



American Plating Post-Interim-Action Groundwater Monitoring Results April and September, 2007

Abstract

This report is one in a series that describes groundwater monitoring results at the former American Plating site located on the Thea Foss Waterway in Tacoma, Washington. During April and September 2007, groundwater samples were collected from four site monitoring wells. The samples provided groundwater data on dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel) and weak acid dissociable (WAD) cyanide. A volatile organic compounds (VOC) sample was also taken from one well.

Results confirmed the presence of dissolved chromium, nickel, cadmium, copper, and WAD cyanide in the groundwater.

- All four wells contained dissolved chromium. April concentrations increased significantly over those seen in the past, ranging from 28 $\mu\text{g/L}$ to a high of 750 $\mu\text{g/L}$. Concentrations in September ranged from 28 to 84 $\mu\text{g/L}$, falling within the historic range of non-detect, 2.5 to 104 $\mu\text{g/L}$. The cause of the April increase is undetermined.
- Dissolved hexavalent chromium was not detected in any of the samples, indicating that the less toxic and less mobile trivalent chromium is present.
- All four wells contained dissolved nickel at concentrations from 1 to 6.7 $\mu\text{g/L}$, below the groundwater cleanup level of 8.2 $\mu\text{g/L}$.
- Cadmium and copper were detected in the sampled wells, but at concentrations below the cleanup levels.
- With the exception of well MW-2, WAD cyanide was detected in all wells at concentrations of 7 to 13 $\mu\text{g/L}$, above the cleanup level of 1 $\mu\text{g/L}$. While detected in well MW-4 since 2006, this is the first occurrence of WAD cyanide in wells MW-3 and MW-5. Total cyanide has been detected in on-site wells in the past.

Well MW-10, sampled since February 2004, was damaged during 2006 and should be decommissioned. Past samples from MW-10 contained elevated dissolved nickel (29 to 62 $\mu\text{g/L}$) and low concentrations of some volatile organics. A replacement well is warranted if monitoring continues.

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Background

American Plating was a metal electroplating company that operated on the Thea Foss Waterway in Tacoma (Figure 1). The company ceased production in 1986 when it was discovered that facility operations potentially violated Washington 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. The site had been occupied by plating companies since 1955. All of 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. Removal of the waste material as well as site cleanup began in June 1987. A series of site investigations, which included the installation of 12 monitoring wells, were conducted from 1988 to 1994. In 1997, the former American Plating site was given a ranking of 2 under the Washington Ranking Method, and the site was placed on Ecology's Hazardous Site List (Hart Crowser, 2001).

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. (SAIC, 2003.) During the 2003 interim action, metals-contaminated concrete rubble from one of the former sump liners was piled on the site. Ecology removed the pile, consisting of 108.4 tons of concrete in June 2007. 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 and cyanide concentrations have been detected throughout the site soils. Cyanide solutions are common components of electroplating processes and were widely used at the site. Elevated metal and cyanide concentrations in the site groundwater are assumed to be associated with leaching from the contaminated soils.

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 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.

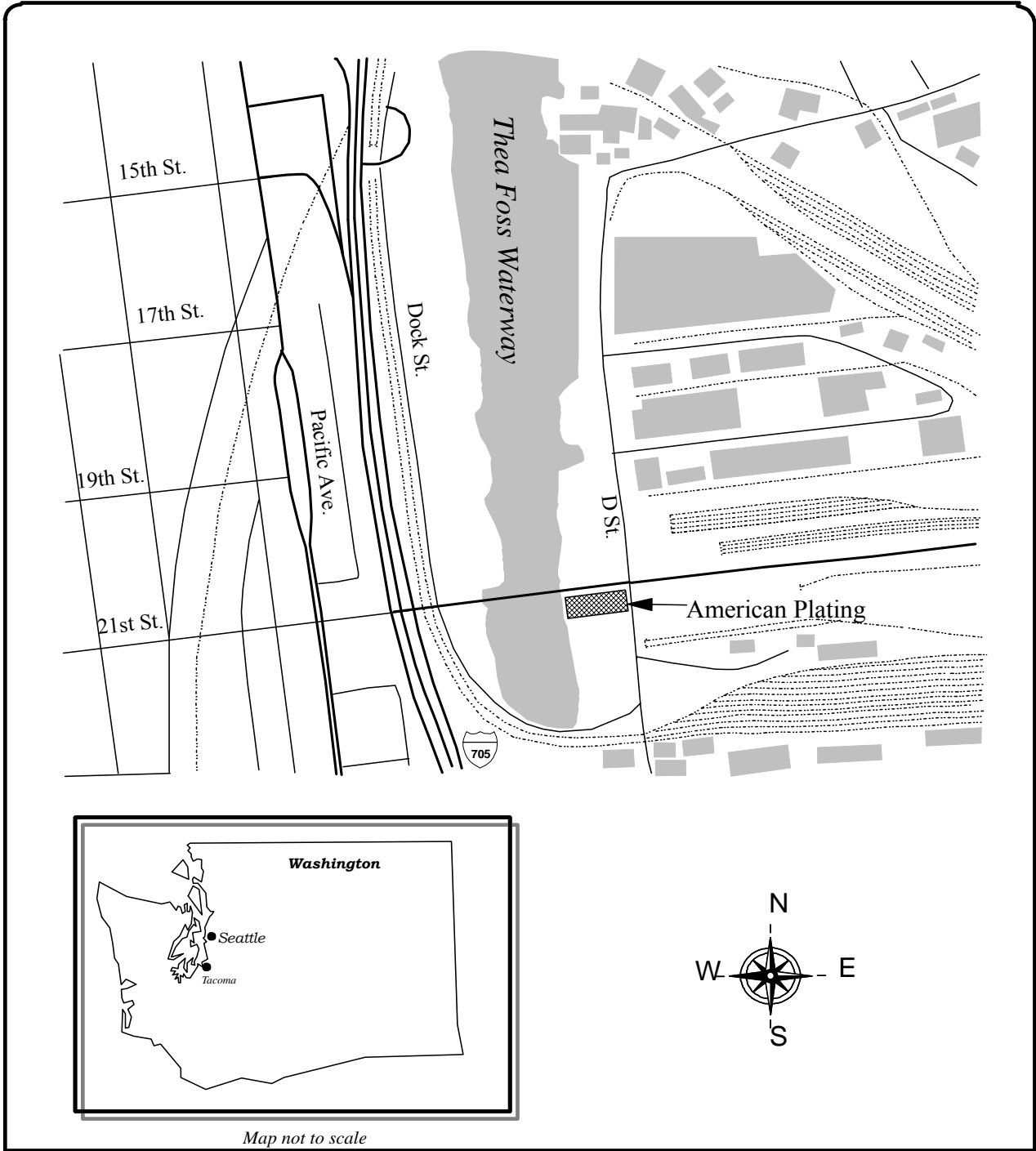


Figure 1. American Plating Site Location.

