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Post-Interim-Action
Groundwater Monitoring Results**

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Post-Interim-Action
Groundwater Monitoring Results**

May and September, 2008

*by
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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 May and September 2008, 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 collected from one well in May.

Dissolved cadmium, chromium, copper, and nickel, as well as WAD cyanide, continue to be detected in groundwater samples collected at the site. No VOC were detected.

Due to the proximity of the site to the waterway, the groundwater cleanup levels 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. The point of compliance for the groundwater cleanup levels is along the banks of the waterway where groundwater discharges to the surface water.

In 2008 most concentrations detected in the groundwater samples were below the cleanup levels, with the exception of nickel (8.9 and 13.3 µg/L) and WAD cyanide (3 J¹ and 6 µg/L). However, it is assumed that a further reduction in these measured concentrations may occur due to natural processes such as sorption and tidal dispersion as groundwater flows toward the point of compliance.

The Foss Waterway Development Authority plans to eventually develop this area as a public park.

¹ J = Analytical result is an estimate.

Introduction

Background

The American Plating Company operated a metal electroplating facility adjacent to the Thea Foss Waterway in Tacoma, Washington (Figure 1) beginning in 1976. The site had been occupied by plating companies since 1955. American Plating ceased production at the site in 1986 due to violations of Washington State's dangerous waste regulations².

In 1986 a preliminary site assessment by the U.S. Environmental Protection Agency (EPA) concluded that high concentrations of plating waste and contaminated materials were present throughout the site. Based on these and previous findings by the Washington State Department of Ecology (Ecology), formal removal of waste materials and site cleanup activities began in June 1987. Additional soil and groundwater investigations were conducted between 1988 and 1994. In 1997, the site was ranked on Ecology's Hazardous Site List as a "2" (1 being high priority relative to other statewide sites; 5 being low).

In 2003 Ecology initiated an interim action cleanup (IAC) of the site. This was done to reduce the potential human health risk from contact with contaminated soils and to reduce the potential ecological risk to aquatic organisms in the waterway from the discharge of contaminated groundwater. Contaminants of concern at the site included cadmium, chromium, copper, nickel, cyanide, and volatile organic compounds (VOCs). The cleanup included the removal of site buildings, a concrete pad, sumps, an underground storage tank, and soils designated as dangerous waste (Figure 2). Clean fill and top soil were added to excavated areas (SAIC, 2003).

Remediation of any remaining contaminated site soils will be performed under a final cleanup action plan when the Foss Waterway Development Authority develops the site as a public park.

Ecology is currently monitoring the site groundwater until the final cleanup action has been developed. Data provided from this monitoring will help determine the final cleanup remedy.

² The Department of Ecology conducted several site inspections between 1980 and 1985. These inspections showed that discharges, leaks, and spills of brass, cadmium, chromium, copper, nickel, and zinc plating materials had occurred at the site during operations by American Plating and prior site operators.

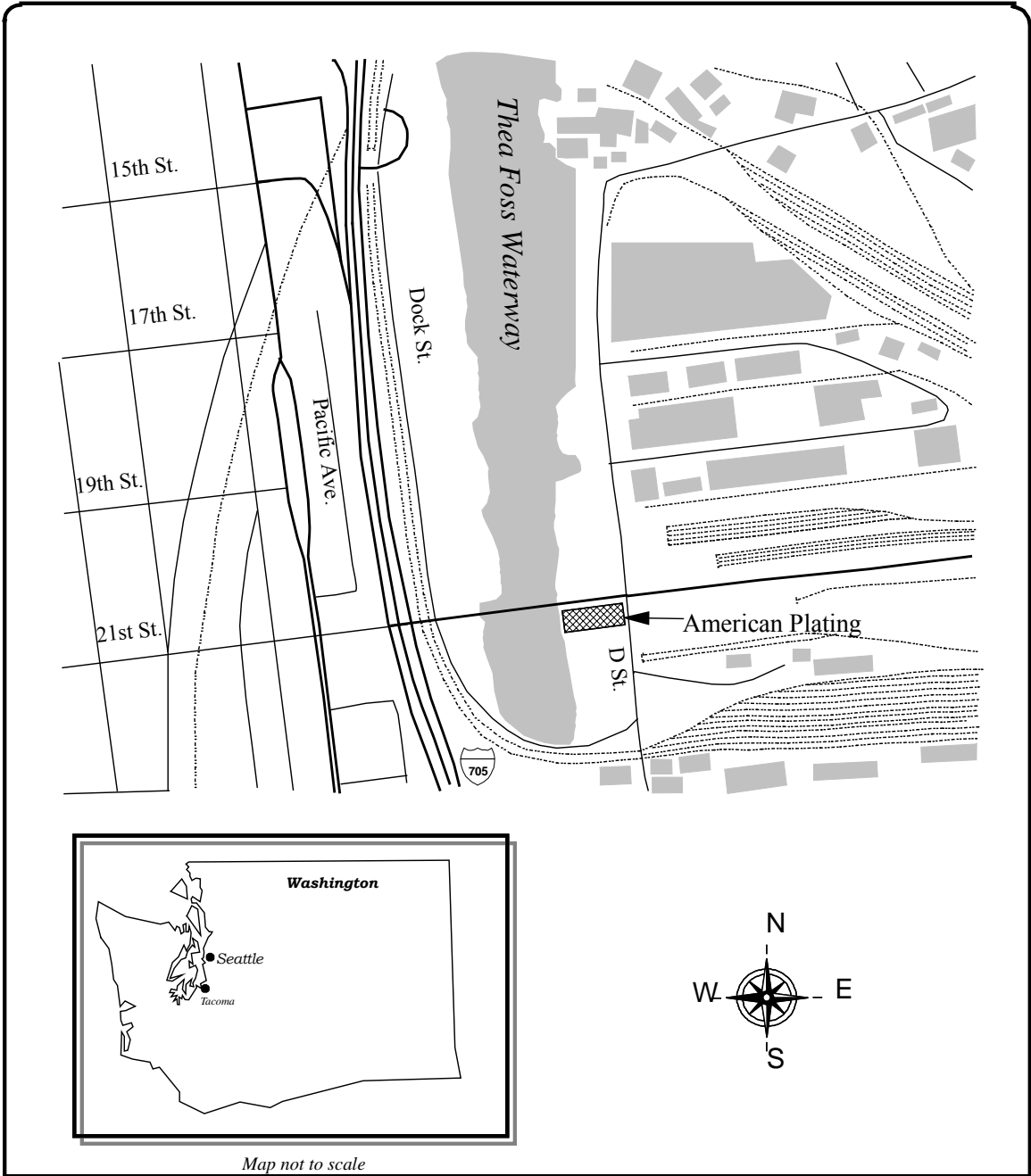


Figure 1. American Plating Site Location.

