



American Plating Post-Interim-Action Groundwater Monitoring Results May and September, 2006

Abstract

During May and September, 2006, groundwater samples were collected from four monitoring wells at the former American Plating site located on the Thea Foss Waterway in Tacoma, Washington. Samples were analyzed for dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel) and weak acid dissociable (WAD) cyanide. Results provided the Department of Ecology's Toxics Cleanup Program with post-interim-action groundwater monitoring data.

Dissolved cadmium, chromium, copper, and nickel, as well as WAD cyanide, were detected in groundwater at the site during May and September.

- Dissolved chromium was detected in all four wells. In May, chromium concentrations ranged from 30 to 104 ug/L, decreasing in September to a range of 16 to 41 ug/L. Dissolved hexavalent chromium was not detected in any of the samples. Therefore, it is assumed that the less toxic and less mobile trivalent chromium was present.
- Dissolved nickel was detected in all four wells with concentrations ranging from 1 to 3.8 ug/L which is below the groundwater cleanup standard of 8.2 ug/L. Nickel concentrations had exceeded the cleanup standard in wells MW-5 and MW-10 in 2004/2005.
- Dissolved cadmium and copper were detected in the sampled wells, but at concentrations below the cleanup standards.
- WAD cyanide was detected in well MW-4 at concentrations of 5 and 8 ug/L which exceeds the cleanup standard of 1 ug/L. This is the first detection of WAD cyanide since Ecology began monitoring in 2004.

Well MW-10, which has been part of the monitoring program since February 2004, was damaged during 2006 and should be decommissioned. Since elevated dissolved nickel concentrations (29 to 62 ug/L) and low concentrations of some volatile organics have been detected in this well, installation of a new well should be considered if monitoring is to continue at the American Plating site.

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Background

American Plating, a metal electroplating company formerly operating on the Thea Foss Waterway in Tacoma (Figure 1), ceased production in 1986 when it was discovered that facility operations potentially violated state dangerous waste regulations. The Washington State Department of Ecology (Ecology) conducted several site inspections from 1980 to 1985. These inspections determined that discharges, leaks, and spills of plating materials had occurred at the site. The site had been occupied by plating companies since 1955. All these companies performed metal electroplating including brass, cadmium, chromium, copper, nickel, and zinc plating.

A preliminary site assessment conducted by the U.S. Environmental Protection Agency (EPA) in 1986 concluded that high levels of plating waste and contaminated materials were present on the site. Removal of waste material and site cleanup began in June 1987. A series of site investigations, which included the installation of 12 monitoring wells, was conducted from 1988 to 1994. In 1997, the site was given a ranking of 2 under the Washington Ranking Method, and placed on Ecology's Hazardous Site List.

An interim remedial action was initiated by Ecology in the summer of 2003, with the primary objective of reducing the human health risk from contact with contaminated soil. The interim action included the removal of site buildings, a concrete pad, sumps, and an underground storage tank. Soil was excavated from depths of 3 to 8 feet (or to the water table) and removed from the site. Clean fill and top soil were added to the excavated areas. It is anticipated that additional soil cleanup will be performed by the new site owner under the provisions of a Prospective Purchaser Consent Decree.

Contaminants of concern in groundwater at this site include cadmium, chromium, copper, nickel, cyanide, and volatile organic compounds (VOCs), particularly vinyl chloride. Elevated metal concentrations have been detected throughout the site soils. Elevated metal concentrations in groundwater are assumed to be associated with leaching from the contaminated soils. Cyanide solutions are common components of electroplating processes and were widely used at the site. Elevated levels of cyanide have been detected in the site soils and are the probable source of the cyanide observed in the groundwater.

In addition to metals, site soils and groundwater show elevated concentrations of VOCs. A 1,000-gallon degreasing tank had been located in Building 1 (Figure 2). Chlorinated solvents stored in the tank were used to degrease parts prior to plating. The source of the vinyl chloride is most likely from leaks or spills of degreasing solvents and their subsequent degradation in the environment.

Historical data for the wells sampled during this monitoring period are presented in the Appendix.

