Final Close-Out Report
Frontier Hard Chrome Superfund Site
WAD53614988

City of Vancouver
Clark County, Washington

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I. INTRODUCTION

This Final Close Out Report ("FCOR") documents that the U.S. Environmental Protection Agency ("EPA") has determined, in accordance with Close Out Procedures for National Priorities List ("NPL") Sites (OSWER Directive 9320.2-22, May 2011), that all appropriate response actions at the Frontier Hard Chrome ("FHC") Superfund Site ("Site") have been successfully implemented in accordance with the August 30, 2001 Amended Record of Decision ("RODA") issued by EPA for the Site. These response actions were undertaken pursuant to the Comprehensive Environmental Response Compensation and Liability Act ("CERCLA"), 42 U.S.C. § 9601 et seq.

II. SUMMARY OF SITE CONDITIONS

Background

The FHC Site is located at 113 Y Street in an area of southeastern Vancouver, Washington. The area was once dominated by industry but has recently been redeveloped as a commercial and mixed use area. The FHC Site is approximately three-quarters mile north of the Columbia River and covers approximately one-half acre (Figure 1). A chronology of CERCLA-related activities at the Site is summarized in Appendix A.

From 1958 to 1983, the Site was occupied by two chrome plating businesses, Pioneer Plating (1958 to 1970) and Frontier Hard Chrome (1970 to 1983). Since 1983, the Site has been used by various businesses, the most recent being used for storage and light maintenance of large equipment and vehicles. The Site is currently owned by JH Kelly/ Grand Boulevard Investments, LLC "Kelly"), who is currently constructing a commercial building and parking lot at the Site.

Prior to 1975, chromium plating wastes were discharged to the sanitary sewer system. At that time, the City of Vancouver determined that chromium in the wastewater from FHC was interfering with the operation of its new secondary wastewater treatment system and contacted the Washington State Department of Ecology ("Ecology") who directed FHC to cease discharge to the sewer system until an appropriate wastewater treatment system could be installed to remove the chromium.

In 1976, Ecology issued FHC a wastewater disposal permits for discharge of chromium-contaminated wastewater to an on-site dry well. The permit also contained a schedule for the installation of a treatment system for the FHC wastewater stream. Between 1976 and 1981, several extensions of the permit and schedule were granted by Ecology, as deadlines passed without compliance by FHC.

In 1982, Ecology found FHC in violation of the Washington State Dangerous Waste Act for illegal disposal of hazardous wastes. Ecology also discovered that an industrial supply well about one quarter mile southwest of the Site was contaminated with chromium at more than twice the federal drinking water standard. FHC's wastewater permit was again modified by Ecology with a new compliance date. Citing economic reasons, FHC again did not comply with permit requirements. Several other enforcement orders were issued to FHC by Ecology when compliance deadlines passed without action. In January 1983, Ecology ordered FHC to stop discharge of chromium plating wastes to the dry well and to prepare a plan to investigate the groundwater. FHC never developed a work plan for the investigation and instead, closed the business.

In December 1982, EPA proposed that the Site be included on the NPL established under CERCLA. Following consideration of public comments, the listing was finalized by EPA in September 1983. (47 FR 58476, 48 FR 40658)

In March 1983, EPA and Ecology signed a Cooperative Agreement which gave Ecology the lead for further investigation and assessment of the contamination at the Site. The investigation started in the fall of 1984 and was completed during the summer of 1987. A feasibility study was completed in October 1987.

Releases from FHC operations contaminated groundwater with chromium at concentrations as high as 300,000 µg/L. At the time the contamination was first monitored in 1982, a groundwater plume exceeding federal drinking water standards (50 µg/L) extended approximately 1600 feet (approximately one third a mile) southwest from the FHC property.

During the initial investigation, concentrations of total chromium in surface soils on the FHC property were found as high as 5,200 mg/kg. When hexavalent chromium was first measured in the early 2000's, concentrations in soils near the FHC building were as high as 42 mg/kg. Subsurface soil concentrations for total and hexavalent chromium were reported to be as high as 31,800 mg/kg and 7,506 mg/kg, respectively and extended to beneath the neighboring Richardson Metal Works' building (Figure 2).

Records of Decision and Amended Record of Decision

The Site is comprised of two Operable Units ("OU"). The first Record of Decision ("ROD") was issued by EPA for the soils/source control Operable Unit ("OU 1") in December 1987, followed by a ROD for the groundwater Operable Unit ("OU 2") in July 1988. The OU 1 ROD called for excavation, stabilization and replacement of all soils with concentrations greater than 550 mg/kg total chromium (approximately 7,400 cubic yards of soil). The cleanup level was calculated based on a Site specific leachate test for protection of groundwater. The OU 2 ROD called for extraction of groundwater from the area of greatest contamination (levels of chromium in excess of 50,000 µg/L) via extraction wells, and treatment of the extracted groundwater.

During the remedial design for OU 1, bench scale tests indicated that the chosen stabilization method would likely not be effective at preventing the leaching of hexavalent chromium from Site soils. The remedial action stopped while alternatives were evaluated. During this time, groundwater

monitoring indicated the groundwater plume was decreasing in size, at least partially due to downgradient industrial supply wells being taken off-line.

In May 2000, EPA finalized a Focused Feasibility Study that identified and evaluated several new and innovative technologies for addressing the contamination remaining at the Site. One of the new in-situ treatment technologies, In-Situ Redox Manipulation ("ISRM"), was further evaluated in a bench scale test in February 2001. The results of the bench scale test indicated that the technology would be appropriate for use at the FHC Site.

In June 2001, EPA issued a Proposed Plan to change the selected remedy in the RODs for both soils and groundwater to in-situ treatment using reducing compounds. Following public comment on the Proposed Plan, EPA issued the RODA in August 2001, thereby changing the remedial action for the Site to ISRM.