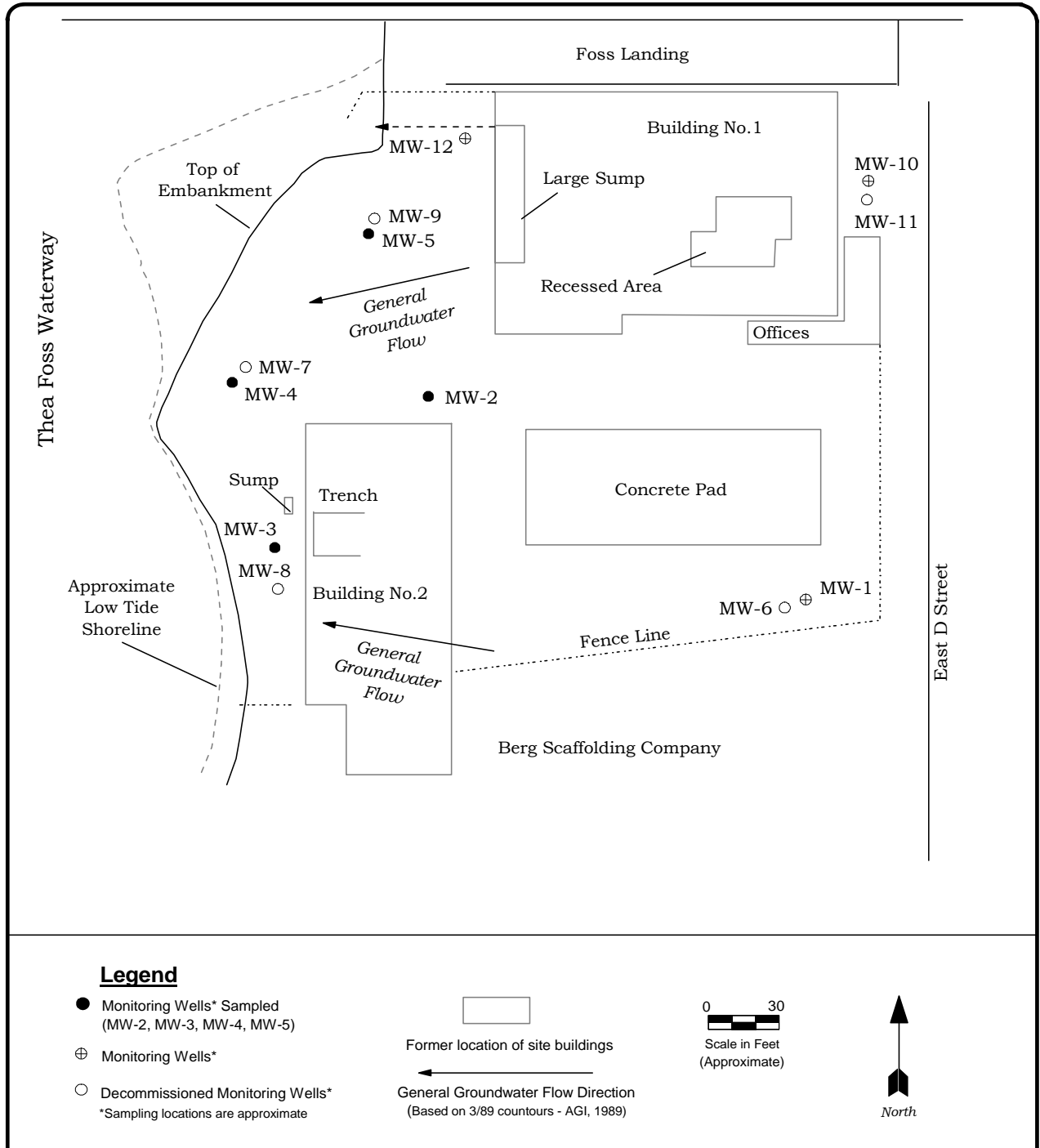


Figure 2. American Plating Sampling Site Locations.

Site geology has been previously described as a series of deposits that include, 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 undifferentiated fill and marsh deposits consist of very soft sandy silts to clayey silts. These silts were generally encountered around 3 to 12 feet below the surface, ranging up to 15 feet thick (SAIC, 1994; PRC, 1995).

The deltaic deposits contain medium-dense, silty sand and silty gravel about 5 feet thick, encountered at a depth of about 18 feet. 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.

Aquifers exist in both the fill/marsh aquifer and the sand aquifer 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 westerly 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

Groundwater Sampling

Groundwater samples were collected from four monitoring wells in April and September 2007. Previous investigations showed no contamination in the lower confined aquifer; therefore, samples taken by Ecology since 2004 have been limited to 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. Samples for volatile organics (VOCs) were collected from well MW-5 as a replacement for well MW-10 (Figure 2).

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

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. Purge water waste transport and disposal procedures followed 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, with a clean, high-capacity 0.45 micron membrane filter, into a 1/2-liter, high-density polyethylene container. The samples were then 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. VOC samples were collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid.

After sample collection and proper labeling, all samples were stored in an ice-filled cooler. In order to meet the analytical method holding time of 24 hours, the hexavalent chromium samples were delivered to the contract laboratory directly following sampling. The remainder of the samples were transported to Ecology's Operation Center in Lacey, where the samples were kept

in the walk-in cooler and transported by courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocols (Ecology, 2005).

Laboratory

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), weak acid dissociable (WAD) cyanide, and VOCs.