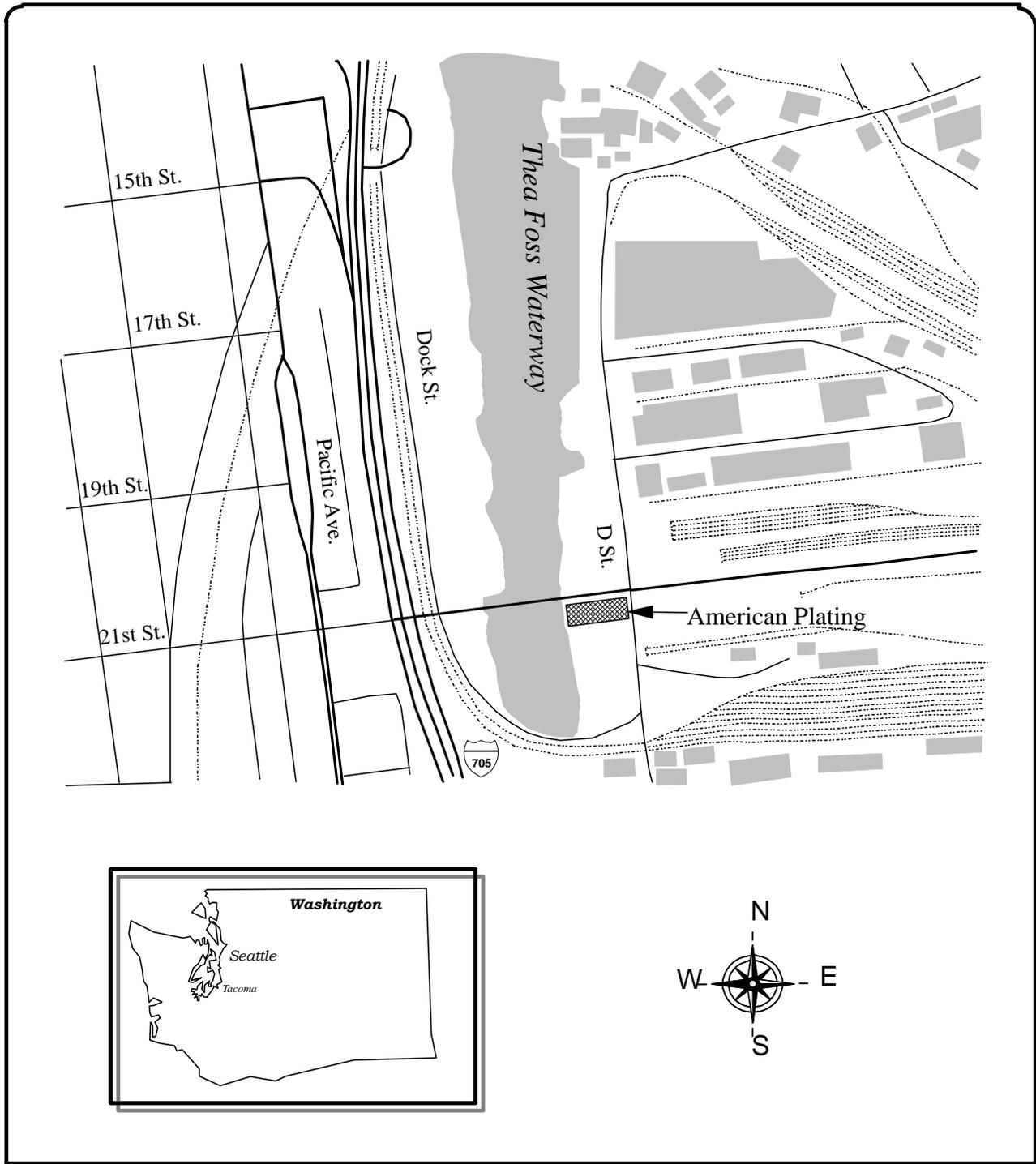


Figure 1: American Plating Site Location

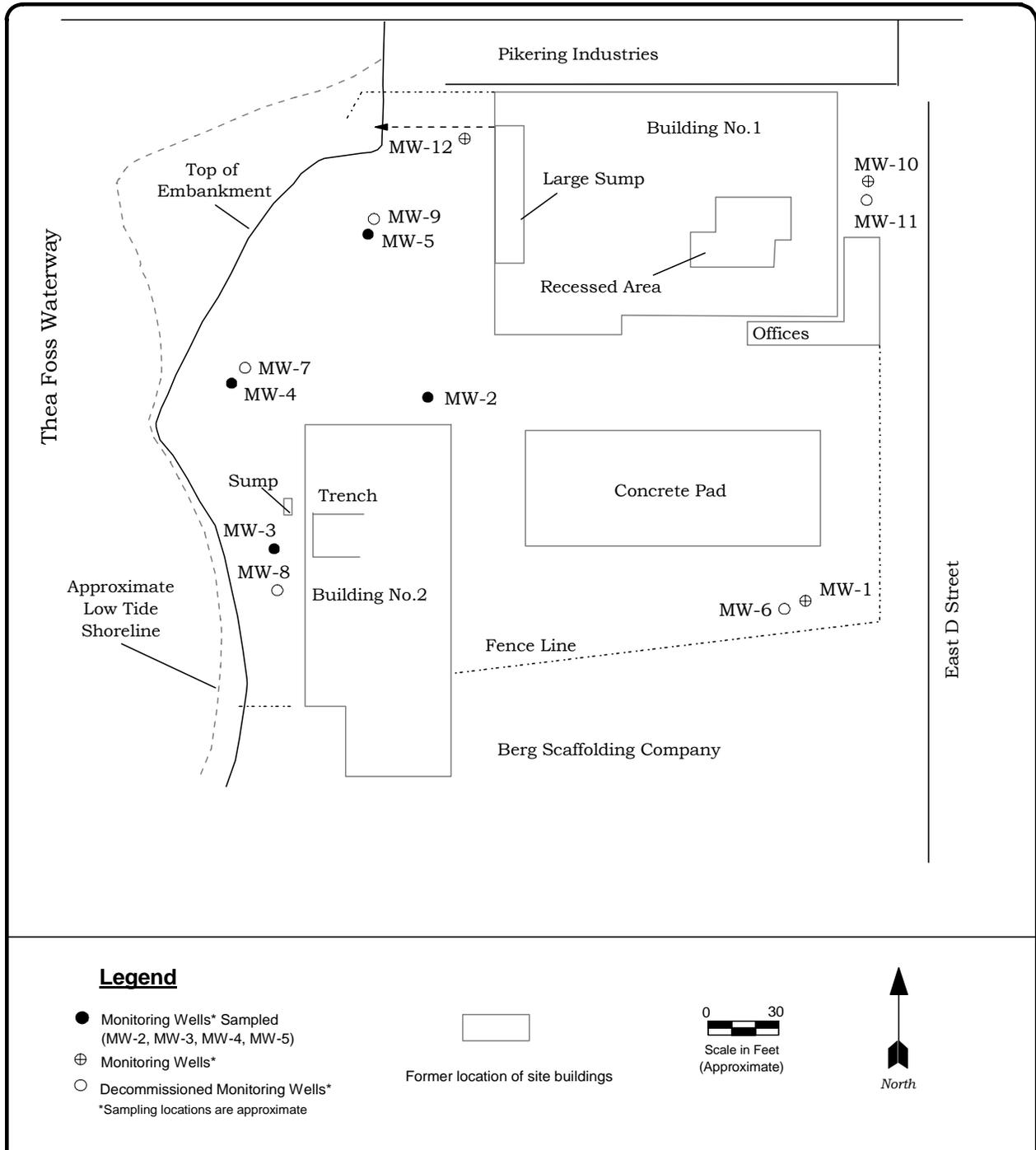


Figure 2: American Plating Sampling Site Locations

Site geology has been described in several documents (SAIC, 1994; PRC, 1995) and is summarized as follows. Geology of the site consists of a series of deposits including, from the surface down: fill materials, undifferentiated fill and marsh deposits, deltaic deposits, and glacial till. Prior to the interim action excavations, the fill materials were heterogeneous, consisting of gravels, silty sand, and wood debris to a depth of 5 to 18 feet below the surface. The fill and marsh deposits are undifferentiated, consisting of very soft sandy silts to clayey silts that are generally encountered at depths of about 3 to 12 feet below the surface and range up to 15 feet thick.

The wells sampled in May and September, 2006, are screened in the fill and marsh aquifer that is encountered in these deposits. The deltaic deposits are medium-dense, silty sand and silty gravel, encountered at a depth of about 18 feet, and are about 5 feet thick. These deposits appear to be relatively continuous beneath the site and seem to thicken to the northwest across the site. The sand aquifer is encountered in this unit. The till is generally encountered at depths of about 23 to 29 feet, with an unknown thickness, and consists of slightly consolidated, very dense, silty sand to silty gravel.