Contaminant of Concern

Chromium is the hazardous substance of primary concern at the FHC Site. Chromium is present in two forms, trivalent chromium and hexavalent chromium. Hexavalent chromium is a potential carcinogen when inhaled, is highly mobile in groundwater, and is toxic at low concentrations. For protection of public health, the current federal drinking water standard ("Maximum Contaminant Level" or "MCL") for total chromium is 100 µg/L (0.1 mg/L).

Remedial Action Objectives

The RODA established the following Remedial Action Objectives ("RAOs") for contaminated soils at the Site:

> *Prevent hexavalent chromium in soils from serving as an uncontrolled, ongoing source of contamination to groundwater.*
>
> *Prevent current and future exposure to soil contaminated with chromium above state standards for unrestricted future use.*

In addition, the following RAOs were established for contaminated groundwater at the Site:

> *Restore all hexavalent chromium-contaminated groundwater to state standards ("Model Toxic Control Act" or "MTCA" Method A standards).*
>
> *Prevent ingestion of hexavalent chromium-contaminated groundwater above state groundwater cleanup standards (MTCA Method A standards).*
>
> *Prevent chromium-contaminated groundwater from seeping into the Columbia River above chronic state standards for the protection of fresh water aquatic organisms.*

Cleanup Levels

Cleanup levels specified in the RODA are as follows:

Cleanup Levels Identified in RODA for Frontier Hard Chrome Superfund Site

Medium	Chemical of Concern	Cleanup Level	Source of Cleanup Level[1]
Groundwater	Total Chromium	50 µg/L	MTCA Method A
		100 µg/L	Federal Safe Drinking Water Act MCL
		10.5 µg/L	State Chronic Surface Water Stds
Soil	Hexavalent Chromium	19 mg/kg	MTCA Method A
	Hexavalent Chromium	400 mg/kg	MTCA Method B
	Trivalent Chromium	80,000 mg/kg	MTCA Method B

EPA has reviewed the cleanup levels for groundwater and found that the MTCA level has not changed since issuance of the RODA in 2001. In addition, the federal and state drinking water standard remain unchanged at 100 µg/L, a level less protective than the MTCA Method A groundwater cleanup level of 50 µg/L. Thus, attainment of the more stringent MTCA cleanup level for groundwater will also result in attainment of the federal drinking water standard and thus remains protective of human health.

The MTCA Method B soil cleanup levels for hexavalent and trivalent chromium have been changed to 2,400 mg/kg hexavalent chromium and 120,000 trivalent chromium. Both values are less stringent than the level adopted in the RODA, the existing cleanup levels are still protective of human health and the environment.

The State Chronic Surface Water standard for total chromium identified in the RODA has been replaced by criteria for hexavalent chromium and trivalent chromium (total chromium = hexavalent chromium + trivalent chromium). Hexavalent chromium is a potential carcinogen

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[1] MTCA Method A = Model Toxics Control Act, Method A was set by the Washington State of Department of Ecology. Values are set for unrestricted future use. A value of 100 µg/L may be used if the chromium in groundwater is trivalent chromium.

While RAOs for groundwater address hexavalent chromium, SDWA and MTCA values were expressed as Total Chromium, thus, Total Chromium was used for groundwater cleanup levels.

MTCA Method A for hexavalent chromium in soils is established for the protection of groundwater. Values are set for unrestricted future use.

MTCA Method B for hexavalent chromium in soils was established for human health protection through direct contact. The value of 400 mg/kg was determined not to be protective of groundwater at the site. Therefore, the MTCA hexavalent chromium value of 19 mg/kg serves as the cleanup level for cleanup.

MTCA B for trivalent chromium is established for human health protection through direct contact.

State Surface Water Standard applicable where groundwater flows into Columbia River.

when inhaled, is highly mobile in groundwater, and is toxic at low concentrations. To ensure protectiveness of the remedy, both the total and the hexavalent criteria are used in the attainment assessment below (Section V).

The Selected Remedy

In December 1987 and July 1988, EPA issued RODs addressing soils/source control (OU 1) and groundwater (OU 2). During remedial design of the selected remedy, EPA determined that the selected remedy likely would not achieve the cleanup levels required by the RODs. As such, further work towards implementing that remedy stopped and additional studies were performed to develop an alternate remedy.

In June 2001, EPA issued a RODA that altered the original RODs by setting forth an amended remedy for both soils and groundwater. The amended remedy consists of the following:

Contain Highly-Contaminated Groundwater

The most heavily contaminated groundwater at the Site (the groundwater hot spot) was to be contained through injection of reducing compounds into soils and groundwater on the downgradient side of the soils source area. The injected compounds were to react with naturally occurring iron in the soils to create a permeable reactive zone where the hexavalent chromium in the groundwater would be reduced to trivalent chromium. This ISRM zone/barrier was to be in place prior to treatment of the soils source area and the groundwater "hot spot" in order to provide containment of the hot spot as quickly as possible, protection of downgradient groundwater during remedy implementation and long-term protection against future leaching of hexavalent chromium.

In-Situ Treatment of Source Area Soils and Groundwater Hot Spot

In-situ treatment of the soils source area and the groundwater hot spot was to occur through the delivery of reducing compounds directly to Site soils with levels of hexavalent chromium exceeding 19 mg/kg, and to contaminated groundwater with concentrations of hexavalent chromium exceeding 5,000 µg/L. The reducing agent was to be delivered through injection into auger holes or injection wells. After treatment, the augured soils were to be compacted in order to allow for future use of the affected property.

Groundwater Restoration

Following treatment, natural dispersion and dilution was projected to restore groundwater that exceeded the state groundwater cleanup level of 50 µg/L (MTCA Method A, total chromium). Regular monitoring of downgradient groundwater was to be conducted until all remaining groundwater met the cleanup level.