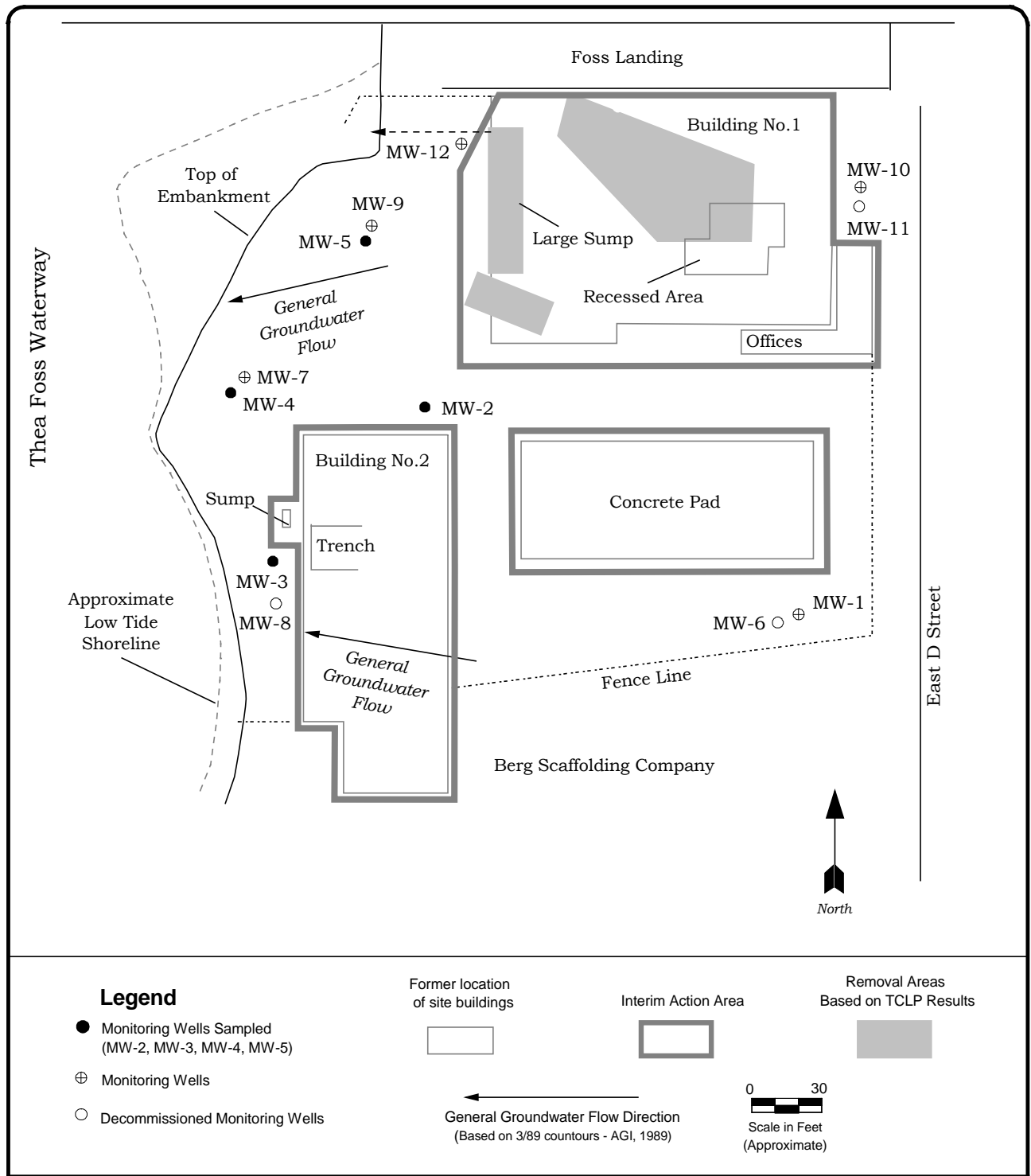


Figure 2. American Plating Sampling Site Locations.

Hydrogeology

The site geology was described during initial site characterization efforts and includes, from the surface down: fill materials, undifferentiated fill and marsh deposits, deltaic deposits, and glacial till.

Prior to site excavation, 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, and ranged 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.

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 unconfined fill/marsh deposits and the deltaic deposits which contain a semi-confined sand aquifer. The two aquifers are interconnected and tidally influenced. The relationship between the two aquifers and the waterway is complex. Variations in groundwater elevations reflect tidal phases in both aquifers. High salinity has been measured in much of the site groundwater (SAIC, 2003). Vertical flow components between the two aquifers are difficult to establish because of the complicated stratigraphy and tidal influence at the site.

The unconfined water table in the fill/marsh aquifer ranges from approximately 5 to 9 feet below ground surface. 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 samples were collected from four monitoring wells in May and September 2008. Previous investigations showed no contamination in the lower semi-confined aquifer; therefore, samples taken by Ecology since 2004 have been limited to wells screened in the upper unconfined aquifer. The goal of the sampling is to determine post-interim-action groundwater concentrations of dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel) and WAD cyanide. Samples for volatile organics (VOCs) also were collected from well MW-5 in May (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 well and purged at a rate of 0.5-liter/minute or less. Wells were purged through a continuous flow cell until pH, temperature, and specific conductance 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 directly from the discharge tubing into laboratory-supplied containers. The pump was decontaminated between wells 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 collection and proper labeling, 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 remaining samples were transported to Ecology's Operation Center in Lacey, where they were kept in the walk-in cooler until transported by courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed (Ecology, 2008).

Results

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), WAD cyanide, and VOCs.

Table 1. Field and Laboratory Methods.

Field Measurements	Instrument Type	Method*	Accuracy
Water Level	Solinst Water Level Meter	SOP EAP052	±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	EPA 1994/APHA 1992	EPA Method 200.7/ SM 3500-Cr D	5 µg/L
WAD Cyanide	APHA 1998	SM 4500CN-I	5 µg/L
VOCs	EPA 1996	EPA SW-846 Method 8260B	1-5 µg/L

*See reference.

Data Quality Assessment

The May 2008 hexavalent chromium samples were inadvertently analyzed using EPA methods 218.5 and 200.7 revision 4.4. Method 218.5 is not on the approved list for inorganic test procedures under the Federal Register for NPDES and Clean Water Act samples. Some of the May samples were also analyzed after the 24-hour holding time. For these reasons the May hexavalent chromium data is being “J” qualified as estimated. Since hexavalent chromium was reported in the May samples, alternative analytical methods will be investigated for future sample analysis. All previous hexavalent chromium samples and the September 2008 samples were analyzed using method SM 3500-Cr D.