Groundwater in the fill/marsh aquifer and the sand aquifer occurs under unconfined and semi-confined conditions, respectively. The two aquifers are interconnected and tidally influenced. The unconfined water table ranges from approximately 5 to 9 feet below ground surface. Variations in groundwater elevations reflect tidal phases in both aquifers. Groundwater flow is interpreted to be in a general northwesterly direction towards the Thea Foss Waterway. However, the hydraulic gradient in the unconfined aquifer may reverse at high tide phases at least beneath the western portion of the site.

Methods for Groundwater Sampling

Groundwater samples were collected in May and September, 2006, from four monitoring wells screened in the upper unconfined aquifer. The primary goal of the sampling was to determine post-interim-action groundwater concentrations of dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel) and weak acid dissociable (WAD) cyanide.

The four wells sampled (MW-2, MW-3, MW-4, and MW-5) are screened in the upper fill/marsh deposits aquifer. The wells were completed to depths of about 14.5 to 17 feet, with 5-foot screened intervals at the base of the completion depth.

Well MW-10, which has been part of the monitoring program since February 2004, can no longer be sampled. The top of the PVC casing has been destroyed and is beyond repair.

Static water levels were measured in all wells using a Solinst water level meter prior to well purging and sampling. Measurements were recorded to 0.01 foot and are accurate to 0.03 foot. The probe was rinsed with deionized water between measurements.

The monitoring wells were purged and sampled using a Grundfos Redi-Flo2 stainless steel submersible pump with dedicated tubing for each well. The pump intake was placed at the middle of the screened interval in each monitoring well and purged at a rate of 0.5-liter/minute or less. Wells were purged through a continuous flow cell until pH, specific conductivity, and temperature readings stabilized and turbidity readings decreased. Purge water from the wells was collected and stored on site in a 55-gallon drum. The purge water waste was transported and disposed of in accordance with Washington State regulations (Chapter 173-303-400 WAC). At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory supplied containers. The pump was decontaminated between each well by circulating laboratory-grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

Metal samples were field filtered using a clean, high-capacity 0.45 micron membrane filter into a 1/2-liter, high-density polyethylene container and immediately acidified with nitric acid to a pH <2. Hexavalent chromium samples were field filtered into a 125-mL polyethylene bottle. WAD cyanide samples were collected in a 250-mL amber polyethylene bottle with sodium hydroxide preservative. Upon sample collection and proper labeling, all samples were stored in an ice-filled cooler. Samples were transported to Ecology's Operation Center in Lacey. Samples were kept in the walk-in cooler until picked up by the courier and transported to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Environmental Laboratory protocol (Ecology, 2005).

Analysis

Analytes, analytical methods, and reporting limits for both field and laboratory parameters are listed in Table 1. Groundwater samples were analyzed for selected dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel), and weak acid dissociable (WAD) cyanide.

Table 1: Field and Laboratory Methods

Analytes	Method	Reference	Accuracy
<i>Field</i>			
Water Level	Solinst Water Level Meter	NA	±0.03 feet
pH	Orion 25A Field Meter	NA	±0.1 std. units
Temperature	YSI 3510 Temperature Probe	NA	±0.1 C
Specific Conductance	YSI 3520 Conductivity Cell	NA	±10 umhos/cm
<i>Laboratory</i>			<i>Reporting Limit</i>
Dissolved Metals	EPA Method 200.8	EPA 1996	0.02-1.0 ug/L
Dissolved Hexavalent Chromium	SM3500-CR-D	APHA 1998	5 ug/L
WAD Cyanide	SM4500CN-I	APHA 1998	5 ug/L

The quality of the data is acceptable. Quality control samples collected in the field consisted of blind replicate samples, which were obtained from well MW-3 during both rounds of sampling. The numeric comparison of replicate results is expressed as the relative percent difference (RPD). The RPD is calculated as the difference between sample results, divided by the mean and expressed as a percent. The RPD for the dissolved chromium and nickel was 8% in May. In September, the RPD for dissolved chromium was 1%.

A review of the data quality control and quality assurance from laboratory case narratives indicates that analytical performance was good. The reviews include descriptions of analytical methods, holding times, instrument calibration checks, blank results, surrogate recoveries, and laboratory control samples. No problems were reported that compromised the usefulness or validity of the sample results. No data were rejected, and all results were usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

All field measurements and analytical result data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm.

Results

Field Observations

Depth-to-water in each monitoring well was measured prior to sampling. pH, specific conductivity, and turbidity readings measured at the time of sampling, as well as the total purge volume, are listed in Table 2. Temperature measurements recorded during purging were collected for comparative purposes only and have not been included in the table. Because water temperature is measured in a flow cell which is influenced by ambient air conditions, the temperatures are not considered to be representative of actual groundwater conditions.

Table 2: Summary of Field Parameter Results for May 30 and September 20, 2006

Monitoring Well	Total Depth (feet) ¹	Depth-to-Water (feet) ¹ May		Depth-to-Water (feet) ¹ September		pH (standard units)		Specific Conductivity (umhos/cm)		Turbidity (NTU)		Purge Volume (gallons)	
		Time	5/06	Time	9/06	5/06	9/06	5/06	9/06	5/06	9/06	5/06	9/06
MW-2	16.65	14:25	6.19	12:25	7.21	6.8	6.6	2,890	2,980	6	65	4	5
MW-3	14.67	09:25	3.80	09:13	5.44	6.8	7.2	24,300	27,700	0.6	1.2	3	4
MW-4	16.89	10:45	5.95	10:07	7.08	7.5	7.6	11,800	16,600	0.7	1.2	3.5	3.5
MW-5	16.84	12:20	6.70	11:20	7.43	7.3	7.5	20,600	21,300	73	5	1.5	3.5

¹ Measured from top of PVC casing.

Completion depths for the four monitoring wells ranged from 14.67 to 16.89 feet. Depth-to-water was measured prior to purging each well. Figure 3 shows the tidal phase when water levels were measured and samples were collected. Monitoring was conducted during a falling tide in May and a low tide in September. Depth-to-water ranged from 3.80 to 6.70 feet below the measuring point in May and 5.44 to 7.43 feet in September.