Institutional Controls

Institutional controls (ICs) were to be evaluated during the remedial design and implemented after the cleanup portion of the remedial action to prevent 1) access to contaminated groundwater, 2) access to soils contaminated with residual concentrations of hexavalent chromium above state MTCA Method A levels (if applicable), and 3) future activities that threaten to remobilize chromium in Site soils. To implement the institutional controls, it was anticipated that there would be deed notices and restrictions on certain activities at the Site.

Remedy Implementation

As mentioned above, the 1987 remedy for OU 1 required excavation, stabilization and replacement of all soils with concentrations greater than 550 mg/kg total chromium. In 1994, Ecology excavated 160 cubic yards contaminated source material from the easternmost portion of the Site and disposed it off-Site. The excavated area was subsequently backfilled with clean material and has been developed as a commercial office building with adjacent parking.

The remedial action selected in the 2001 RODA was implemented during 2003. The existing building on the FHC property was first removed, the ISRM wall was installed to contain any chrome from leaving the source area and, finally, the soil source area and groundwater hot spot were treated with a similar solution to that used in the ISRM wall. This solution was a blend of sodium dithionite and ferrous sulfate. The work performed is described in greater detail in the Remedial Action Report and Preliminary Close Out Report (PCOR). The PCOR certified that the physical construction of the soil and groundwater cleanup actions were completed consistent with the remedial design plans and specifications and that appropriate institutional controls were in the process of being implemented.

An Operational and Functional Report, issued in March 2004, presented two rounds of groundwater sampling data collected after the remedial action was complete and found that the remedy was functioning in a protective manner, and that long term monitoring was in place to verify that the remedy would continue to function in a protective manner. Data collected since 2004 have continued to confirm the remedy is functioning in a protective manner. In September 2009, EPA signed a Sitewide Ready for Anticipated Use Certification for the Site.

An Institutional Control Plan ("ICP") was prepared by EPA in December 2003. Specific to groundwater, the ICP found that the location of the off-Site plume was well delineated, water to area residents and businesses was supplied by the City's water system, and no residential wells were located in the area of impact. Furthermore, a review of existing controls and restrictions found that City of Vancouver policies and regulations required all new buildings to connect to the public water supply; Clark County regulations required Health District review of all new water supply wells; and State regulations required a permit prior to drilling and prohibited new water supply wells near areas of potential contamination. Based on the local and state controls already in place, EPA did not find it necessary to implement any ICs for groundwater downgradient of the Site.

Off-Site perimeter sampling at the conclusion of the remedial action indicated that hexavalent chromium adjacent to the Site was not present at detectable concentrations in soils (<5 mg/kg) and average total chromium concentrations adjacent to the Site were below levels of human health concern. Since no significant off-Site soil contaminant exposure pathways were present, EPA did not implement ICs for off-Site soils.

To address potential on-Site routes of exposure, in July 2004 EPA entered into an Agreement and Covenant Not to Sue with the Kelly Development LLC and its affiliates ("Kelly") in Docket No. 10-2003-2009 ("Agreement"). Kelly then purchased the FHC property, and remains the current

owner of this property. The Agreement required Kelly to abide by seven (7) institutional controls applicable to the FHC Site, including prohibitions on the installation of groundwater wells and use of groundwater, as well as restrictions related to the movement or excavation of soil. These ICs were designed to eliminate human exposure to contamination that might be present following implementation of the remedy. Kelly was also obligated by the Agreement to inform lessees and buyers of the FHC property of the need to act consistent with the ICs, and to further record a deed notice which alerted members of the public to these ICs.

In February 2004, a Long Term Monitoring Plan was developed by EPA to track the size of the chromium plume downgradient of the Site and to ensure the protectiveness of the remedy. Data collected by Ecology between 2004 and 2007 were reviewed by EPA as part of an optimization review of the groundwater monitoring network (Groundwater Monitoring Network Optimization, December 2007). In June 2008, consistent with the recommendations of the optimization review, ten (10) wells were removed from the monitoring network and the sample frequency at all wells was reduced to annual sampling.

III. ATTAINMENT OF SOIL CLEANUP LEVELS (OU 1)

Based on the analysis provided in the PCOR, EPA finds that the results of the soil sampling have demonstrated attainment of the soil RAOs and cleanup levels established for the Site. Furthermore, EPA has not found any significant changes at the Site that might affect the protectiveness of the remedy selected in the 2001 RODA, or identified any other information that would jeopardize the protectiveness of the remedy. Therefore, EPA finds that the remedy has been successfully implemented and no further action is required for soils at the site (OU 1).

IV. MONITORING RESULTS

Analytical results from samples taken during and immediately following the remedial action are presented in the Remedial Action Report (December 2003) and Operational and Functional Report (March 2004). Subsequent groundwater monitoring has been performed by Ecology consistent with the Long Term Monitoring Plan (2004). Data was reviewed in greater detail during the 2003 and 2008 Five-Year Reviews ("FYRs").

A Long Term Monitoring Optimization (LTMO) conducted in 2007 by EPA found that the monitoring network was appropriate for the Site and contained no apparent gaps (EPA, 2007). Chromium concentrations at 82% of the wells were found to be below the cleanup level while 63% of the wells showed a stable or decreasing trend (no increasing trends were observed).

The data review and assessment conducted as part of the 2013 FYR indicated that 21 of the 22 wells demonstrated attainment with the cleanup level during all sampling events conducted between 2008 and 2013. Data from Well B87-8, however, indicated that chromium concentrations at this well were greater than the cleanup level of 50 µg/L during three consecutive sample events in 2007 and 2008. Since chromium levels were below the cleanup

level for five sampling events prior to the excursion and returned to levels below the cleanup level following the three exceedances, it is likely that a slow moving slug of elevated chromium was moving past the well during this period of time.