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 ($\mu\text{g/L}$) for May and September 2008.

Well Sample ID	Dissolved Cadmium		Dissolved Chromium		Dissolved Hexavalent Chromium		Dissolved Copper		Dissolved Nickel		WAD Cyanide	
	5/08	9/08	5/08	9/08	5/07	9/08	5/07	9/08	5/07	9/08	5/08	9/08
MW-3	0.2 U	0.2 U	7.6	9.6 J	3.2 J	5 U	2.1	2.9	6.0	2.3	10	5 U
MW-3A	0.2 U	0.2 U	7.2	2.5 UJ	1.1 J	5 U	2.0	2.9	5.7	2.9	170	5 U
RPD (%)	--	--	5%	--	--	--	5%	0%	5%	23%	178%	--

MW-3A is the duplicate sample identification.

The RPDs in May and September ranged from 5% to 23%, with the exception of WAD cyanide in May with a RPD of 178%. The May RPD for the WAD cyanide data was significantly higher than the data quality objectives: therefore these data have been rejected and not included in the dataset. The September RPD for nickel slightly exceeds the data quality objective of 20% for metals (Marti, 2004a); therefore, the nickel data for this sample date have been “J” qualified as estimated.

A review of the data quality control and quality assurance from laboratory case narratives indicates that, overall, analytical performance was good. The reviews include descriptions of analytical methods, holding times, instrument calibration checks, blank results, surrogate recoveries, and laboratory control samples. Some of the May hexavalent chromium samples were analyzed up to two hours after the 24-hour holding time. The results have been qualified as estimates. The September dissolved chromium data have been qualified as estimates because one of the routine calibration verification checks failed during analysis. The lab did not encounter difficulties during analysis; all other checks, as well as the calibration correlation coefficients, were acceptable.

The quality of the remaining 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 (EIM) System database: www.ecy.wa.gov/eim/index.htm at study ID, AMERPLAT.

Field Results

Table 3 displays depth-to-water in each well, measured prior to purging. Table 3 also presents 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 May 21 and September 15, 2008.

Monitoring Well	Total Depth (feet) ¹	Depth-to-Water (feet) ¹ May		Depth-to-Water (feet) ¹ September		pH (standard units)		Specific Conductivity (µmhos/cm)		Turbidity (NTU)		Purge Volume (gallons)	
		Time	5/08	Time	9/08	5/08	9/08	5/08	9/08	5/08	9/08	5/08	9/08
MW-2	16.65	13:05	6.60	10:00	7.07	6.8	6.8	845	2,930	17	9.7	4	3.5
MW-3	14.67	09:30	4.22	09:44	4.85	6.5	6.6	18,740	29,400	0.9	6.5	3	4
MW-4	16.89	10:40	6.57	09:46	6.80	7.0	7.3	9,720	16,340	0.8	4.7	2.5	4
MW-5	16.84	11:50	6.90	09:57	7.30	7.2	7.3	18,000	22,300	47	11.4	2.5	3

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. Samples collected at low tide are assumed to be more representative of groundwater conditions flowing toward the waterway. Depth-to-groundwater ranged from 4.22 to 6.9 feet below the measuring points in May, and 4.85 to 7.3 feet below the measuring points in September. Groundwater elevations ranged from about 9 to 11 feet during the two sample rounds.

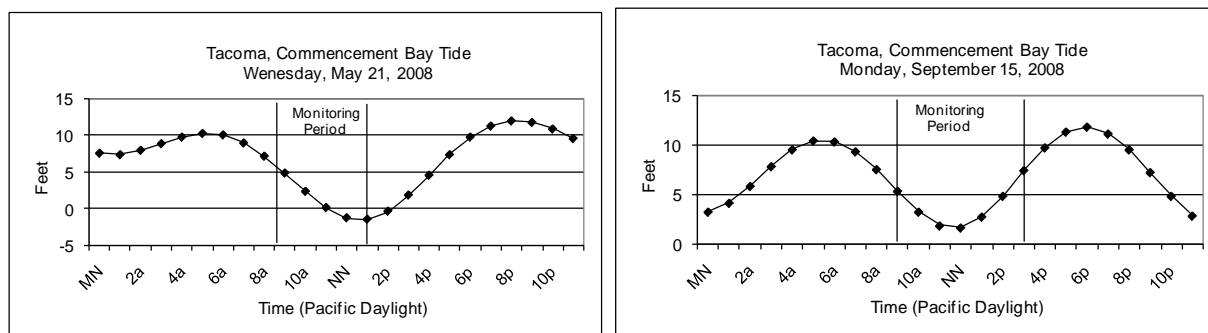


Figure 3. Tide Phase for May 21 and September 15, 2008.

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 all wells in May and September.

The pH of groundwater ranged from 6.5 to 7.3 units. Groundwater temperatures measured in the flow cell in May ranged from 13.0 to 13.6 °C, increasing to 15.2 to 18.5 °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 845 to 29,400 µmhos/cm. Specific conductivity values for wells closer to the Thea Foss Waterway were higher, consistent with the close proximity to salt water. Specific conductivity of the Waterway has been reported between 15,000 to 35,000 µmhos/cm. (SAIC 1994.) Turbidity measurements ranged from 0.8 to 47 NTUs.

Analytical Results

Analytical results for dissolved metals and WAD cyanide are summarized in Table 4 and presented graphically in Figure 4. VOCs were not detected in the May sample. A summary of historical data for this project is presented in Appendix A.

Table 4. Summary of Analytical Results (µg/L) for May and September 2008.

Well	Dissolved Cadmium		Dissolved Chromium		Dissolved Hexavalent Chromium		Dissolved Copper		Dissolved Nickel		WAD Cyanide	
	5/08	9/08	5/08	9/08	5/08	9/08	5/08	9/08	5/08	9/08	5/08	9/08
MW-2	0.02 U	0.027	11.2	6.9 J	8 J	5 U	1.1	1 U	13.3	4.0 J	REJ	5 U
MW-3	0.2 U	0.2 U	7.6	9.6 J	3.2 J	5 U	2.1	2.9	6.0	2.3 J	REJ	5 U
MW-4	0.2 U	0.2 U	11	9.4 J	4.7 J	5 U	1 U	2.2	3.7	1 U	REJ	6.0
MW-5	0.2 U	0.2 U	6.2	2.8 J	1.6 J	5 U	1.8	3.0	8.9	5.0 J	REJ	3 J

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

J – Analytical result is an estimate.

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

Bold – Analyte was detected.