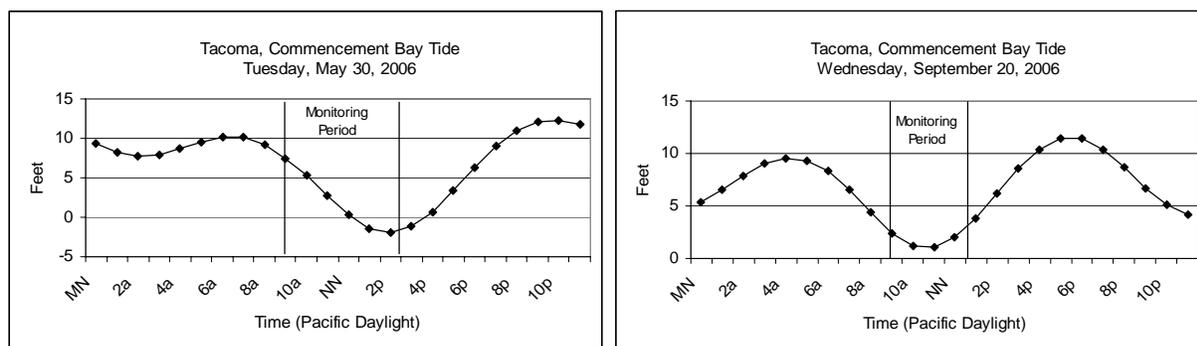


Figure 3: Tide Phase for May 30 and September 20, 2006

The four shallow wells sampled are screened in the soft sandy silt, silt, and clayey silt of the fill/marsh deposits, and are low yielding. While purging at the lowest flow possible, water levels dropped in wells MW-4, and MW-5 in both May and September. In May, the water level dropped below the pump intake in these two wells. The pump was shut off during purging to allow the wells to recover.

During the monitoring period, the pH of groundwater ranged from 6.6 to 7.6. Groundwater temperatures measured in the flow cell in May ranged from 14.0° to 15.5°C, increasing to 15.9° to 19.2°C in September. The higher temperatures in September are partly caused by the combination of purging at a low flow rate through a flow cell. Specific conductivity measurements were high, ranging from about 2,900 to 28,000 umhos/cm. Specific conductivity values were higher for those wells closer to the waterway. The high conductivity is consistent with the close proximity to the salt water. Specific conductivity of the waterway has been reported between 15,000 to 35,000 umhos/cm. Turbidity measurements ranged from 0.6 to 73 NTUs, with wells MW-2 and MW-5 representing the higher end. Turbidity measurements in these wells had been lower during purging before the pump was shut off, but increased when the pump was restarted just prior to sampling.

Analytical Results

Analytical results for dissolved metals and WAD cyanide are summarized in Table 3 and presented in Figure 4. A summary of historical data for this project is presented in the Appendix.

Table 3: Summary of Analytical Results (ug/L) for May and September, 2006

Well	Dissolved Cadmium		Dissolved Chromium		Dissolved Hexavalent Chromium		Dissolved Copper		Dissolved Nickel		WAD Cyanide	
	5/06	9/06	5/06	9/06	5/06	9/06	5/06	9/06	5/06	9/06	5/06	9/06
MW-2	0.02 U	0.022	49.9	16.1	5 U	5 U	1 U	0.39	2.8	3.3	5 U	5 U
MW-3	0.2 U	0.2 U	30.6	25	5 U	5 U	2.5 J	2.8 J	3.8	1 U	5 U	5 U
MW-4	0.02 U	0.2 U	66.2	35.8 J	5 U	5 U	1.9 J	1.6 J	2.2	1 U	5	8
MW-5	0.2 U	0.2 U	104	40.7	5 U	5 U	1.4 J	2.4 J	3.6	1.0	5 U	5 U

U – Analyte was not detected at, or above, the reported value.

J – Analyte was positively identified. The associated numerical result is an estimate.

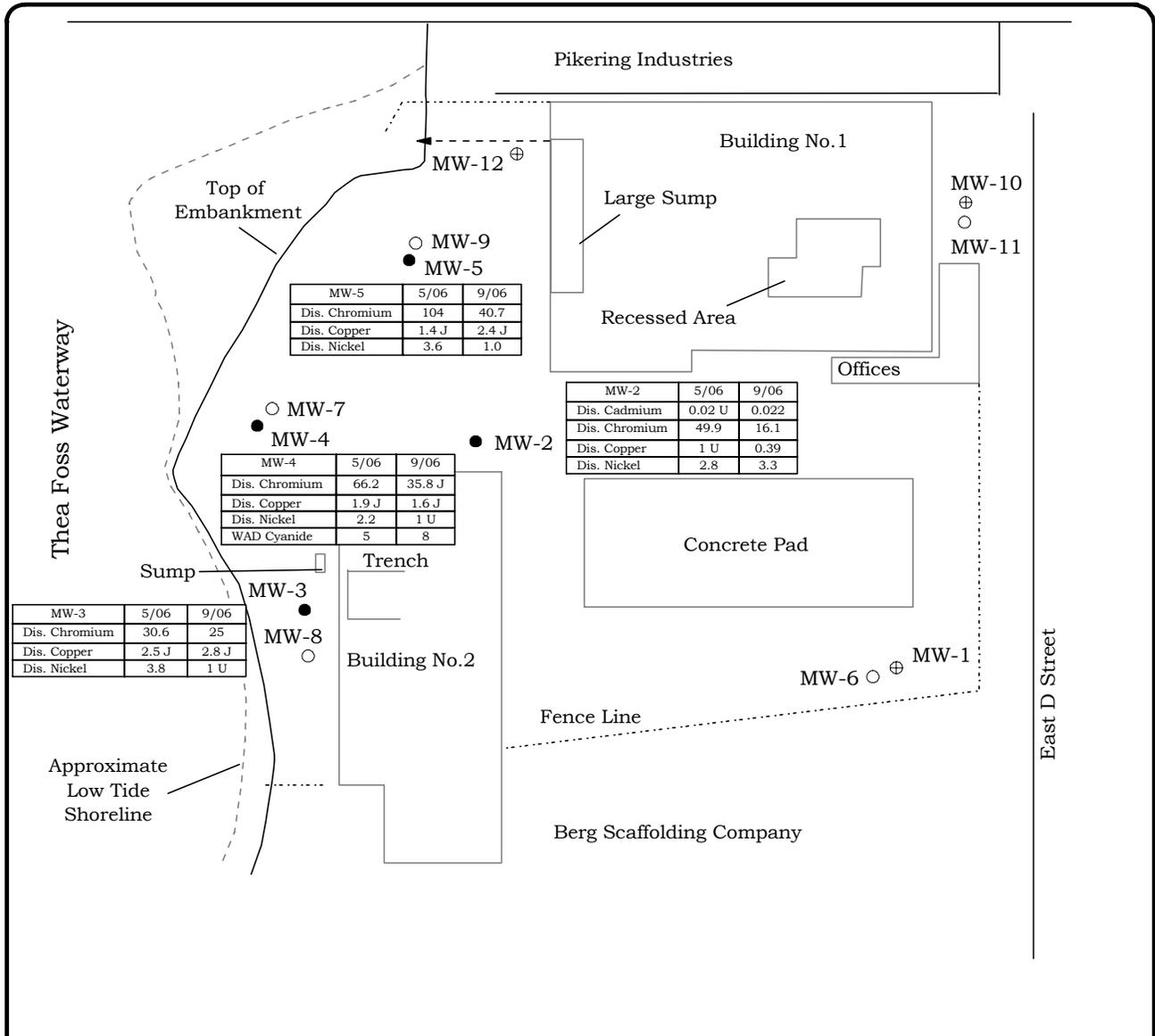
Bold – Analyte was detected.