In 2016, EPA received a request from Kelly to decommission the 11 monitoring wells on the FHC/Kelly property in order to allow for redevelopment of this property. As part of the request, Kelly agreed to sample the on-Site wells and submit the sample results to EPA (MFA, Event 23 On-Property Wells Groundwater Monitoring Report, October 2016). All 11 samples were analyzed for total chromium. Total chromium was below the reporting limit in 9 of the 11 wells. The samples from the 2 wells that had quantifiable levels of total chromium were also analyzed for dissolved chromium and the single sample where dissolved chromium was detected above reporting limits was also analyzed for total and dissolved hexavalent chromium, dissolved sulfur and total sulfate. Following review of the data, EPA approved the request to decommission the wells. Kelly completed the work in 2016. (MFA, October, 2016b).

In September 2016, Ecology sampled the 11 wells in the long-term monitoring well network located outside the FHC/Kelly property, and provided the results to EPA (Event 23 Long-Term Monitoring Report, December 2016). Total chromium was detected in only one well but the concentration was well below the cleanup level (Well B-87-8; 8.82 µg/L total chromium). Further analysis of this sample indicated that dissolved chromium and hexavalent chromium were also below the cleanup level. These data, along with data collected during earlier sampling events, were used in the attainment analysis presented below.

V. ATTAINMENT OF GROUNDWATER CLEANUP LEVELS (OU 2)

Groundwater Immediately Below the Property

As mentioned above, the remedial action conducted in 2003 consisted of treatment of soil and groundwater on the FHC property in order to reduce chromium concentrations below the cleanup levels established in the RODA. Groundwater sampling conducted during the months following the remedial action indicated that concentrations of chromium in the groundwater immediately downgradient from the FHC property were less than the groundwater cleanup level (50 µg/L). Subsequent data collected from these wells, including data collected during 2016, have continued to indicate chromium levels are below the groundwater cleanup level. Based upon these data, EPA has determined that the remedial action has successfully prevented the hexavalent chromium in the soils from serving as an uncontrolled, ongoing source of contamination to the groundwater. Thus, the second RAO for soils has been attained.

Groundwater Downgradient of the Property

EPA reviewed the chromium data collected from the monitoring wells downgradient of the FHC property during the 2007 groundwater optimization study and the 2013 FYR. As mentioned above, this analysis indicated that chromium concentrations were below cleanup levels in all but one well, B87-8. All data collected subsequent to the FYR have shown all chromium levels to be below the cleanup level. Appendix B shows the results of the evaluation for the 22-monitoring wells in the groundwater monitoring network for this remedy. The evaluation considered the chromium

concentration at each monitoring well and focused on two phases of monitoring - the remediation phase and the attainment phase. The most recent monitoring event at the site occurred in September 2016.

The evaluation was performed consistent with EPA's guidance published in "*Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Action at a Groundwater Monitoring Well"* (OSWER 9283.1-44, August 2014). This approach recommends that a minimum of eight (8) data points be used to evaluate attainment at each location. This guidance recommends that a statistical analysis be conducted using a 95% Upper Confidence Limit ("UCL"), but provides for a non-statistical approach or visual analysis of the data if the parameter is not detected at the reporting limit or is consistently below the cleanup level. The evaluation for the FHC Site used a visual analysis for all but one well (B87-8), because all of the chromium data has been below the cleanup level of 50 µg/L for at least seven (7) years.

During the most recent sampling event, detectable concentrations of total recoverable chromium were identified in only one well, B87-8 (total chromium 8.82 µg/L, dissolved hexavalent chromium 0.029 µg/L). A total of nine (9) samples have been collected at this well since the last exceedance in 2008. The well is screened within the shallow groundwater zone and is located approximately 200 feet downgradient of the ISRM treatment wall.

In order to further evaluate the attainment of the cleanup levels at Well B87-8, EPA calculated the 95% UCL, and the trend of the data using EPA's Groundwater Statistics Tool (EPA, OSWER, July 2014). EPA's evaluation of the data collected from Well B87-8 between 2009 and 2016 indicate that the chromium levels have been below the groundwater cleanup level for the last nine sampling events. A total chromium concentration (µg/L) versus time trend analysis indicated a decreasing trend (Figure 3). Finally, the 95% UCL chromium concentration calculated using the Chebyshev UCL method was found to be 26.5 µg/L, below the Site cleanup level (50 µg/L) (see Appendix C).

Based on this analysis, EPA has determined that the groundwater cleanup level of 50 µg/L has been attained at all wells downgradient of the FHC property and are expected to remain below the cleanup levels in the future. In addition, EPA has determined that the remedial action has achieved the RAOs for restoring hexavalent chromium levels to groundwater cleanup levels, and preventing the ingestion of hexavalent chromium-contaminated groundwater above groundwater cleanup levels.

Groundwater Immediately Upgradient of the Columbia River

In order to address the potential for impacts to the Columbia River (approximately 0.75 miles south of the Site) from releases at FHC, the RODA established a groundwater cleanup level of 10.5 µg/L for total chromium, the State's surface water standards. The State's total chromium criterion has since been replaced by two criteria, one for hexavalent chromium (10.0 µg/L) and another for trivalent chromium (to be determined based on site-specific calculations). The cleanup level was to be attained in wells immediately upgradient of the Columbia River, thus ensuring that the groundwater flowing into the river did not exceed the State's surface water quality standards and, thus, protected fresh water aquatic organisms in the River.

Being conservative, to evaluate the potential for impacts, EPA has reviewed the groundwater data at the well closest to the river and evaluated whether those concentrations exceeded 10.0 µg/L. Initially EPA reviewed the groundwater data collected prior to 2001 and the RODA. These data indicated the total chromium in the well closest to the river was less than 10.0 µg/L at each sample event and predicted that, with no groundwater cleanup, the level at the river would rarely, if ever, exceed a cleanup level of 10.5 µg/L. However, EPA decided to include the cleanup level in the RODA.

In developing the 2013 FYR, EPA reviewed all the groundwater data collected from the well closest to the river (W99-5B). The highest total chromium concentration recorded at that well was 9.9 µg/L and collected in April 2004. Between 2004 and 2007, total chromium concentrations decreased to a level below the reported detection limit (2.5 µg/L). Finally, no samples collected since 2007 have indicated total chromium levels above the detection level.