Table 1. Field and Laboratory Methods.

Field Measurements	Instrument Type	Method	Accuracy
Water Level	Solinst Water Level Meter	EPA SOP 2043	±0.03 feet
pH	Orion 25A Field Meter	EPA 150.1	±0.1 std. units
Temperature	Orion 25A Field Meter	EPA 150.1	±0.1 °C
Specific Conductance	YSI 3520 Conductivity Cell	EPA 120.1	±10 µmhos/cm
Turbidity	HF Scientific DRT-15C Meter	EPA 180.1	±2 NTU
Laboratory Analytes	Reference	Method	Reporting Limit
Dissolved Metals	EPA 1996	EPA Method 200.8	0.02-1.0 µg/L
Dissolved Hexavalent Chromium	APHA 1998	SM3500-CR-D	5 µg/L
WAD Cyanide	APHA 1998	SM4500CN-I	5 µg/L
VOCs	EPA 1996	EPA SW-846 Method 8260B	1-5 µg/L

Quality control samples collected in the field consisted of blind duplicate samples, which were obtained from well MW-3 during both rounds of sampling. Field duplicates were collected by splitting the pump discharge between two sets of sample bottles, which provides a measure of the overall sampling and analytical precision.

Precision estimates are influenced not only by the random error introduced by collection and measurement procedures, but also by the natural variability of the concentrations in the media being sampled. The numeric comparison of duplicate 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. Table 2 shows the results of the duplicate samples and the RPD for samples collected from well MW-3.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (µg/L) for April and September 2007.

Well Sample ID	Dissolved Chromium		Dissolved Copper		Dissolved Nickel		WAD Cyanide	
	4/07	9/07	4/07	9/07	4/07	9/07	4/07	9/07
MW-3	180	33.2	1.5	2.5	1 U	4.1	7	5 U
MW-3A	170	34.9	1.2	2.3	1 U	4.2	6	5 U
RPD (%)	6%	5%	22%	8%	--	2%	15%	--

The RPDs in April and September ranged from 5% to 15%, with the exception of dissolved copper in April with a RPD of 22%. Because the RPD for copper was slightly above the data quality objectives of 20% for metals (Marti, 2004a), an average concentration of the duplicate sample results will be used in the remainder of this report.

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, with the exception of the September hexavalent chromium samples which were analyzed over the holding time. Because data for these samples did not meet quality control criteria, the data have been rejected and are not included in the dataset. The quality of the rest of the data is acceptable and usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available from the authors upon request.

All field measurements and analytical result data are available in electronic format from Ecology's Environmental Information Management System database: www.ecy.wa.gov/eim/index.htm at study ID, AMERPLAT.

Results

Field Observations

Table 3 displays depth-to-water in each well, measured prior to purging, along with pH, specific conductivity, and turbidity readings measured at the time of sampling, as well as the total purge volume. Because temperature measurements were recorded from water moving through a flow cell influenced by ambient conditions, the values provide a comparative measurement useful to indicate well stabilization, but not true groundwater conditions, and thus are not presented here.

Table 3. Summary of Field Parameter Results for April 18 and September 26, 2007.

Monitoring Well	Total Depth (feet) ¹	Depth-to-Water (feet) ¹ April		Depth-to-Water (feet) ¹ September		pH (standard units)		Specific Conductivity (μmhos/cm)		Turbidity (NTU)		Purge Volume (gallons)	
		Time	4/07	Time	9/07	4/07	9/07	4/07	9/07	4/07	9/07	4/07	9/07
MW-2	16.65	10:11	6.09	09:40	7.29	--	6.6	1,870	3000	5	38	4.5	4.5
MW-3	14.67	10:15	3.41	09:50	4.72	--	6.3	18,750	24,900	2.2	4.5	3	2.5
MW-4	16.89	10:05	6.19	09:45	7.02	--	7.1	6,350	12,100	10	1.3	4	3.5
MW-5	16.84	10:09	6.55	09:35	7.39	--	7.1	21,100	20,700	10	15	3	3.5

¹ Measured from top of PVC casing.

Figure 3 shows the tidal phase when water levels were measured and samples were collected. Both monitoring sessions occurred during low tides. Depth-to-water ranged from 3.41 to 6.55 feet below the measuring points in April, and 4.72 to 7.39 feet below the measuring points in September.

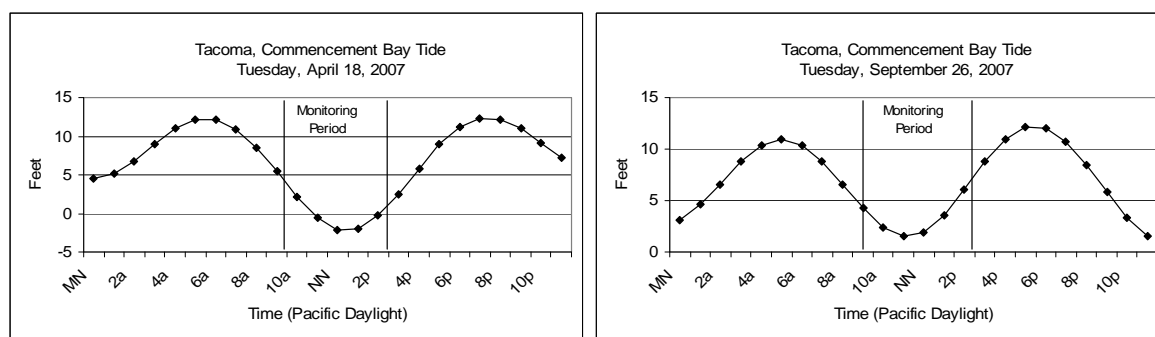


Figure 3. Tide Phase for April 18 and September 26, 2007.

Screened in the soft sandy silt, silt, and clayey silt of the fill/marsh deposits, the four wells sampled are low yielding. While purging at the lowest flow possible, water levels dropped in wells MW-2, MW-4, and MW-5 in April and in all wells in September. In September, the water level dropped below the pump intake in wells MW-4 and MW-5. The pump was shut off during purging to allow the water in these two wells to recover.