Dissolved cadmium, chromium, hexavalent chromium, copper, nickel, and WAD cyanide were detected in groundwater at the former American Plating site in 2008.

Dissolved chromium was detected in all four wells in May and September. Dissolved hexavalent chromium was detected for the first time in May 2008 at concentrations ranging from an estimated 1.6 to 8 µg/L. The May hexavalent chromium samples were analyzed using a different analytical method than previous samples. Dissolved hexavalent chromium was not detected in the September samples which were analyzed using the standard method.

WAD cyanide was detected in September in wells MW-4 and MW-5. May data were rejected due to high RPDs between duplicate samples. Sampling for WAD cyanide began in 2004, and has been consistently detected in well MW-4 since 2006 and well MW-5 since 2007. WAD cyanide was also detected in the April 2007 sample from well MW-3. Total cyanide has been detected in wells MW-2, MW-3, and MW-4 in the past as shown in Appendix A.

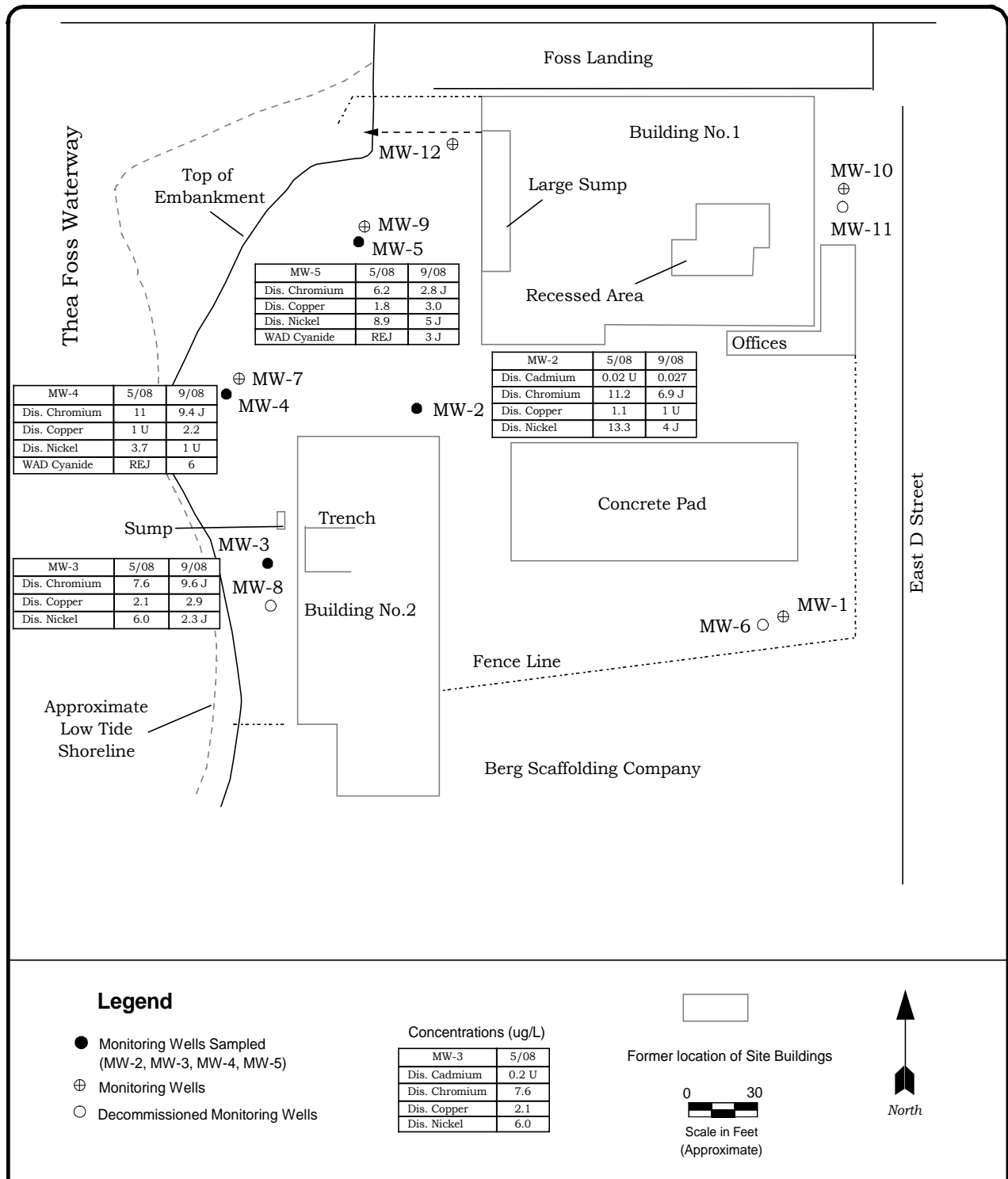


Figure 4. American Plating Summary of Analytical Results ($\mu\text{g/L}$).

As a substitute for well MW-10, well MW-5 was sampled for VOCs in May. Well MW-10 had been sampled for VOCs due to its location next to Building 1 which housed a degreasing tank. Chlorinated solvents stored in the tank were used to degrease parts prior to plating. Well MW-10 was removed from the monitoring network after it was damaged in 2006. A variety of VOCs were detected in well MW-10 at concentrations near the practical quantitation limit of 1 µg/L, including vinyl chloride in August 2004. The source of the vinyl chloride was most likely leaks or spills of degreasing solvents and their subsequent degradation in the environment. Historical VOC data for well MW-10 are presented in Appendix A. March 2005 water levels indicate that well MW-5 is the nearest down-gradient well to MW-10; however, VOCs have not been detected in this well in either 2007 or May 2008.

Discussion

Low concentrations of the sampled metals continue to be detected in groundwater samples from the American Plating site. Table 5 shows a comparison of the 2008 analytical results to numerical cleanup levels established for the site.

Due to the proximity of the site to the Thea Foss Waterway, the groundwater cleanup levels were developed based on protection of human health due to contact with surface water (MTCA Method B surface water levels) and on protection of marine organisms (WAC 173-201A) for the groundwater-to-surface-water pathway. The surface water cleanup level for cyanide (1 µg/L for acute exposure) is based on the WAD cyanide.

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

Table 5. Comparison of 2008 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 - 0.027	0.2 U	0.2 U	0.2 U
Chromium	--	6.9 J - 11.2	7.6 - 9.6 J	9.4 J - 11	2.8 J - 6.2
Copper	3.1	1 U - 1.1	2.1 - 2.9	1 U - 2.2	1.8 - 3
Hexavalent Chromium	--	8 J	3.2 J	4.7 J	1.6 J
Nickel	8.2	4 - 13.3	2.3 J - 6	1 U - 3.7	5 J - 8.9
<i>WAD Cyanide</i>	1 (WAD)	5 U	5 U	6	3 J

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 first detected during the 2006 sample event in well MW-4 at concentrations of 5 and 8 µg/L. In 2007 it was detected in wells MW-3, MW-4, and MW-5 at concentrations ranging from 6 to 13 µg/L. In 2008 WAD cyanide was detected in wells MW-4 and MW-5 at concentrations ranging from an estimated 3 to 6 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 Appendix A.