Based on this review of sample results at well W99-5B, EPA has determined that the total chromium concentration in groundwater immediately adjacent to the Columbia River is below 10.0 µg/L and thus, also below the groundwater cleanup level adjacent to the river and the State's current surface water criterion of 10.0 µg/L for hexavalent chromium. As such, EPA finds that the groundwater immediately upgradient of the Columbia River is below the established cleanup level and that the third groundwater RAO (prevent chromium contaminated groundwater from seeping into the Columbia River above chronic water quality standards) has been attained.

Sulfate

Sulfate is as a by-product of the reactions created by the reductant injection used during treatment. To ensure that the distribution of byproducts from the ISRM treatment did not adversely affect groundwater quality, samples from several monitoring wells were routinely analyzed for sulfate and dissolved sulfur. While there is no primary MCL for sulfate or sulfur, to address the aesthetic effects (i.e., taste and odor) of sulfate in drinking water, a secondary maximum contaminant level for sulfate has been established at 250 mg/L.

Concentrations of both sulfate and dissolved sulfur have decreased over time. During the 2016 sampling event, sulfate concentrations ranged from 12.6 mg/L to 76.2 mg/L while dissolved sulfur concentrations ranged from 3.8 to 24 mg/L. These data indicate that elevated sulfate levels created during the treatment are not expected to create aesthetically displeasing impacts to groundwater downgradient of the Site.

PFAS

FHC, like other chrome plating operations, placed metal parts into large, open vats of warmed chrome and left them for a sufficient time for a surface of chrome to cover the parts. When the metal parts were placed into or withdrawn from the vats, chrome emissions were released into the air, resulting in working conditions in the plants where workers were exposed to elevated airborne chrome.

In 1986, chromium was first officially listed as a toxic air contaminant ("TAC") by the California EPA Air Resources Board, in part, to address concerns of potential health impacts from hexavalent chrome in the air released from chromium plating and chromic acid anodizing facilities. In 1988, and amended in 1998, Airborne Toxics Control Measures ("ATCM") requiring a 99 percent reduction in airborne

hexavalent chrome were adopted for chrome plating facilities (Cal EPA, ATCM, August, 2006). Prior to the adoption of regulations requiring the ATCMs be implemented, nothing was required of chrome plating facilities with respect to reducing chromium air emissions.

One common method used to reduce chrome emissions was to apply a chemical fume suppressant to the surface of the vats, reducing the surface tension and suppressing the release of fumes into the air. Fluorinated or per-fluorinated compounds ("PFAS") were commonly used as surfactants (U.S. EPA, 1998). PFAS are man-made substances that are highly mobile in groundwater, persistent in the environment and toxic when inhaled.

Potential for use of PFAS at Frontier Hard Chrome

In evaluating the likelihood that PFAS may have been used at the FHC Site, EPA considered the following. First, FHC closed in 1983, three years prior to California's first steps to address hexavalent chrome in air at chrome plating facilities. Second, emission controls were not required of chrome platers until 1988, five years after operations ceased. Finally, throughout its years of operation, FHC was repeatedly cited by the City of Vancouver and State of Washington for failure to operate consistent with environmental requirements. Even after compliance actions were taken by the State, FHC failed to make improvements to its waste disposal practices (e.g. continued to dispose of all liquid wastes into a dry well) and stated that it did not have the money to implement the required controls.

Based on these facts, EPA has determined that there is a very small likelihood that a chemical fume suppressant, such as PFAS, would have been used at the FHC Site. Even so, EPA calculated the groundwater travel time from the Site to its discharge to the Columbia River and compared that to the time elapsed since both the operations ceased in 1983 and the ISRM treatment was implemented in 2004. EPA also reviewed the records to identify downgradient drinking water wells that might have been affected if PFAS were used at the Site and was still present in the subsurface environment. The findings are reported below.

Groundwater Travel Time: FHC is located approximately three quarters of a mile (approximately 3,750 feet) north of the Columbia River. All groundwater impacted by the Site flows through an alluvial aquifer at a rate of approximately 0.8 to 6 feet per day and discharges to the river. At the slowest travel rate (0.8 feet per day), groundwater potentially impacted by Site sources would be expected to discharge to the river within 13 years (see Appendix D). FHC closed in January 1983, (34 years ago) and the treatment remedy was completed in September 2003 (14 years ago). Given this history and the groundwater travel time to the river, if PFAS had been released from the Site, it likely has since seeped into the Columbia River and no longer present in the groundwater system.

Downgradient Wells: In 2003, prior to establishing institutional controls, a well survey was conducted in order to identify existing wells that may have been impacted by releases from FHC. No residential water supply wells were located during that survey. However, records were located for four (4) industrial wells downgradient of the Site. The records indicated that three of the four were abandoned in 1999 and the fourth well was assumed to be closed since its location placed it under a condominium complex.

Records filed with Ecology indicate that at least 25 resource protection/monitoring wells were identified downgradient of the Site. The records indicate that all but one of these wells have been abandoned and the one remaining well was not located. Furthermore, during reviews in 2008 and 2013, EPA did not identify any new wells downgradient of the Site. The City of Vancouver prohibits the drilling of new water production wells within the City limits, including the area downgradient of the Site, limiting the potential for future exposure via ingestion of groundwater.

Vancouver Water Supply Wells: The City of Vancouver obtains its drinking water from 40 groundwater supply wells located throughout the City. Two sets of these well are located approximately 1 mile from the Site. One is located upgradient of the Site while the other is cross gradient to the Site.