During the September monitoring period, the pH of groundwater ranged from 6.3 to 7.1 units. A faulty pH probe prohibited the collection of pH measurements in April. Groundwater temperatures measured in the flow cell in April ranged from 13.6 to 14.6 °C, increasing to 16.3 to 19.6 °C in September. Because the measurements are taken through a flow cell, the higher temperatures in September are partly caused by the influence of warmer ambient air. Specific conductivity measurements ranged from about 1870 to 25,000 µmhos/cm. Specific conductivity values for wells closer to the waterway were higher, consistent with the close proximity to salt water. Specific conductivity of the Thea Foss Waterway has been reported between 15,000 to 35,000 µmhos/cm. (SAIC 1994.) Turbidity measurements ranged from 1.3 to 38 NTUs.

Analytical Results

Analytical results for dissolved metals and weak acid dissociable (WAD) cyanide are summarized in Table 4 and presented in Figure 4. Volatile organics (VOCs) were not detected in either sampling. A summary of historical data for this project is presented in the Appendix.

Table 4. Summary of Analytical Results (µg/L) for April and September 2007.

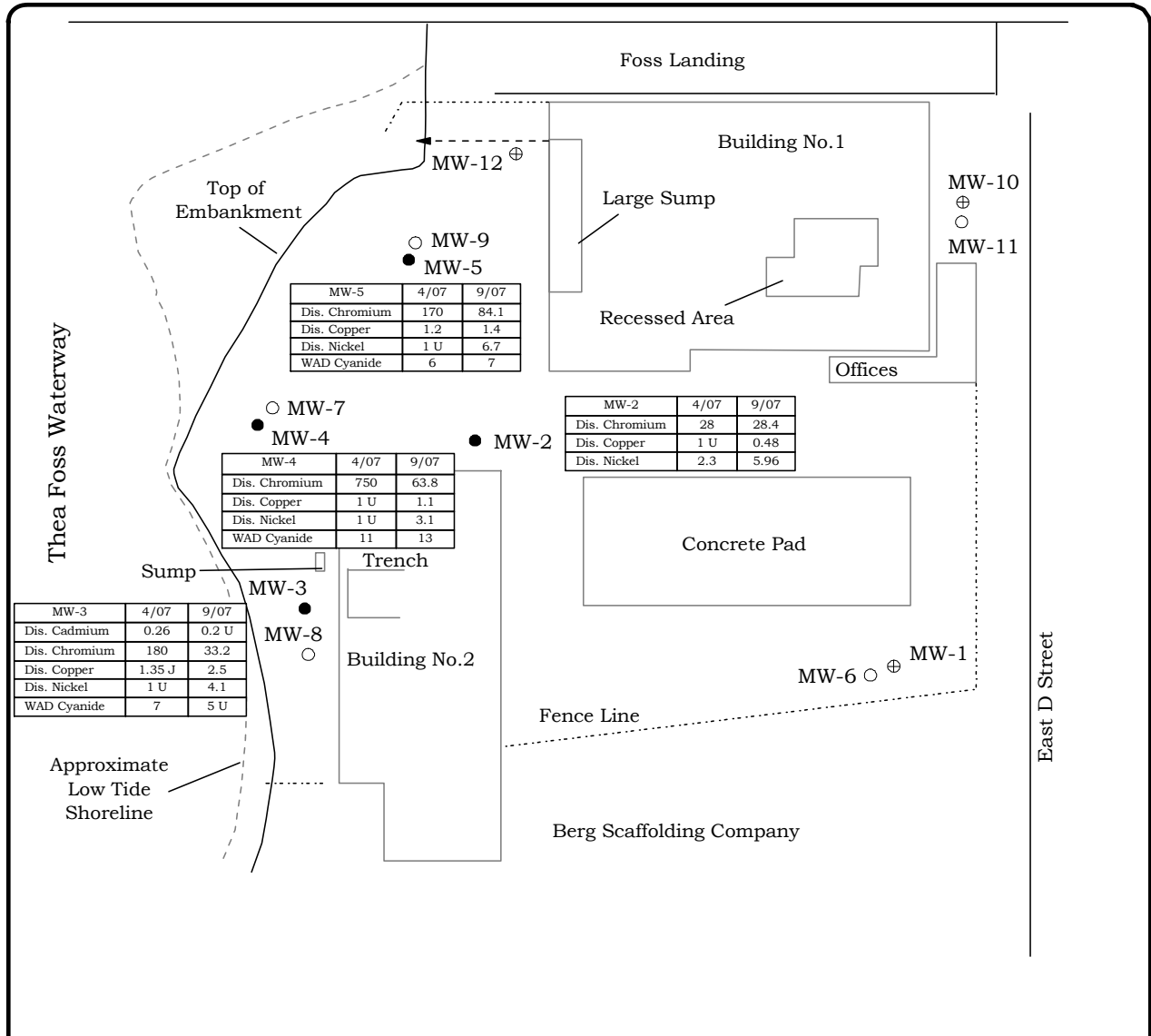
Well	Dissolved Cadmium		Dissolved Chromium		Dissolved Hexavalent Chromium		Dissolved Copper		Dissolved Nickel		WAD Cyanide	
	4/07	9/07	4/07	9/07	4/07	9/07	4/07	9/07	4/07	9/07	4/07	9/07
MW-2	0.2 U	0.02 U	28	28.4	5 U	REJ	1 U	0.48	2.3	5.96	5 U	5 U
MW-3	0.26	0.2 U	180	33.2	5 U	REJ	1.35J*	2.5	1 U	4.1	7	5 U
MW-4	0.2 U	0.2 U	750	63.8	5 U	REJ	1 U	1.1	1 U	3.1	11	13
MW-5	0.2 U	0.2 U	170	84.1	5 U	REJ	1.2	1.4	1 U	6.7	6	7

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

* Average concentration of duplicate samples. Results are J qualified as estimate.

REJ - Results have been rejected because the samples were analyzed past the holding time and the data did not meet quality control criteria..

Bold – Analyte was detected.