In 2004, dissolved chromium concentrations in wells MW-4 and MW-5 did not meet (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. Dissolved hexavalent chromium has not been detected in any of the samples with the exception of May 2008. As discussed previously, the May 2008 samples were analyzed using a different analytical method. The samples were reported to contain estimated concentrations from 1.6 to 8 µg/L, which is below the state surface water quality standards. Dissolved hexavalent chromium was not detected in the September 2008 samples.

Prior to April 2007, dissolved chromium concentrations ranged from 8.2 to 104 µg/L. In April 2007 an unexplained increase in concentrations occurred in wells MW-3 (180 µg/L), MW-4 (750 µg/L), and MW-5 (170 µg/L). While the cause of this increase is unknown, a July 2003 composite sample of a metals-contaminated, concrete rubble pile that remained on-site after the interim cleanup 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. By 2008, dissolved chromium concentrations decreased to some of the lowest observed, ranging from an estimated 2.8 to 11.2 µg/L.

During 2008, dissolved nickel concentrations exceeded the cleanup criterion of 8.2 µg/L for the first time since 2005. May concentrations in wells MW-2 and MW-5 were 13.3 and 8.9 µg/L, respectively.

Summary of Results

Cleanup levels for this site were based on Washington State surface water quality standards with the point of compliance for groundwater being the areas where groundwater discharges to surface water along the bank of the Thea Foss Waterway. Groundwater concentrations measured in the site monitoring wells are considered the conditional point of compliance. With the exception of cyanide and an occasional nickel result, most groundwater concentrations meet (are below) the cleanup levels established for the point of compliance. It is assumed that a further reduction in concentrations may occur due to natural processes of sorption and tidal dispersion as the groundwater flows toward the point of compliance (GeoEngineers, 2003).

Conclusions

Dissolved cadmium, chromium, copper, and nickel, as well as WAD cyanide, continue to be detected at low concentrations in groundwater samples collected at the former American Plating site. With the exception of nickel and WAD cyanide, most concentrations are below the regulatory site cleanup levels. However, it is assumed that a further reduction in measured concentrations may occur due to natural attenuation processes as groundwater flows toward the regulatory point of compliance along the banks of the waterway.

Dissolved hexavalent chromium was detected for the first time in May 2008. The May samples were analyzed using a different analytical method than used previously. Results reported at estimated concentrations were well below the Washington State surface water quality standard. Dissolved hexavalent chromium was not detected in the September 2008 samples which were analyzed using the earlier method.

Recommendations

1. Sample analysis should be expanded to include iron because of the potential for iron to interfere with the accuracy of chromium analysis (Parks et al., 2004)
2. Wells MW-10 and MW-5 have been sampled for VOCs due to the presence of volatile organics in the groundwater at well MW-10. Since VOC concentrations in well MW-10 were near the practical quantitation limit of 1 µg/L when it was last sampled in 2005 and VOCs have not been detected in well MW-5, it is recommended that sampling for VOCs be discontinued.
3. The condition of monitoring wells MW-2 and MW-3 has declined. To prevent further damage, new concrete pads, bollards, or some other protective barrier should be installed at these wells and any of the wells located near planned construction activities.
4. Well MW-10 was part of the monitoring program from February 2004 until it was damaged in 2006. This well should be located and properly decommissioned.
5. Responsibility for compliance monitoring should be transferred to the Foss Waterway Development Authority after park development is underway.

References

References Cited

APHA, 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, Washington, D.C.

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

Ecology, 2008. Manchester Environmental Laboratory - Lab Users Manual. 9th Edition. Washington State Department of Ecology, Manchester, WA.

EPA, 1994a. Method 200.7, Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1994b. 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, 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.

GeoEngineers, 2003. Draft Final Cleanup Action Plan, Former American Plating Inc., Tacoma, Washington. November 24, 2003.

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.

Parks, Jeffrey, et al., 2004. Determination of total chromium in environmental samples. Article in Press. Virginia Tech University.

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.

Other References

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

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.

Marti, Pamela, 2008. American Plating Post-Interim-Action Groundwater Monitoring Results, April and September, 2007. Washington State Department of Ecology, Olympia, WA. Publication No. 08-03-004. www.ecy.wa.gov/biblio/0803004.html.

Marti, P., 2009. Standard Operating Procedure (SOP) for Manual Well-Depth and Depth-to-Water Measurements, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP Number EAP052. www.ecy.wa.gov/programs/eap/quality.html

Appendices

Appendix A. Historical Data

Table A-1. Historical Dissolved Metals and Total Cyanide Results (µg/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
MW-2								
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
MW-3								
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	--
MW-4								
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
MW-5								
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	--
MW-10								
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.

PRC = PRC Environmental Management.

Table A-2. Dissolved Metals and WAD Cyanide Results (µg/L) from February 2004 to September 2008.