In 1999, EPA's Environmental Response Team constructed a groundwater model to evaluate a remedial pumping proposal at a nearby location (Data Evaluation and Groundwater Modeling, Vancouver Well Field, 1991). At that time, EPA requested that the groundwater capture areas for Vancouver Water Stations 1 and 4 (WS1 and WS4) be evaluated to assess potential of impacts from FHC or other known sources. Simulations found that FHC was outside of the modeled capture zone under all modeled conditions. Thus, the modeling suggests that it is highly unlikely that any substances released from the FHC Site, including any potential release of PFAS, would have impacted the City of Vancouver's water supply wells.[2]

Conclusion: Based on the above analysis, EPA has determined it highly unlikely that PFAS was used at FHC. Even if PFAS was used and was released into the subsurface, sufficient time has elapsed such that any substance released, either during the plating operations or during the remedial action, would have migrated to, and discharged into, the Columbia River. Finally, EPA found no potential routes of human health exposure (e.g. wells) present downgradient of the Site, and City regulations prohibit locating new wells within the City boundary, including the area downgradient of the FHC/Kelly property. Thus, EPA has determined that further investigation into the potential use and release of PFAS is not warranted at this time.

Groundwater Attainment Determination

Based on the preceding analysis, EPA has determined that the results of the groundwater sampling show attainment of the groundwater cleanup levels and RAOs established for this Site. Furthermore, EPA has not found any significant changes at the Site that might affect the protectiveness of the remedy selected in the RODA, or identified any other information that would jeopardize the protectiveness of the remedy. The remedy has been successfully implemented, no further groundwater monitoring is needed and no further CERCLA action is required at this OU.

VI. SUMMARY OF OPERATION AND MAINTENANCE REQUIRED

The RODA selected an in-situ treatment remedy to address elevated chromium levels in soils

[2] Water from both of these water stations were analyzed for PFAS as part of the Third Unregulated Contaminant Monitoring Event. No PFAS were detected.

and groundwater from releases at the FHC/Kelly property. The remedy is a passive remedy and requires no ongoing operation or maintenance. However, long term groundwater monitoring was required. EPA has determined that the remedy has been successfully implemented and all RAOs and cleanup levels have been achieved. Therefore, no further monitoring is required. The remaining groundwater monitoring wells at the Site should be decommissioned consistent with State regulations. Following decommissioning of the wells, the State Superfund Contract may be terminated.

The Covenant not to Sue signed by Kelly includes seven (7) institutional controls for the FHC Site. Since EPA has determined that the remedy has been successfully implemented, RAOs and cleanup levels have been achieved and no hazardous substances, pollutants or contaminants remain at the Site above levels that could prevent unlimited use and unrestricted exposure, these institutional controls are no longer required as part of the CERCLA remedy and may be removed from the property deed.

VII. DEMONSTRATION OF CLEANUP ACTIVITY QUALITY ASSURANCE & QUALITY CONTROL

Implementation of the Selected Remedy at the Site was completed consistent with the RODs, RODA and remedial design documents reviewed by EPA and Ecology. A Construction Quality Control Plan for the Building Demolition, ISRM Treatment Wall Installation, and Source Area Treatment was developed by EPA's contractor and included EPA quality assurance and quality control procedures and protocols (Weston 2003b). Work plans issued to contractors during the design and construction included Quality Assurance Project Plans (QAPP). All samples collected during the remedial action were collected in accordance with the sampling procedures specified in the remedial design reports, work plans and/or QA/QC plans. The QA/QC procedures implemented are documented in the December 2003 *Frontier Hard Chrome Remedial Action Report*.

EPA's contractor, EPA's remedial project manager and Ecology's site manager performed oversight of construction and sampling to ensure the work was performed in conformance with approved plans and specifications. Oversight included onsite observations of work and review of project submittals.

Long-term groundwater monitoring was conducted consistent with Ecology approved work plans and QAPPs. QA measures implemented were sufficiently rigorous and in conformance with EPA standards. All analytical data used for this assessing attainment was previously verified.

VIII. FIVE-YEAR REVIEW

Two policy five-year reviews have been completed for the Site, the last one in January 2013.

No issues that affected current or future protectiveness were identified as a result of the FYR

completed in January of 2013. All of the follow up actions that were identified but did not affect protectiveness have been addressed. The protectiveness statement in the 2013 FYR concluded that "Because the remedial actions at both OUs are protective, the site is protective of human health and the environment".

Based on the above attainment analysis, the remedy has been fully implemented and the cleanup levels have been attained. No hazardous substances, pollutants or contaminants remain above levels that could prevent unlimited use and unrestricted exposure. A final FYR will be completed in 2018.

IX. SITE COMPLETION CRITERIA

The implemented remedy achieves the degree of cleanup or protection specified in the RODA for all pathways of exposure. All RAOs and associated cleanup goals are consistent with agency policy and guidance. This Site meets all the Site completion requirements as specified in OSWER Directive 9320.2-22, Close-Out Procedures for National Priorities List Sites. All remedial activities at the FHC Site are complete and the Site poses no unacceptable risk to human health or the environment. Therefore, the EPA has determined in accordance with CERCLA that no further response action is necessary at the FHC Site.

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LIST OF ABBREVIATIONS & ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ecology	Washington Department of Ecology
EPA	United States Environmental Protection Agency
FCOR	Final Close Out Report
FFS	Focused Feasibility Study
FHC	Frontier Hard Chrome Superfund Site
FS	Feasibility Study
FYR	Five-Year Review
ICP	Institutional Control Plan
ICs	Institutional Controls
ISRM	In-Situ Redox Manipulation
Kelly	Kelly Development LLC and its affiliates
MCL	Safe Drinking Water Act Maximum Contaminant Level
mg/kg	Milligrams per kilograms
MTCA	Washington State Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OU	Operable Unit
OU 1	Operable Unit 1, Soils
OU 2	Operable Unit 2, Groundwater
O&M	Operation and Maintenance
PCOR	Preliminary Close Out Report
PFAS	Fluorinated or pre-Fluorinated compounds
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance and/or Quality Concern
RAO	Remedial Action Objectives
RI	Remedial Investigation
ROD	Record of Decision
RODA	Record of Decision Amendment
RPM	Remedial Project Manager
Site	Frontier Hard Chrome Superfund Site
UCL	Upper Confidence Level
µg/L	Micrograms per liter