Legend

- Monitoring Wells* Sampled (MW-2, MW-3, MW-4, MW-5)
 - ⊕ Monitoring Wells*
 - Decommissioned Monitoring Wells*
- *Sample locations are approximate

Concentrations (ug/L)

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

Former location of Site Buildings

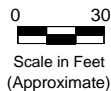


Figure 4. American Plating Summary of Analytical Results (ug/L).

Dissolved chromium was detected in all the sampled wells. In April, chromium concentrations ranged from 28 to 750 µg/L. In September, concentrations decreased, ranging from 28.4 to 84.1 µg/L. The reason for the increase in chromium concentrations in April could not be determined from the available data. Dissolved hexavalent chromium was not detected in April.

Dissolved nickel was detected in well MW-2 in April at a concentration of 2.3 µg/L, and in all four of the wells in September at concentrations from 3.1 to 6.7 µg/L.

Dissolved copper was detected in well MW-3 at an estimated concentration of 1.35 µg/L and MW-5 at 1.2 µg/L in April, and in all four wells at concentrations ranging from 0.48 to 2.5 µg/L in September.

WAD cyanide was detected in well MW-3 at 7 µg/L in April, and wells MW-4 and MW-5 in April and September, at average concentrations of 12 and 6.5, respectively. While WAD cyanide has been detected in well MW-4 since 2006, this is the first occurrence in wells MW-3 and MW-5. Total cyanide has been detected in wells MW-2, MW-3 and MW-4 in the past as shown in the Appendix.

Well MW-5 was also sampled for VOCs as a substitute for well MW-10. Well MW-10 had been sampled for VOCs due to its location next to Building 1 which housed a degreasing tank. A variety of VOCs, including vinyl chloride, have been detected in well MW-10 at concentrations near the practical quantitation limit of 1 µg/L. March 2005 water levels indicate that well MW-5, is the nearest down-gradient well to MW-10; however, VOCs were not detected in this well in either April or September 2007.

Discussion

Dissolved cadmium, chromium, copper, and nickel were detected in groundwater at the former American Plating site in April and September 2007. Table 5 shows a comparison of the 2007 results to numerical cleanup levels 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 cleanup level for cyanide (1 µg/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 graphs in the Appendix.

Table 5. Comparison of 2007 Groundwater Results (µg/L) to Surface-Water Based Cleanup Levels.

Parameter	American Plating Cleanup Levels (µg/L)	Monitoring Wells			
		MW-2	MW-3	MW-4	MW-5
<i>Dissolved Metals</i>					
Cadmium	9.3	0.02 U-0.2 U	0.2 U-0.26	0.2 U	0.2 U
Chromium	--	28-28.4	33.2-180	63.8-750	84.1-170
Copper	3.1	1 U-0.48	1.5-2.5	1 U-1.1	1.2-1.4
Nickel	8.2	2.3-5.96	1 U-4.1	1 U-3.1	1 U-6.7
Cyanide	1 (WAD)	5 U	5 U-7	11-13	6-7

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 began sampling in February 2004, in well MW-4 at concentrations of 5 and 8 µg/L during the 2006 sample events. In 2007 WAD cyanide was detected in well MW-4, as well as in MW-3 and MW-5, at concentrations ranging from 6 to 13 µg/L. WAD cyanide has not been detected in well MW-2; however, the available reporting limit of 5 µg/L exceeds the cleanup level of 1 µg/L 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 µg/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 has not been detected in any of the samples since August 2005. Therefore, it is assumed that the less toxic and less mobile trivalent chromium is present.

Previously, chromium concentrations at the site have ranged from undetected at 2.5 to 104 µg/L. While chromium concentrations in well MW-2 remained consistent, the April 2007 concentrations in wells MW-3, MW-4, and MW-5 increased to 180, 750, and 170 µg/L, respectively.

While the cause of this increase is unknown, a July 2003 composite sample of the concrete from the remaining rubble pile had a toxic characteristic leaching procedure (TCLP) chromium concentration of 37.3 mg/L. The rubble pile was removed in June 2007. Samples of the underlying soils collected in July 2007 had chromium concentrations of 870 to 1400 mg/Kg. TCLP performed on the soil samples showed chromium concentrations ranging from 0.068 to 0.258 mg/L. In September 2007, chromium concentrations in the groundwater samples returned to the previous range, with concentrations of 28.4 to 84.1 µg/L.

Dissolved nickel concentrations, which have exceeded the cleanup criterion of 8.2 µg/L in wells MW-5 and MW-10 in 2004 and 2005, were below the cleanup criterion in samples collected in 2006 and 2007. However, well MW-10, which had the highest nickel concentrations, has not been available for sampling since August 2005.

Recommendations

1. Well MW-10, which has been part of the monitoring program since February 2004, was damaged in 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.

Samples collected from well MW-10 in 2004 and 2005 had dissolved nickel concentrations ranging from 62 to 29 µg/L, which exceeded the groundwater cleanup level of 8.2 µg/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 µg/L.

2. Well MW-5, which is the nearest downgradient well, should be sampled for volatile organics for an additional year since well MW-10 is no longer suitable for sampling.
3. To prevent additional damage to the wells, bollards or some other protective barrier should be installed at existing and future non-flush mounted wells located near planned construction activities.

References

APHA, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, Washington, D.C.

Ecology, 2005. Manchester Environmental Laboratory - Lab Users Manual. 8th Edition. Washington State Department of Ecology, Manchester, WA.

Ecology, 2006. Standard Operating Procedures Field Manual For Groundwater Assessment Program Studies. Draft. Washington State Department of Ecology, Olympia, WA.

EPA, 1979. EPA-600/4-79-020 Methods for Chemical Analysis of Water and Wastes.

EPA, 1993. Method 180.1, Determination of Turbidity By Nephelometry. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1996. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington D.C.

EPA, 2000. Standard Operating Procedure 2043 - Manual Water Level Measurements. U.S. Environmental Protection Agency, Environmental Response Team.

EPA, 2000. EPA 821/R-99-013 Method OIA-1677: Available Cyanide by Flow Injection and Ligand Exchange and Amperometry. U.S. Environmental Protection Agency. NTIS/PB99-132011 or www.epa.gov/ost/methods/. January 2000.