Dissolved chromium was detected in all the sampled wells. In May, chromium concentrations ranged from 30 to 104 ug/L. In September, chromium concentrations decreased, ranging from 16 to 41 ug/L. The reason for the apparent decrease in chromium concentrations could not be determined from the available data. Dissolved hexavalent chromium was not detected.

Dissolved nickel was detected in the four wells in May with concentrations ranging from 2.2 to 3.8 ug/L, and in two of the wells in September at concentrations of 1 to 3.3 ug/L.

Dissolved copper was detected in wells MW-3, MW-4, and MW-5 in May and September at an average concentration range of 1.7 to 2.7 ug/L. Dissolved copper and cadmium were detected in well MW-2, for the first time since Ecology began sampling in February 2004, at a concentration of 0.39 ug/L and 0.022 ug/L, respectively.

WAD cyanide, which has not been detected in any previous Ecology monitoring, was detected in well MW-4 at an average concentration of 6.5 ug/L. Total cyanide has been detected in this well in the past as shown in the Appendix. WAD cyanide was not detected at the reporting limit of 5 ug/L in the other three wells.



Legend

- Monitoring Wells* Sampled (MW-2, MW-3, MW-4, MW-5, MW-10)
- ⊕ Monitoring Wells*
- Decommissioned Monitoring Wells*

*Sample locations are approximate

MW-3	3/05
Dis. Cadmium	0.48
Dis. Chromium	16
Dis. Copper	2.5
Dis. Nickel	6.6

Former location of Site Buildings

0 30

Scale in Feet (Approximate)

North

Figure 5: American Plating Summary of Analytical Results (ug/L)

Discussion

Dissolved cadmium, chromium, copper, and nickel were detected in groundwater at this site in May and September, 2006. Table 5 shows a comparison of the 2006 results to cleanup standards established for the site. Due to the proximity of the site to the waterway, the groundwater cleanup standards were developed based on protection of human contact with surface water (MTCA Method B surface water levels) and on protection of marine organisms (WAC 173-201A). The surface water criterion for cyanide (1 ug/L for acute exposure) is based on the weak acid dissociable (WAD) cyanide.

A summary of historical data for this project is presented in tables and as graphs in the Appendix.

Table 5: Comparison of 2006 Groundwater Results (ug/L) to Surface-Water Based Cleanup Standards

Parameter	American Plating Cleanup Standards (ug/L)	Monitoring Wells			
		MW-2	MW-3	MW-4	MW-5
<i>Dissolved Metals</i>					
Cadmium	9.3	0.2 U-0.022	0.2 U	0.2 U	0.2 U
Chromium	--	16.1-49.9	25-30.6	35.8 J-66.2	40.7-104
Copper	3.1	1 U-0.39	2.5 J-2.8 J	1.6 J-1.9 J	1.4 J-2.4 J
Nickel	8.2	2.8-3.3	1 U-3.8	1 U-2.2	1.0-3.6
Cyanide	1 (WAD)	5 U	5 U	5-8	5 U

U – Analyte was not detected at, or above, the reported value.

J – Analyte was positively identified. The associated numerical result is an estimate.

Bold – Concentration exceeded established cleanup level.

WAD cyanide was detected, for the first time since Ecology started sampling in February 2004, in well MW-4 at concentrations of 5 and 8 ug/L. WAD cyanide was not detected in the other three wells during this monitoring. However, the available reporting limit of 5 ug/L does not meet the cleanup standard of 1 ug/L for WAD cyanide established for this site. Total cyanide has been detected in wells MW-2, MW-3, MW-4, and MW-10 in samples collected from 1988 to 1994 as shown in the Appendix.

In 2004, dissolved chromium concentrations exceeded Washington State surface water quality standards for protection of aquatic organisms in marine waters for acute exposure to hexavalent chromium of 50 ug/L (WAC 173-201A). Since it was not possible to determine which form of chromium (trivalent or hexavalent) was present, samples have been collected and analyzed for hexavalent chromium since August 2005. As stated previously, dissolved hexavalent chromium was not detected in any of the 2006 samples. Therefore, it is assumed that the less toxic and less mobile trivalent chromium is present.

Dissolved nickel concentrations, which have exceeded the cleanup criterion of 8.2 ug/L in wells MW-5 and MW-10 in 2004 and 2005, were below the cleanup criterion in samples collected in 2006. However, well MW-10, which had the highest nickel concentrations, is no longer available for sampling.

Recommendations

1. Well MW-10, which has been part of the monitoring program since February 2004, was damaged during 2006 and should be decommissioned. Installation of a new well should be considered in the area of MW-10 because it appears that monitoring will continue at the former American Plating site for a few more years.

Samples collected from well MW-10 in 2004 and 2005 had dissolved nickel concentrations ranging from 62 to 29 ug/L which exceeded the groundwater cleanup standard of 8.2 ug/L for this site.

Well MW-10 was also sampled for volatile organics due to its location next to Building 1 which housed a degreasing tank. A variety of volatile organics, including vinyl chloride, have been detected in this well at concentrations near the practical quantitation limit of 1 ug/L.

2. Well MW-5 should be sampled for volatile organics in the future because well MW-10 is no longer suitable for sampling.