FIGURES

Figure 1: Site Vicinity Map

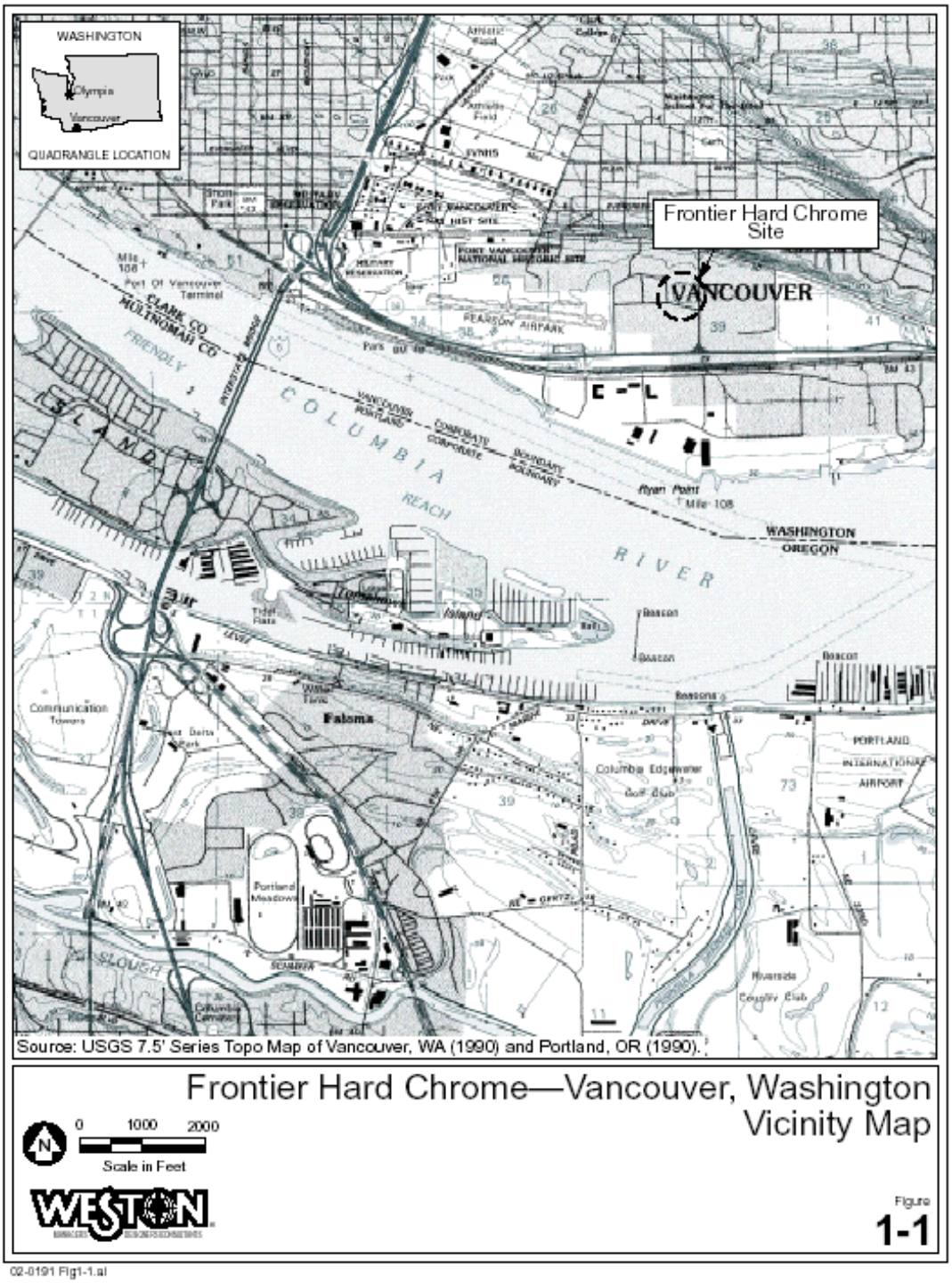
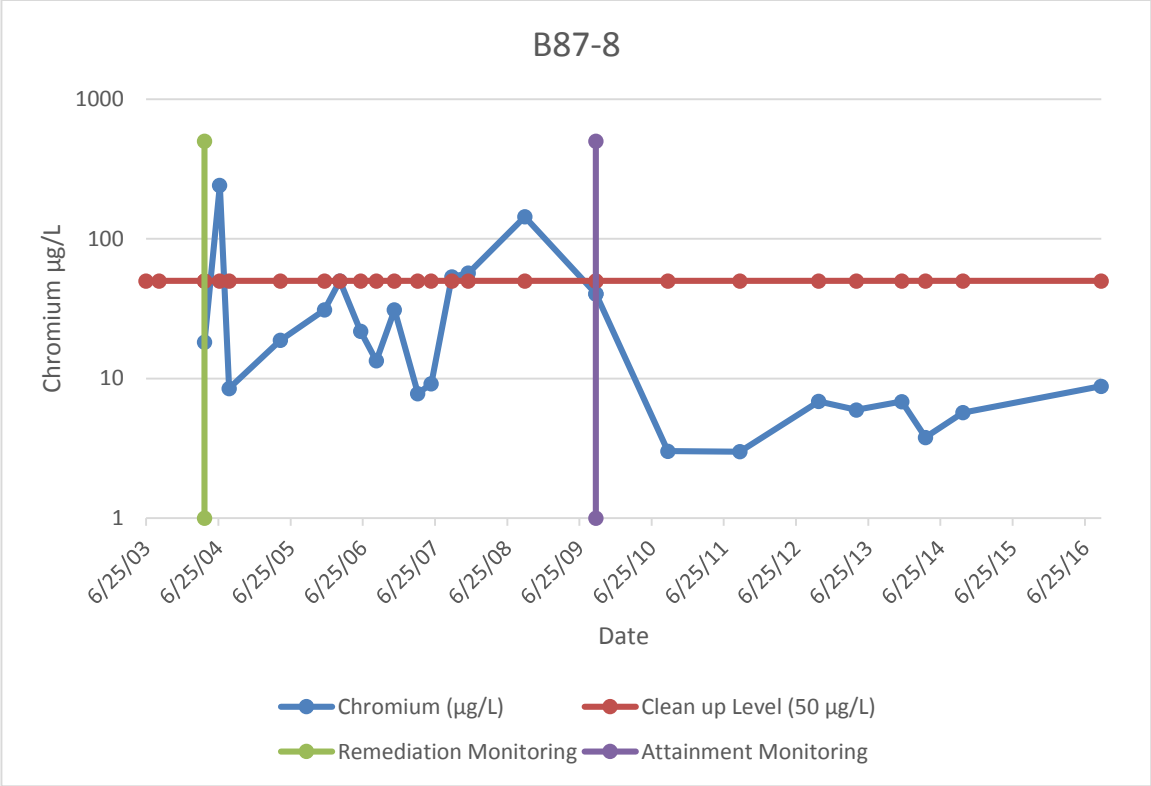