EPA, 2001. Method 150.1, Determination of pH. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

EPA, 2001. Method 120.1, Determination of Conductivity. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

Hart Crowser, 2001. Summary of Data and Potential Cleanup Actions, American Plating Site, Tacoma, Washington. February 13, 2001.

Marti, Pamela, 2004a. Quality Assurance Project Plan: American Plating Post-Interim Action Monitoring. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-105. www.ecy.wa.gov/biblio/0403105.html.

Marti, Pamela, 2004b. American Plating Post-Interim-Action Monitoring Results, February and August, 2004. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-052. www.ecy.wa.gov/biblio/0403052.html.

Marti, Pamela, 2006. American Plating Post-Interim-Action Groundwater Monitoring Results, March and August, 2005. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-005. www.ecy.wa.gov/biblio/0603005.html.

Marti, Pamela, 2007. American Plating Post-Interim-Action Groundwater Monitoring Results, May and September, 2006. Washington State Department of Ecology, Olympia, WA. Publication No. 07-03-005. www.ecy.wa.gov/biblio/0703005.html.

PRC, 1995. Final Report for Resource Conservation and Recovery Act Comprehensive Groundwater Monitoring Evaluation, American Plating Company, Inc. (Lewis R. Jones), Tacoma, Washington. PRC Environmental Management, Inc.

SAIC, 1994. Final RCRA Facility Assessment Preliminary Assessment Report, American Plating, Inc., Tacoma, Washington. Science Applications International Corporation. WAD 08335 0231.

SAIC, 2003. Final Interim Action Plan, American Plating Site, Tacoma, Washington. Science Applications International Corporation.

Appendix. Historical Data

Table A-1. Historical Dissolved Metals and Total Cyanide Results ($\mu\text{g/L}$) from April 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.

EPA = Environmental Protection Agency.

PRC = PRC Environmental Management.

Table A-2. Dissolved Metals and WAD Cyanide Results (µg/L) from February 2004 to September 2007.

Well ID	Ecology							
	Feb-04	Aug-04	Mar-05	Aug-05	May-06	Sep-06	Apr-07	Sep-07
MW-2								
Cadmium	0.2 U	0.2 U	0.2 U	0.2 U	0.02 U	0.022	0.2 U	0.02 U
Chromium	8.2	30.2	18	21	49.9	16.1	28	28.4
Copper	1 U	1 U	1 U	1 U	1 U	0.39	1 U	0.48
Nickel	4.3	4.4	3.7	3.1	2.8	3.3	2.3	5.96
WAD Cyanide	10 U	10 U	10 U	5 U	5 U	5 U	5 U	5 U
MW-3								
Cadmium	0.2 U	0.2 U	0.48	0.2 U	0.2 U	0.2 U	0.26	0.2 U
Chromium	12.2*	24*	16	28	30.6	25	180	33.2
Copper	1.4*	2.7	2.5	3.6	2.5 J	2.8 J	1.35 J*	2.5
Nickel	8.6*	5.8	6.6	4.8	3.8	1 U	1 U	4.1
WAD Cyanide	10 U	10 U	10 U	5 U	5 U	5 U	7	5 U
MW-4								
Cadmium	0.2 U	0.2 U	0.35	0.2 U	0.02 U	0.2 U	0.2 U	0.2 U
Chromium	20	54.9	51	76	66.2	35.8 J	750	63.8
Copper	1 U	2.1	1.3	2.4	1.9 J	1.6 J	1 U	1.1
Nickel	4.9	4.9	3.4	3.2	2.2	1 U	1 U	3.1
WAD Cyanide	10 U	10 U	10 U	5 U	5	8	11	13
MW-5								
Cadmium	0.2 U	0.2 U	0.37	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	30.9	71	37.7	88	104	40.7	170	84.1
Copper	1 U	1.5	2	2.8	1.4 J	2.4 J	1.2	1.4
Nickel	14.8	11.8	9.2	7.9	3.6	1	1 U	6.7
WAD Cyanide	10 U	10 U	10 U	5 U	5 U	5 U	6	7
MW-10								
Cadmium	--	0.2 U	0.32	0.026	--	--	--	--
Chromium	--	25.5	2.5 U	9.1 J	--	--	--	--
Copper	--	1 U	1 U	1 U	--	--	--	--
Nickel	--	62.2	40.3	29	--	--	--	--
WAD Cyanide	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