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Appendix. Historical Data

Table A-1: Historical Dissolved Metals and Total Cyanide Results (ug/L) from May 1988 to September 1994

Well ID	LR Jones				EPA	LR Jones		PRC
	5/88	8/88	11/88	2/89	2/89	3/89	12/93	9/94
<u>MW-2</u>								
Cadmium	4 U	--	--	--	5 U	--	0.5 U	2 U
Chromium	10 U	--	--	--	10 U	--	10 U	5 U
Copper	20 U	--	--	--	25 U	--	10 U	3 U
Nickel	20 U	--	--	--	17 U	--	10 U	19 P
Total Cyanide	10 U	20	20	20	5 U	10	9	13
<u>MW-3</u>								
Cadmium	4 U	--	--	--	5 U	--	0.2 U	--
Chromium	10 U	--	--	--	10 U	--	10 U	--
Copper	20 U	--	--	--	25 U	--	10 U	--
Nickel	20	--	--	--	17 U	--	10 U	--
Total Cyanide	10 U	10 U	10	10 U	5 U	10	27	--
<u>MW-4</u>								
Cadmium	4 U	--	--	--	5 U	--	0.5 U	10 U
Chromium	10 U	--	--	--	10 U	--	10 U	25 U
Copper	20 U	--	--	--	25 U	--	10 U	15 U
Nickel	20 U	--	--	--	17 U	--	10 U	50 U
Total Cyanide	10 U	30	30	20	5 U	10	9	15
<u>MW-5</u>								
Cadmium	4 U	--	--	--	5 U	--	0.4 U	--
Chromium	10 U	--	--	--	10 U	--	10 U	--
Copper	20 U	--	--	--	41.9	--	10 U	--
Nickel	20 U	--	--	--	17 U	--	28	--
Total Cyanide	10 U	10 U	10	10 U	5 U	10 U	5 U	--
<u>MW-10</u>								
Cadmium	--	--	--	--	--	--	0.5 U	--
Chromium	--	--	--	--	--	--	10 U	--
Copper	--	--	--	--	--	--	10 U	--
Nickel	--	--	--	--	--	--	110	--
Total Cyanide	--	--	--	--	--	40	24	--

-- = not sampled.

Bold = Analyte was detected.

U = Analyte was not detected at, or above, the reported value.

P = Analyte was detected but at a concentration between the instrument detection limit and the quantitation limit.

Table A-2: Dissolved Metals and WAD Cyanide Results (ug/L) from February 2004 to September 2006

Well ID	Cleanup Standards (ug/L)	Ecology					
		2/04	8/04	3/05	8/05	5/06	9/06
<u>MW-2</u>							
Cadmium	9.3	0.2 U	0.2 U	0.2 U	0.2 U	0.02 U	0.022
Chromium	--	8.2	30.2	18	21	49.9	16.1
Copper	3.1	1 U	1 U	1 U	1 U	1 U	0.39
Nickel	8.2	4.3	4.4	3.7	3.1	2.8	3.3
WAD Cyanide	1	10 U	10 U	10 U	5 U	5 U	5 U
<u>MW-3</u>							
Cadmium	9.3	0.2 U	0.2 U	0.48	0.2 U	0.2 U	0.2 U
Chromium	--	12.2*	24*	16	28	30.6	25
Copper	3.1	1.4*	2.7	2.5	3.6	2.5 J	2.8 J
Nickel	8.2	8.6*	5.8	6.6	4.8	3.8	1 U
WAD Cyanide	1	10 U	10 U	10 U	5 U	5 U	5 U
<u>MW-4</u>							
Cadmium	9.3	0.2 U	0.2 U	0.35	0.2 U	0.02 U	0.2 U
Chromium	--	20	54.9	51	76	66.2	35.8 J
Copper	3.1	1 U	2.1	1.3	2.4	1.9 J	1.6 J
Nickel	8.2	4.9	4.9	3.4	3.2	2.2	1 U
WAD Cyanide	1	10 U	10 U	10 U	5 U	5	8
<u>MW-5</u>							
Cadmium	9.3	0.2 U	0.2 U	0.37	0.2 U	0.2 U	0.2 U
Chromium	--	30.9	71	37.7	88	104	40.7
Copper	3.1	1 U	1.5	2.0	2.8	1.4 J	2.4 J
Nickel	8.2	14.8	11.8	9.2	7.9	3.6	1.0
WAD Cyanide	1	10 U	10 U	10 U	5 U	5 U	5 U
<u>MW-10</u>							
Cadmium	9.3	--	0.2 U	0.32	0.026	--	--
Chromium	--	--	25.5	2.5 U	9.1 J	--	--
Copper	3.1	--	1 U	1 U	1 U	--	--
Nickel	8.2	--	62.2	40.3	29	--	--
WAD Cyanide	1	10 U	10 U	10 U	5 U	--	--

-- = not sampled.

Bold = Analyte was detected.

* = Average concentration of duplicate samples.

U = Analyte was not detected at, or above, the reported value.

