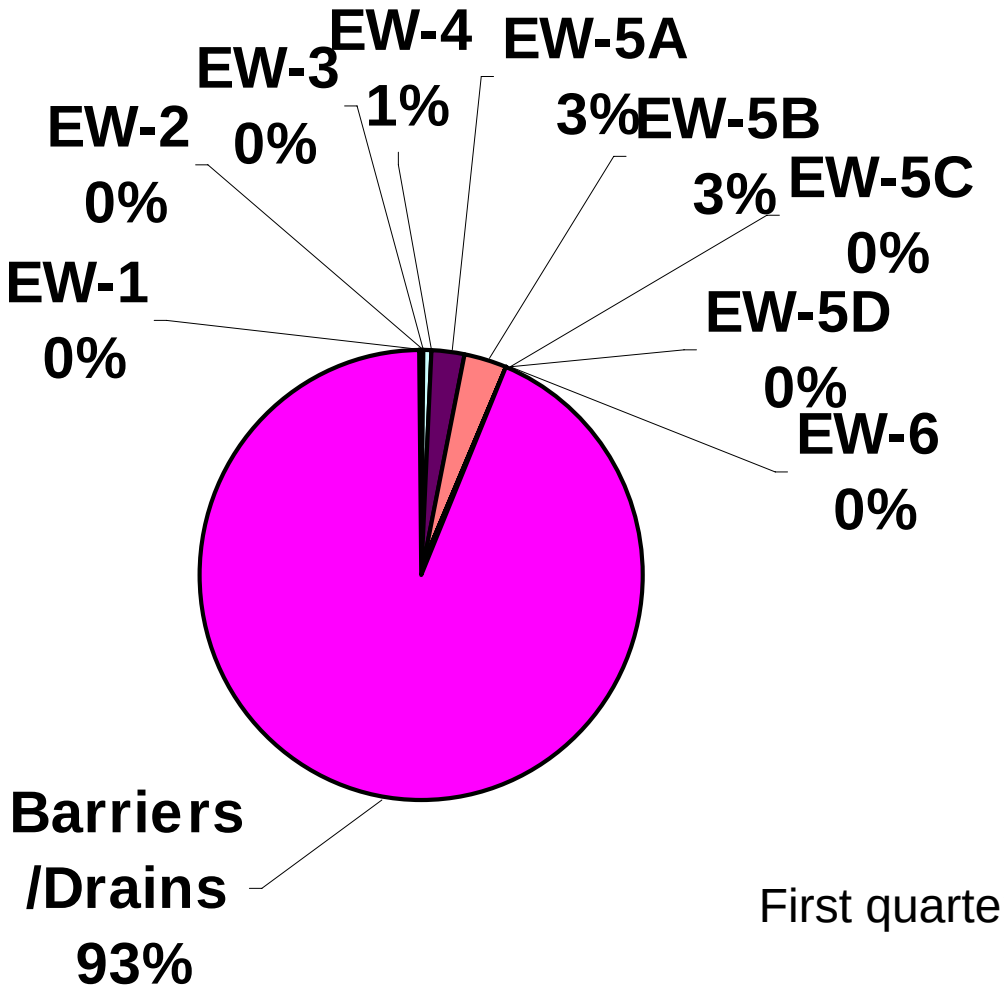


April 2002

420 gpm



Recent Molybdenum Load Percentages for Seepage Interception System



First quarter 2003 data

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Nature and Extent

Isoconcentration Contour Maps (GIS)

- Upper Aquifer October 2003:
  - Molybdenum and sulfate
- Basal Aquifer October 2003:
  - Molybdenum and sulfate

Summary: Tailings Facility Groundwater

- Groundwater flow direction in the Upper and Basal aquifers is toward the south/southwest
- Molybdenum, manganese, and sulfate are the primary constituents with elevated concentrations
- No VOCs or SVOCs were detected other than low concentrations of lab contaminants

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Summary (cont): Tailings Facility Groundwater

- The Seepage Interception System effectively collects tailing seepage from Dam No. 1A, and from Dam No. 4 within the 003 drainage
- The seepage barriers collect the majority of the seepage, as compared to extraction wells
- Elevated concentrations of molybdenum, manganese, and sulfate are observed south of Dam No.1A and near the 002 outfall in the Upper alluvial aquifer

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Summary (cont): Tailings Facility Groundwater

- Elevated concentrations of molybdenum are observed south of Dam No. 4 in the Basal volcanic aquifer
- Molybdenum concentrations greater than the NMED groundwater standard are limited to the Dam No.1A area
- Molybdenum concentrations greater than the NMED groundwater standard have also occurred downgradient of the dry maintenance area, but the most recent concentrations are below the standard

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