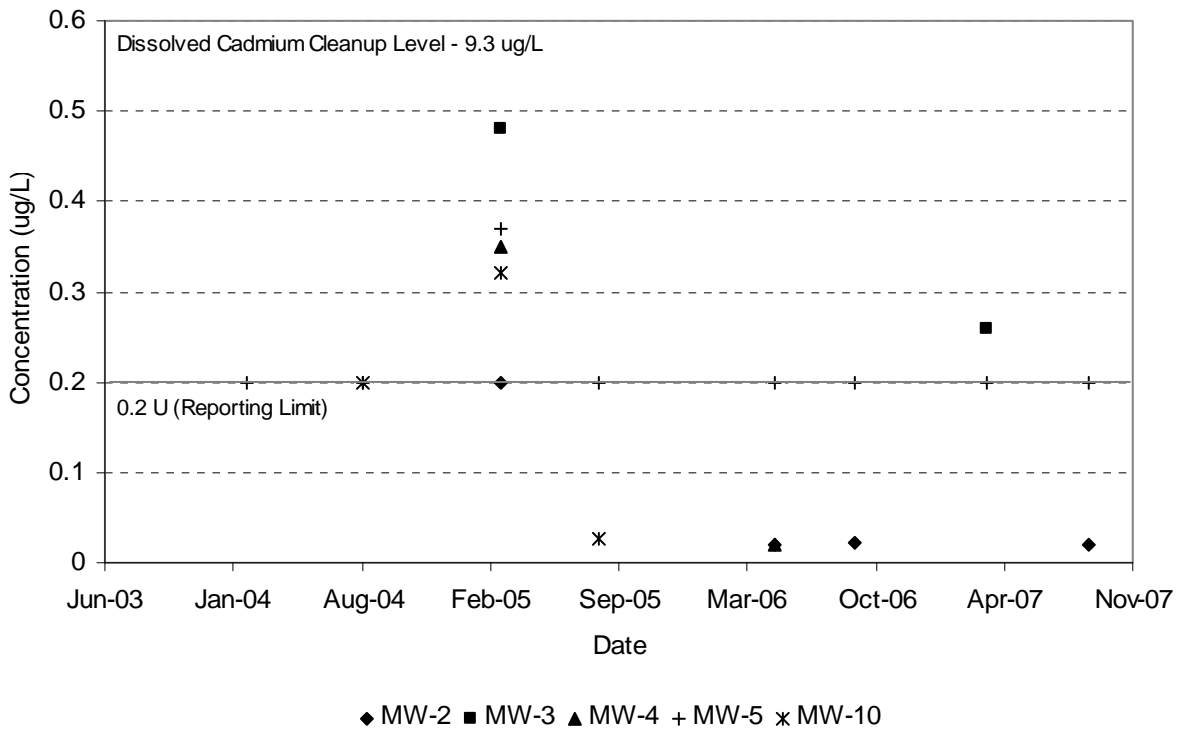


Figure A-1. Dissolved Cadmium Results (µg/L) from February 2004 to September 2007.

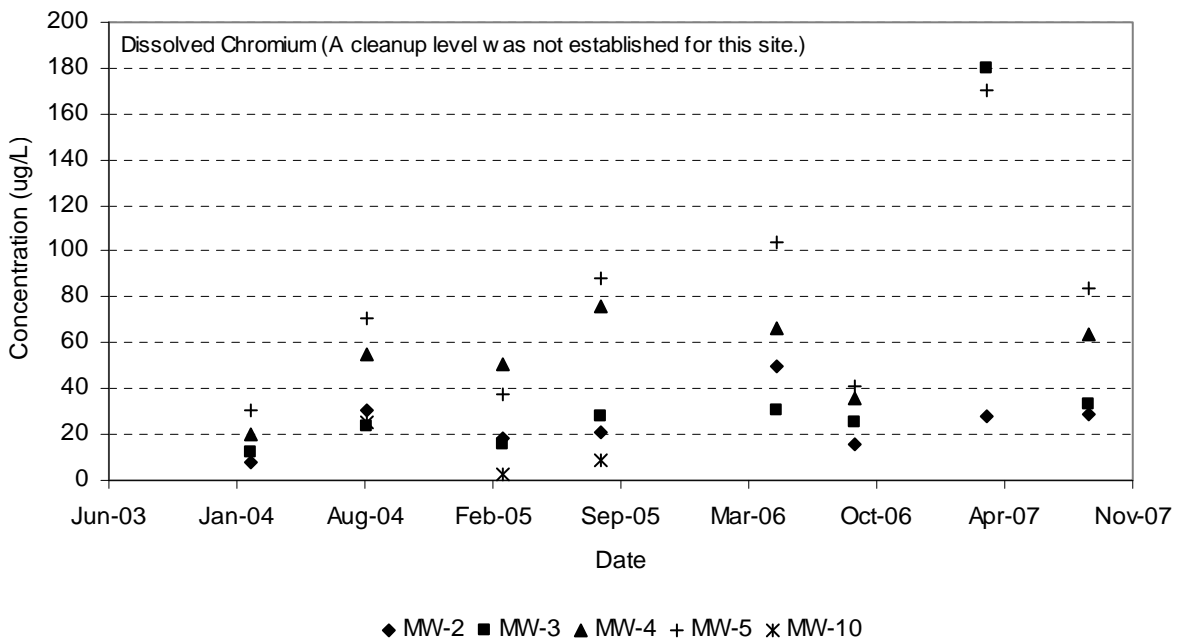


Figure A-2. Dissolved Chromium Results (µg/L) from February 2004 to September 2007.
 *April 2007, MW-4 value of 750 µg/L is not plotted.

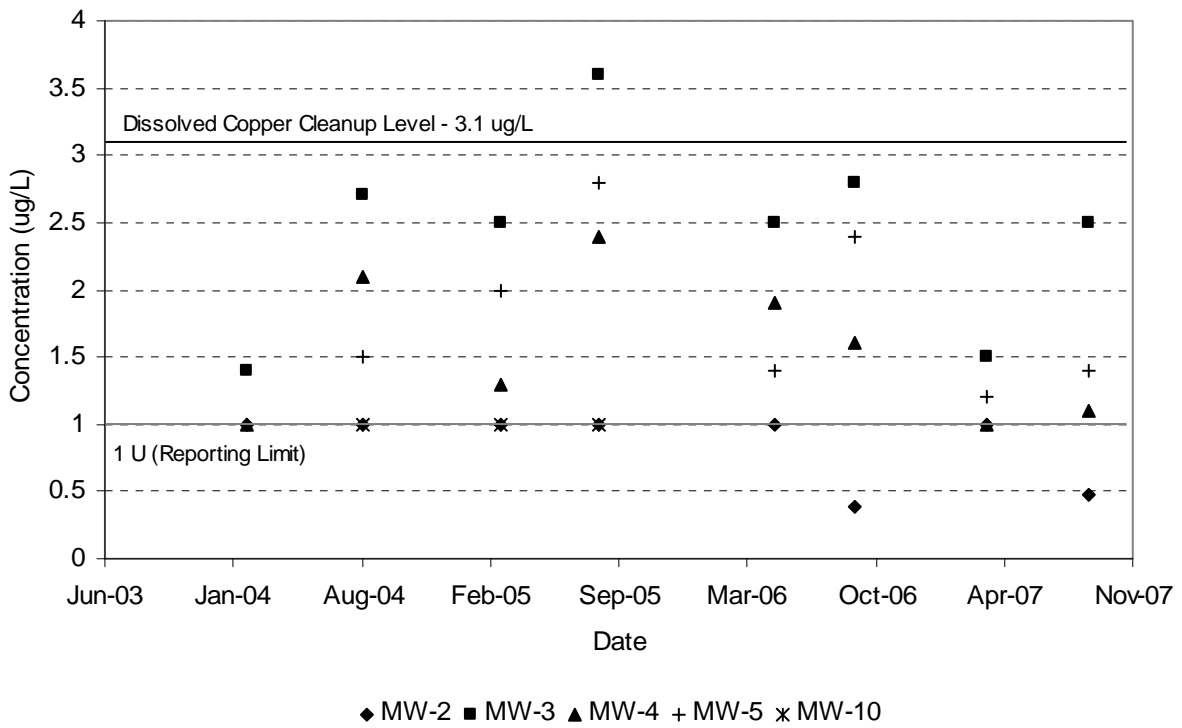


Figure A-3. Dissolved Copper Results ($\mu\text{g/L}$) from February 2004 to September 2007.