Shaded values are greater than Model Toxics Control Act (MTCA) Cleanup Levels

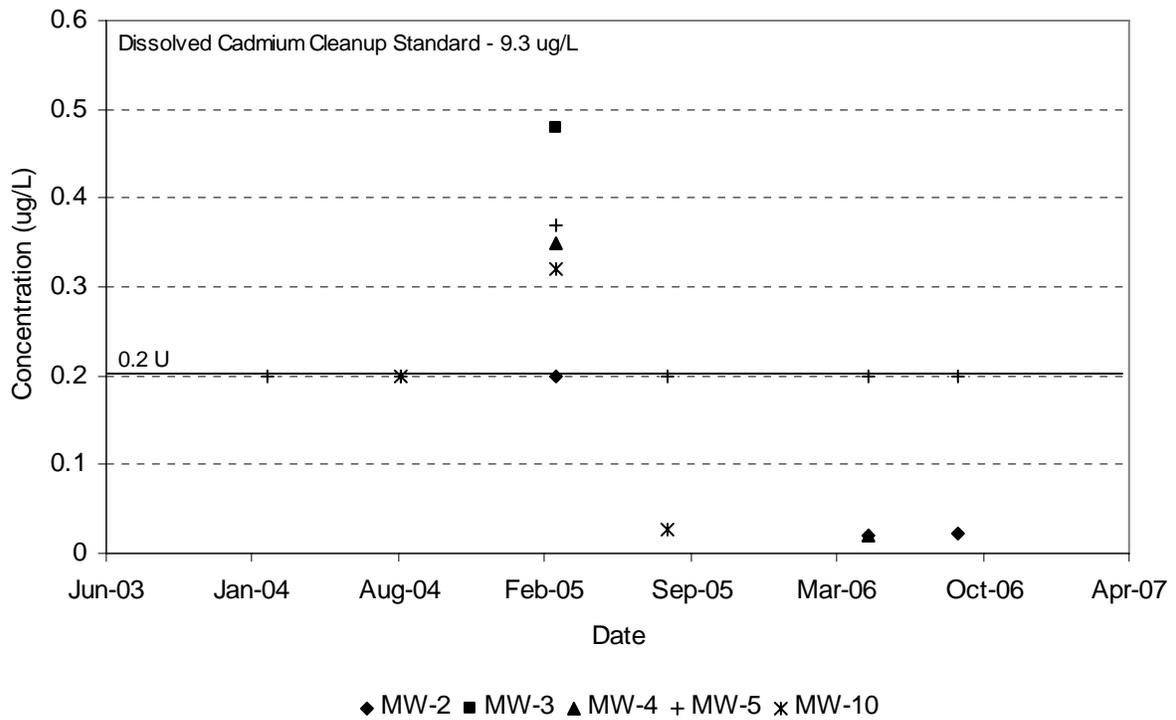


Figure A-1: Dissolved Cadmium Results (ug/L) from February 2004 to September 2006

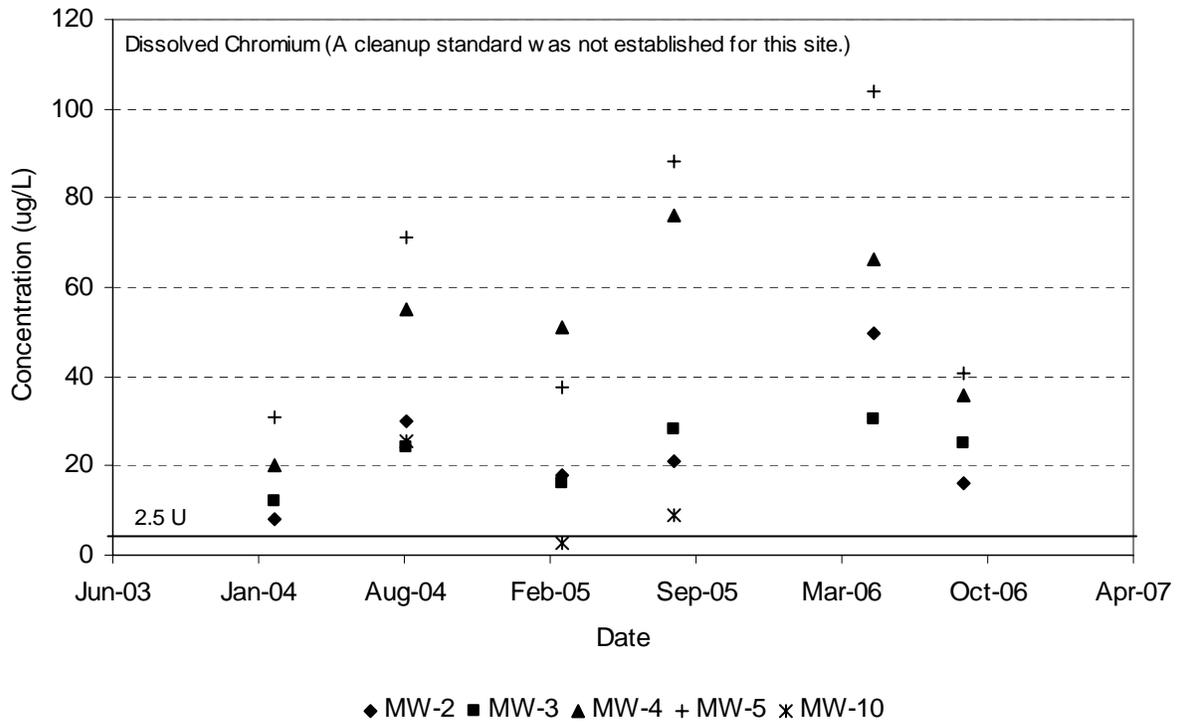


Figure A-2: Dissolved Chromium Results (ug/L) from February 2004 to September 2006