Well ID	Ecology									
	Feb-04	Aug-04	Mar-05	Aug-05	May-06	Sep-06	Apr-07	Sep-07	May-08	Sep-08
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	0.02 U	0.027
Chromium	8.2	30.2	18	21	49.9	16.1	28	28.4	11.2	6.9 J
Hexavalent Chromium	--	--	--	2 UJ	5 U	5 U	5 U	REJ	8 J	5 U
Copper	1 U	1 U	1 U	1 U	1 U	0.39	1 U	0.48	1.1	1 U
Nickel	4.3	4.4	3.7	3.1	2.8	3.3	2.3	5.96	13.3	4 J
WAD Cyanide	10 U	10 U	10 U	5 U	5 U	5 U	5 U	5 U	REJ	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	0.2 U	0.2 U
Chromium	12.2*	24*	16	28	30.6	25	180	33.2	7.6	9.6 J
Hexavalent Chromium	--	--	--	2 UJ	5 U	5 U	5 U	REJ	3.2 J	5 U
Copper	1.4*	2.7	2.5	3.6	2.5 J	2.8 J	1.35 J*	2.5	2.1	2.9
Nickel	8.6*	5.8	6.6	4.8	3.8	1 U	1 U	4.1	6	2.3 J
WAD Cyanide	10 U	10 U	10 U	5 U	5 U	5 U	7	5 U	REJ	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	0.2 U	0.2 U
Chromium	20	54.9	51	76	66.2	35.8 J	750	63.8	11	9.4 J
Hexavalent Chromium	--	--	--	2 UJ	5 U	5 U	5 U	REJ	4.7 J	5 U
Copper	1 U	2.1	1.3	2.4	1.9 J	1.6 J	1 U	1.1	1 U	2.2
Nickel	4.9	4.9	3.4	3.2	2.2	1 U	1 U	3.1	3.7	1 U
WAD Cyanide	10 U	10 U	10 U	5 U	5	8	11	13	REJ	6
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	0.2 U	0.2 U
Chromium	30.9	71	37.7	88	104	40.7	170	84.1	6.2	2.8 J
Hexavalent Chromium	--	--	--	2 UJ	5 U	5 U	5 U	REJ	1.6 J	5 U
Copper	1 U	1.5	2	2.8	1.4 J	2.4 J	1.2	1.4	1.8	3.0
Nickel	14.8	11.8	9.2	7.9	3.6	1	1 U	6.7	8.9	5 J
WAD Cyanide	10 U	10 U	10 U	5 U	5 U	5 U	6	7	REJ	3 J
MW-10										
Cadmium	--	0.2 U	0.32	0.026	--	--	--	--	--	--
Chromium	--	25.5	2.5 U	9.1 J	--	--	--	--	--	--
Hexavalent Chromium	--	--	--	2 UJ	--	--	--	--	--	--
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 higher than Cleanup Levels established for the site.

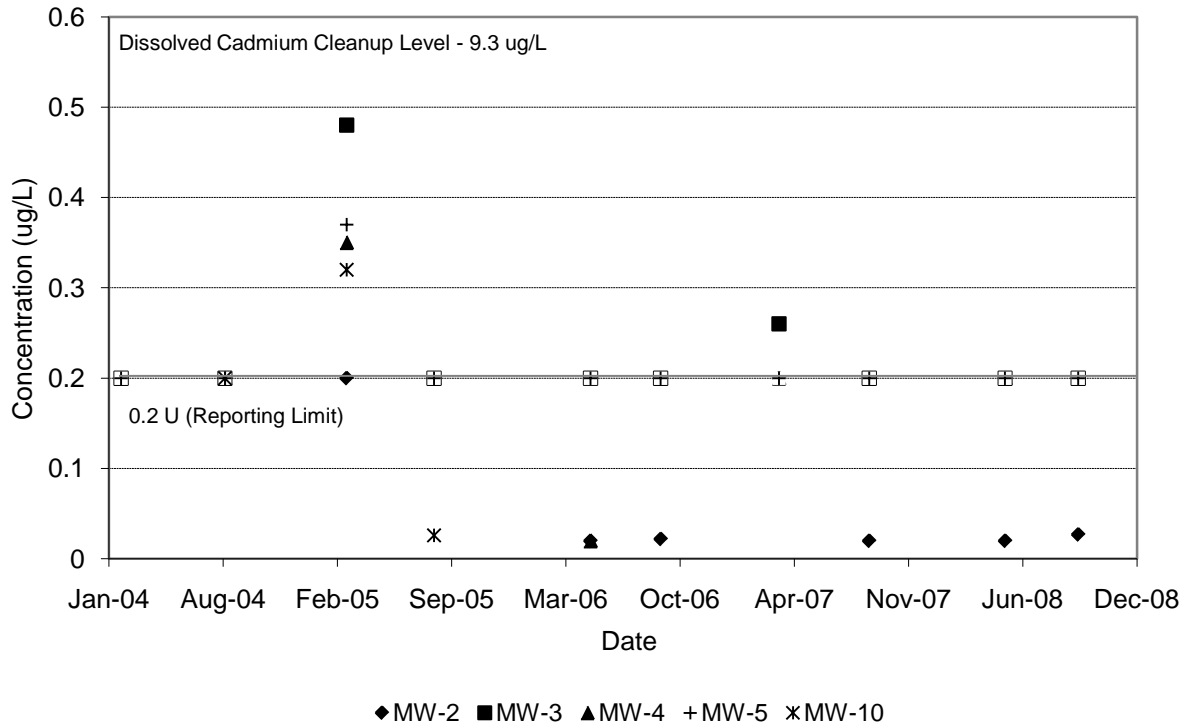


Figure A-1. Dissolved Cadmium Results ($\mu\text{g/L}$) from February 2004 to September 2008.

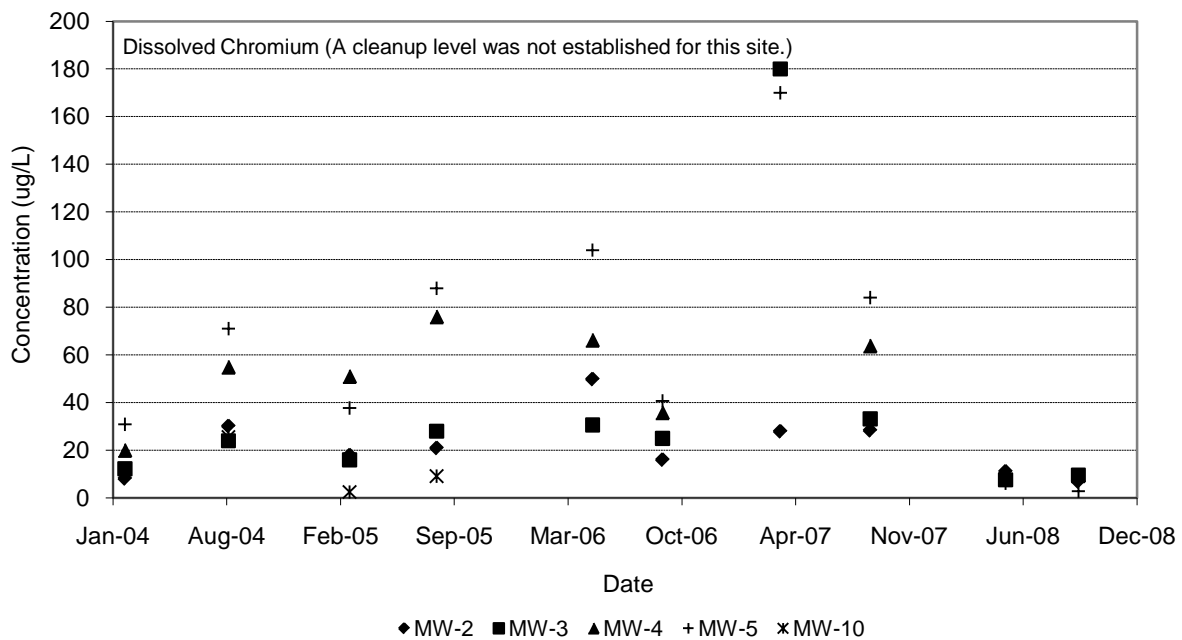


Figure A-2. Dissolved Chromium Results ($\mu\text{g/L}$) from February 2004 to September 2008.
 *April 2007, MW-4 value of 750 $\mu\text{g/L}$ is not plotted.