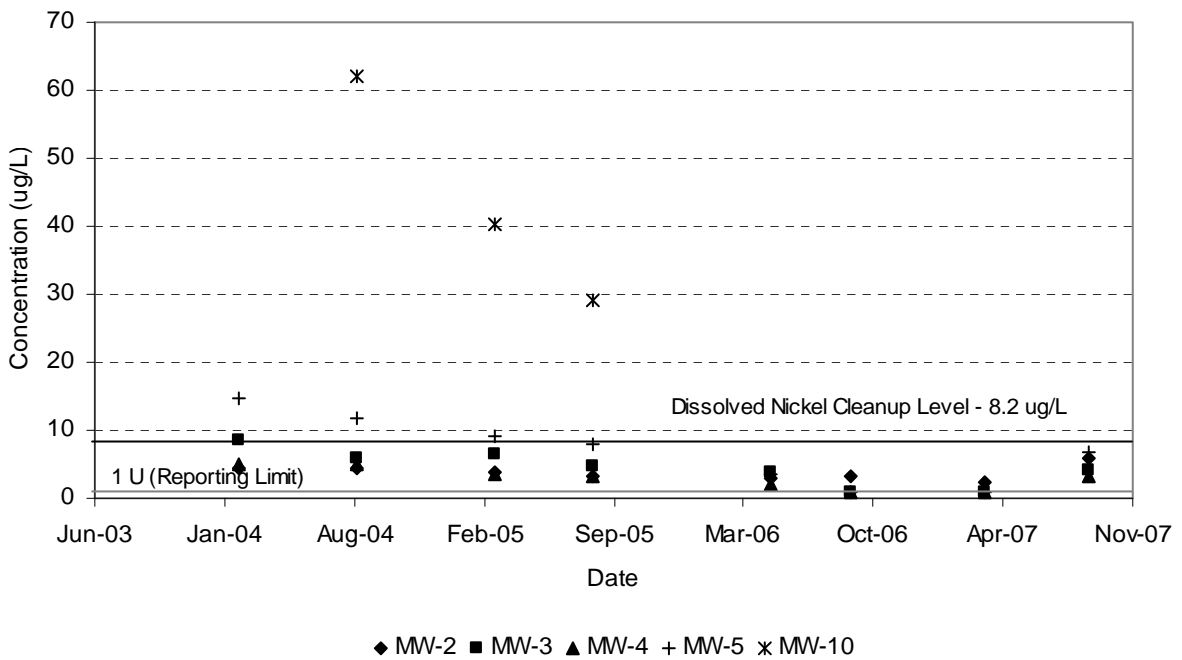


Figure A-4. Dissolved Nickel Results ($\mu\text{g/L}$) from February 2004 to September 2007.

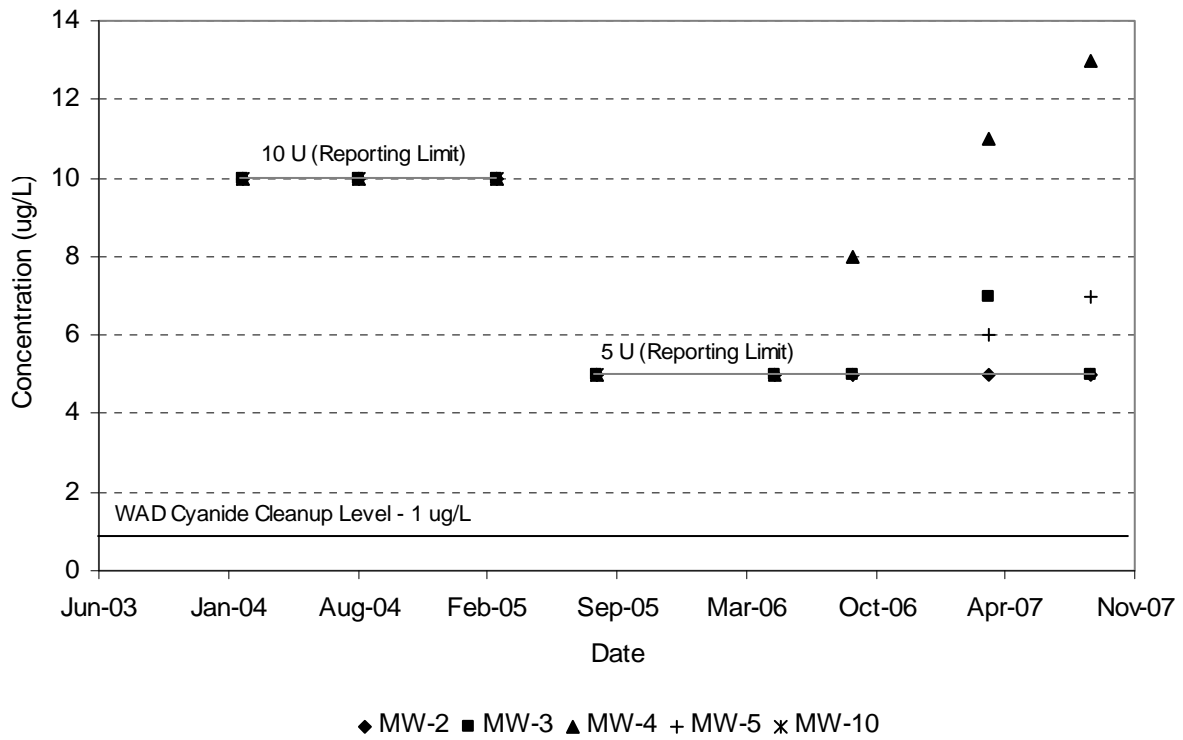


Figure A-5. WAD Cyanide Results ($\mu\text{g/L}$) from February 2004 to September 2007.