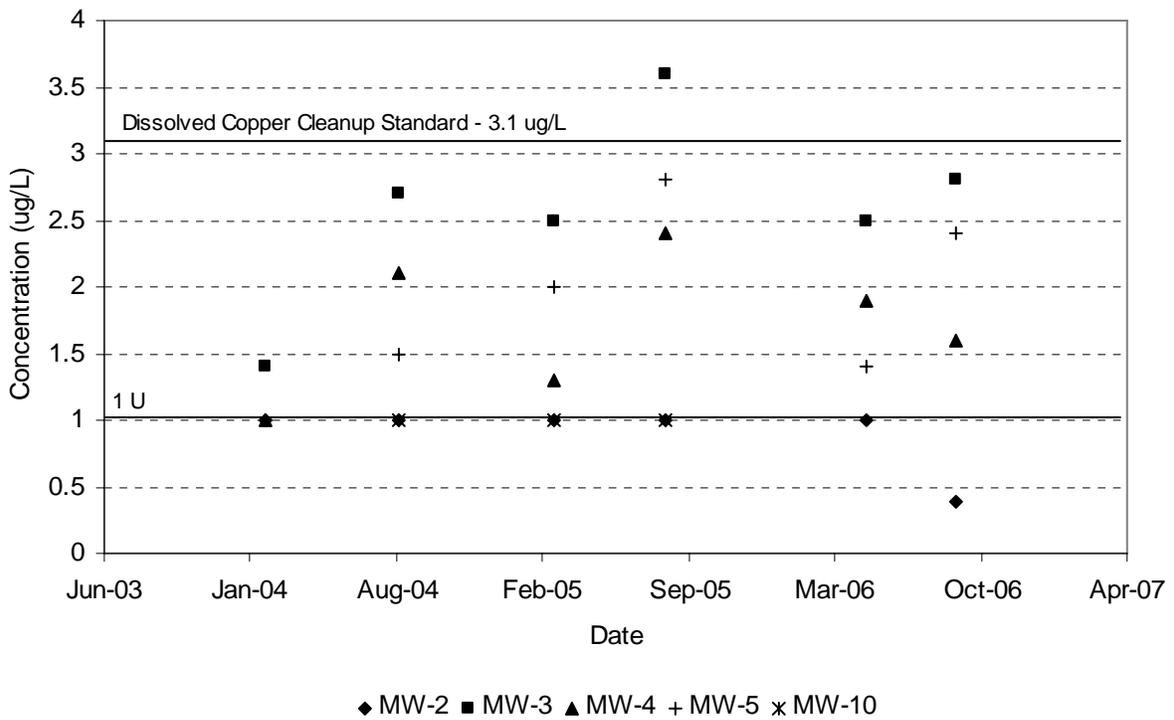


Figure A-3: Dissolved Copper Results (ug/L) from February 2004 to September 2006

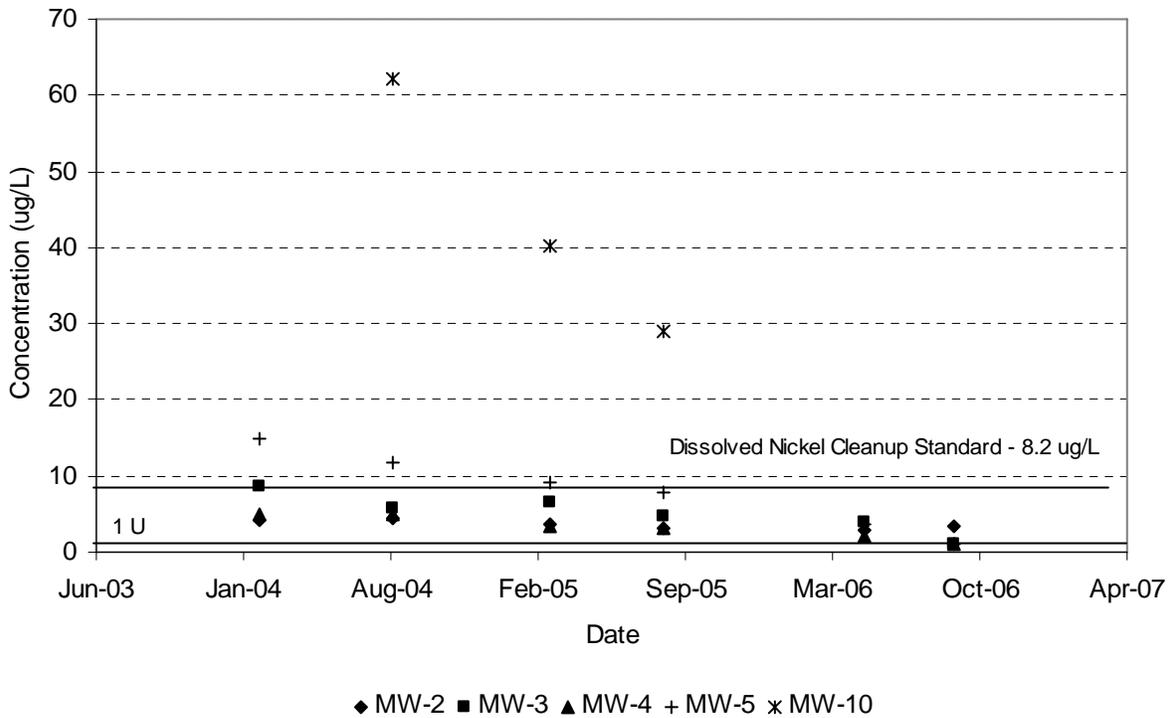


Figure A-4: Dissolved Nickel Results (ug/L) from February 2004 to September 2006

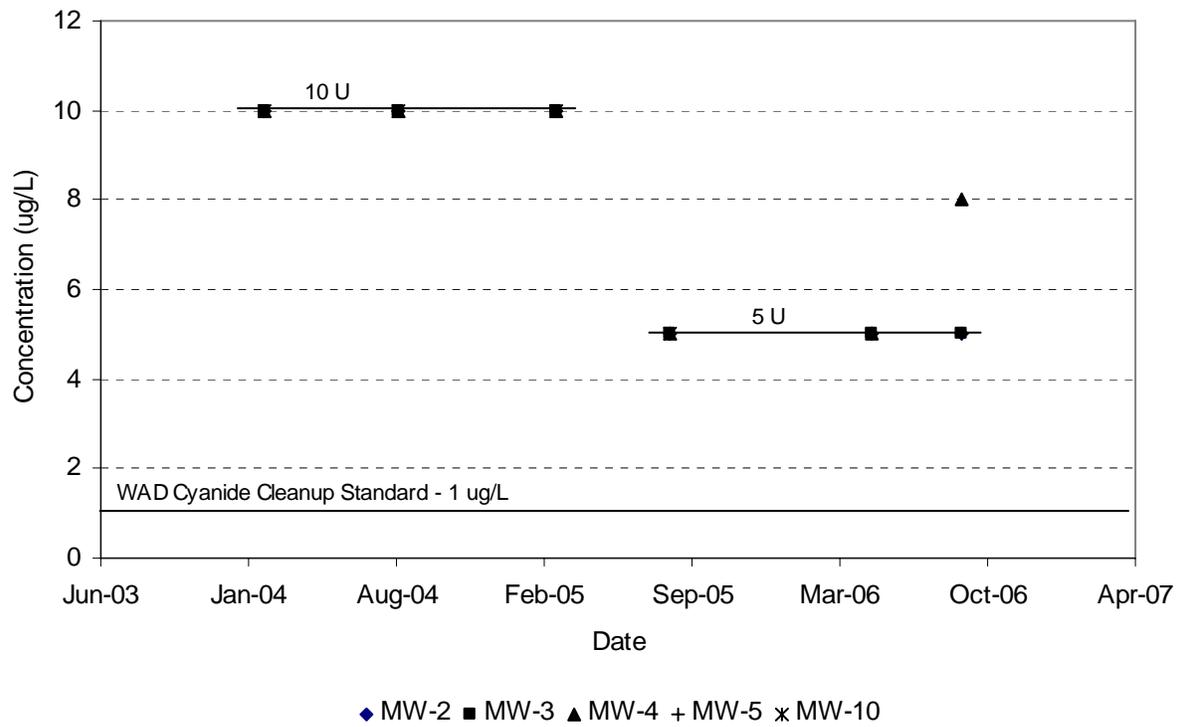


Figure A-5: WAD Cyanide Results (ug/L) from February 2004 to September 2006