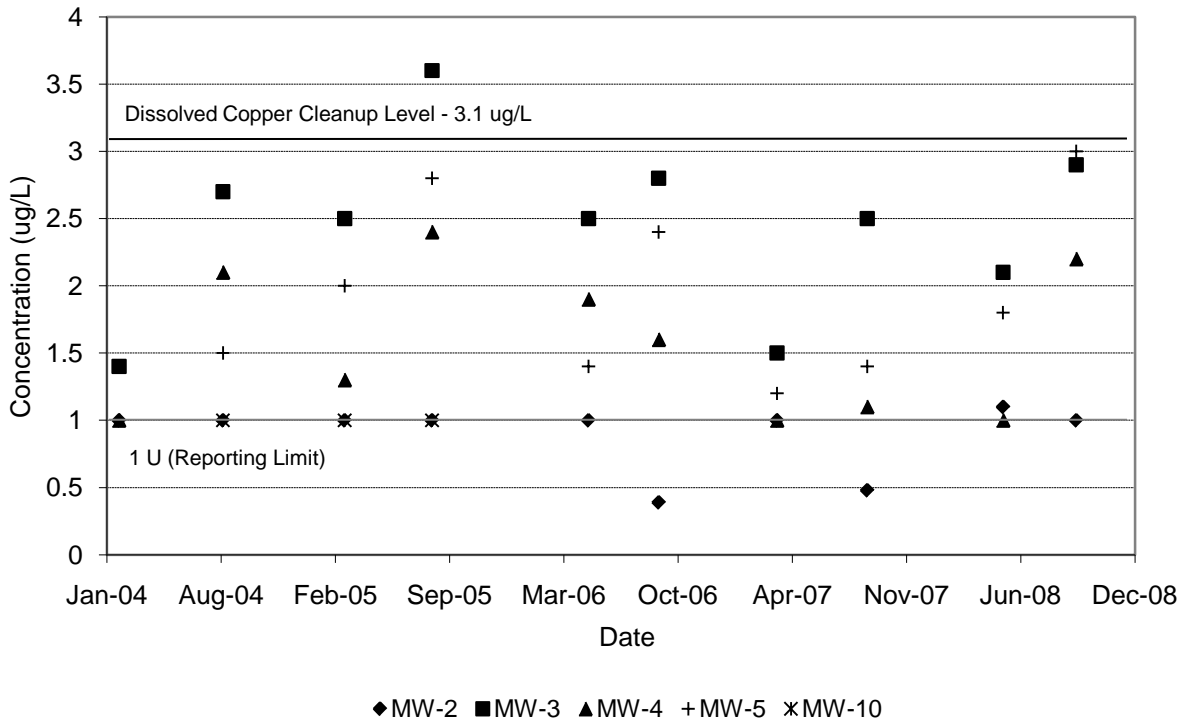


Figure A-3. Dissolved Copper Results ($\mu\text{g/L}$) from February 2004 to September 2008.

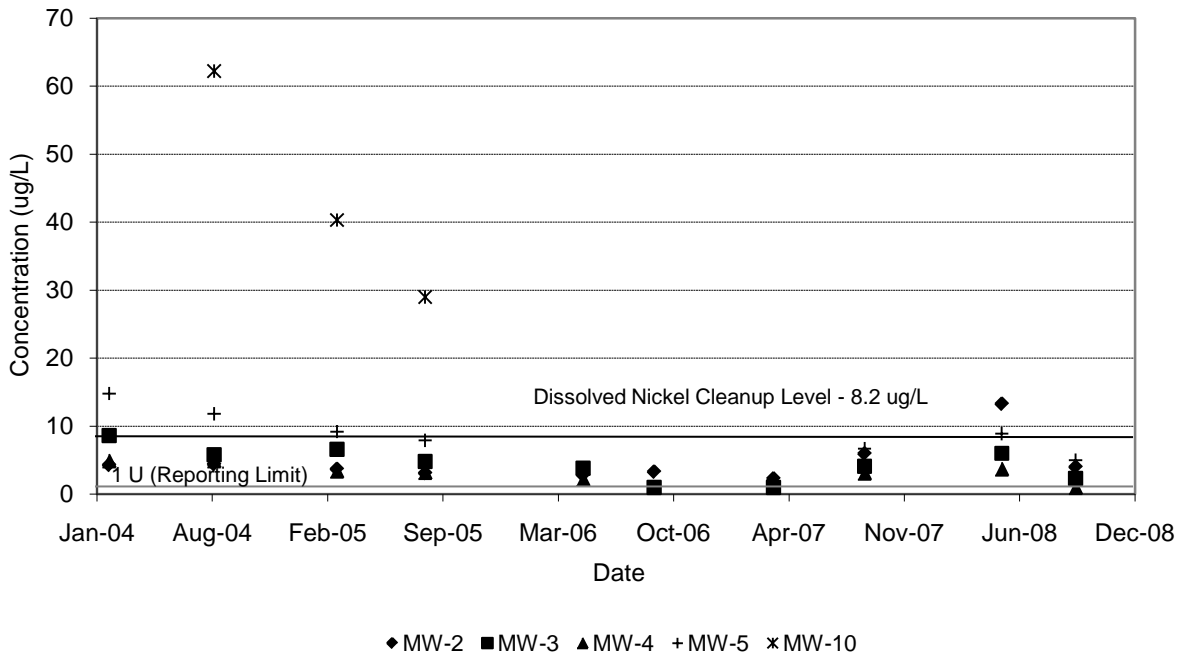


Figure A-4. Dissolved Nickel Results ($\mu\text{g/L}$) from February 2004 to September 2008.

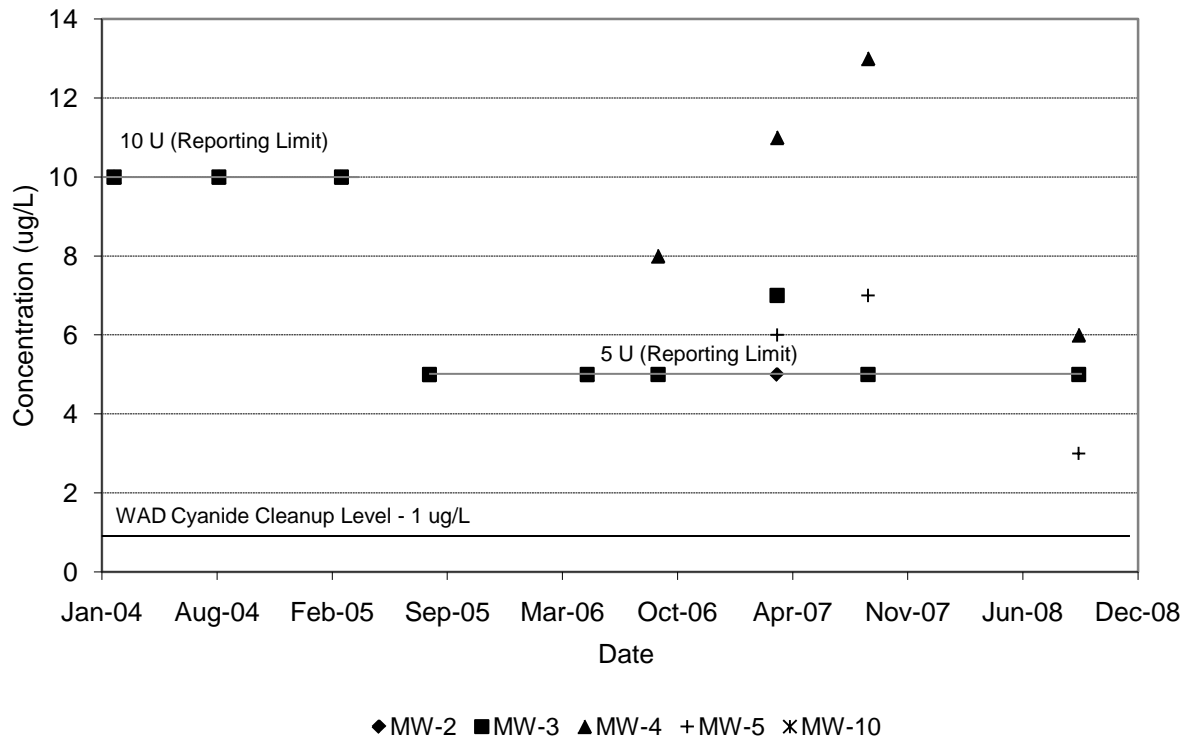


Figure A-5. WAD Cyanide Results ($\mu\text{g/L}$) from February 2004 to September 2008.

Table A-3. VOC Results (ug/L) for well MW-10 from May 1989 to August 2005.

MW-10	LR Jones		PRC	Ecology			
	3/89	1/94	9/94	2/04	8/04	3/05	8/05
Benzene	--	1.5	1.8	10 U	0.33 J	0.22 J	1 U
2-Butanone	--	--	1 U	20 U	1.8 NJ	2 U	1.3 J
Chloroethane	18	150 D6	178	12 U	15	16	8.8
Chloroform	3	0.2 U	1 U	10 U	1 U	1 U	1 U
Chloromethane	2.1	2 U	0.13 J	20 U	2 U	2 U	5 UJ
1,1-Dichloroethane	170 D4	140 D6	10	27	0.49 J	7.2	0.41 J
1,2-Dichloroethane	1.6	0.2	1 U	10 U	0.3 NJ	1 U	1 U
1,1-Dichloroethene	4	1	1 U	10 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	430 D4	8.2	2.3	10 U	0.93 J	0.87 J	0.81 J
Trans-1,2-Dichloroethene	1.3	0.2 U	1 U	10 U	1 U	2 U	1 U
1,2-Dichloropropane	0.2 U	1.3	0.34 J	10 U	1 U	1 U	1 U
Ethylbenzene	--	0.5	0.56 J	10 U	1 UJ	1 U	1 U
Propylbenzene	--	--	0.19 J	10 UJ	1 UJ	2 U	2 U
Tetrahydrofuran	--	--	--	20 U	1.4	2 U	2 U
Toluene	--	0.5 U	0.29 J	10 U	1 UJ	1 U	1 U
1,1,1-Trichloroethane	41 D4	0.2 U	1 U	10	1 UJ	1 J	2 U
Trichloroethene	8.6	0.7	0.89 J	10 U	0.46 NJ	1 U	0.62 J
1,2,4-Trimethylbenzene	--	--	2.5	10 UJ	1 UJ	1 U	1 U
1,3,5-Trimethylbenzene	--	--	0.42 J	10 UJ	1 UJ	1 U	1 U
Vinyl chloride	190 D4	6.1	1	20 U	0.94 NJ	2 U	2 U
Xylene	--	0.6	2 J	20 U	2 UJ	4 U	2 U

-- = not analyzed.

Bold = Analyte was detected.

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

D = The detection limit was elevated due to matrix interference.

J = The analyte was positively identified. The associated numerical result is an estimate.

UJ = The analyte was not detected at or above the reported estimated result.

NJ = There is evidence that the analyte is present. The associated numerical result is an estimate.

PRC = PRC Environmental Management.

Appendix B. Glossary, Acronyms, and Abbreviations

Glossary

Ambient: Refers to the surrounding air temperature.

Analyte: Water quality constituent being measured (parameter).

Deltaic deposits: The accumulation of sediment at the mouth of a river (delta).

Depth-to-water: A measure of depth to the water (i.e., water level) in a well.

Groundwater: Water in the subsurface that saturates the rocks and sediment in which it occurs. The upper surface of groundwater saturation is commonly termed the water table.

Hydraulic gradient: The difference in hydraulic head between two measuring points, divided by the distance between the two points.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Semi-confined aquifer: An aquifer partially confined by soil layers of low permeability through which recharge and discharge can still occur.

Sorption: The process in which one substance takes up (absorption) or holds another (adsorption).

Specific conductance: A measure of water's ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

Stratigraphy: Refers to the natural divisions of rocks and their arrangement according to their composition, distribution, correlation, and mutual relationships.

Turbidity: A measure of the amount of suspended silt or organic matter in water.

Unconfined aquifer: An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well.

Acronyms and Abbreviations

EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MTCA	Model Toxic Control Act
NPDES	National Pollutant Discharge Elimination System
PVC	Polyvinyl chloride
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
TCLP	Toxic Characteristic Leaching Procedure
VOC	Volatile Organics Compound
WAC	Washington Administrative Code
WAD	Weak Acid Dissociable

Units of Measurement

°C	degrees centigrade
ft	feet
mg/kg	milligrams per kilogram (parts per million)
mL	milliliters
NTU	Nephelometric Turbidity Units
µg/L	micrograms per liter (parts per billion)
umhos/cm	micromhos per centimeter, a unit of conductivity