Figure 2: Frontier Hard Chrome Superfund Site Groundwater Monitoring Network (wells highlighted in yellow).

Figure 3: Total Chromium concentration (µg/L) vs Time trend plot. Remediation monitoring started in April15, 2004 and Attainment monitoring began in September 16, 2009. The groundwater remediation or treatment started on June 25, 2003 and the treatment ended on August 29, 2003.



Appendix A

Chronology of Site Events

Event	Date
City of Vancouver determined that chromium in the wastewater from FHC was interfering with the operation of its new secondary treatment system. FHC directed to cease discharge to the sewer system until an appropriate wastewater treatment system could be installed to remove chromium from wastewater discharges at the Site.	1975
Ecology gave the FHC a wastewater disposal permits for discharge of chromium-contaminated wastewater to an on-Site dry well. The permit also contained a schedule for the installation of an appropriate treatment system for the FHC wastewater stream.	1976
Several extensions of the permit and schedule were granted as the deadlines were passed without compliance	1976-1981
Ecology found FHC in violation of the Washington State Dangerous Waste Act for illegally disposing of hazardous wastes.	1982
Ecology prohibits use of dry well for chromium waste disposal. FHC was also required to prepare a plan for the investigation of groundwater. FHC halted all operations at the Site without undertaking the investigation.	1983
EPA and Ecology sign Cooperative Agreement to investigate wastes. Ecology had the lead for the Site until it was listed on the NPL.	March 1983
The Site was listed on the NPL.	September 1983
Remedial Investigation (RI) conducted.	Fall 1984 – Summer 1987
Feasibility Study (FS) was completed.	October 1987
Record of Decision (ROD) for OU 1 (soils/source control) selected excavation of contaminated soils, on-site treatment of excavated materials by chemical stabilization, and replacement of treated materials.	December 1987
Remedial design start for OU 1. Evaluation of the soils remedy by EPA after the ROD was issued revealed that the chosen stabilization method was ineffective at preventing the leaching of hexavalent chromium from site soils.	April 1988
ROD for OU 2 (groundwater) selected a groundwater extraction and treatment system. Groundwater monitoring conducted after the ROD was issued indicated that the contaminated groundwater plume was decreasing in size as down-gradient industrial supply wells located at FHC were taken off line.	July 1988
Ecology conducted an interim removal action by removing approximately 160 cubic yards of chromium-contaminated surface soil on the property adjacent to and east of the FHC Site.	1994
EPA finalized a Focused Feasibility Study (FFS) which identified and evaluated new and innovative technologies. One of those technologies was *In Situ* Redox Manipulation (ISRM).	May 2000
ISRM evaluated further in bench scale test	February 2001
EPA issued a Proposed Plan for cleanup of both soils and groundwater that identified in situ treatment using reducing compounds as the preferred alternative.	June 2001
Amendment to the RODs for OU 1 and OU 2 selected ISRM	August 2001

Event	Date
EPA issued Remedial Design Scope of Work	October 2001
ISRM Wall design completed	December 2002
Phase 1 Building Demolition began and completed	January – February 2003
Source Area Treatment design completed	February 2003
ISRM Wall Installation began and completed	April – August 2003
Phase 2 Building Demolition began and completed	May 2003
Source Area Treatment began and completed	August 2003
Preliminary Close Out Report signed; site achieved construction completion status.	September 2003
Remedial Action Report	December 2003
Kelly Development LLC and EPA sign Agreement and Covenant Not to Sue	July 2004
Operational and Functional Determination; Ecology resumes lead for Site during Operation and Maintenance phase	Fall 2004
Survey of wells impacted by development south of the Site completed	November 2007
Long Term Monitoring Optimization (LTMO) Study assessed the groundwater monitoring network	December 2007
First Five-Year Review	January 29, 2008
Monitoring recommendations from LTMO study adopted	June 2008
Sitewide Ready for Anticipated Use Certification Signed	September 2009
Second Five-Year Review	January 29, 2013
Site owner, (b) (6) notified EPA of his intent to develop the property and volunteered to sample eleven (11) monitoring wells the located within the area he wanted to develop. Using similar sampling procedures and analytical methods as used for other Site sampling, Maul Foster & Alongi. Inc., with EPA oversight, collected the groundwater samples. Samples were sent to Specialty Analytical in Clackamas, Oregon for analysis.	June 2016
Maul Foster & Alongi, Inc. for the Site Owner (b) (6) submitted a Work Plan for the decommissioning of groundwater monitoring wells on the site property. EPA approved the Work Plan and 40-monitoring wells were decommissioned and reported as required in Washington Administrative Code (WAC) 173-16-460.	September 2016

Appendix B

GROUNDWATER ATTAINMENT EVALUATION

APPENDIX B

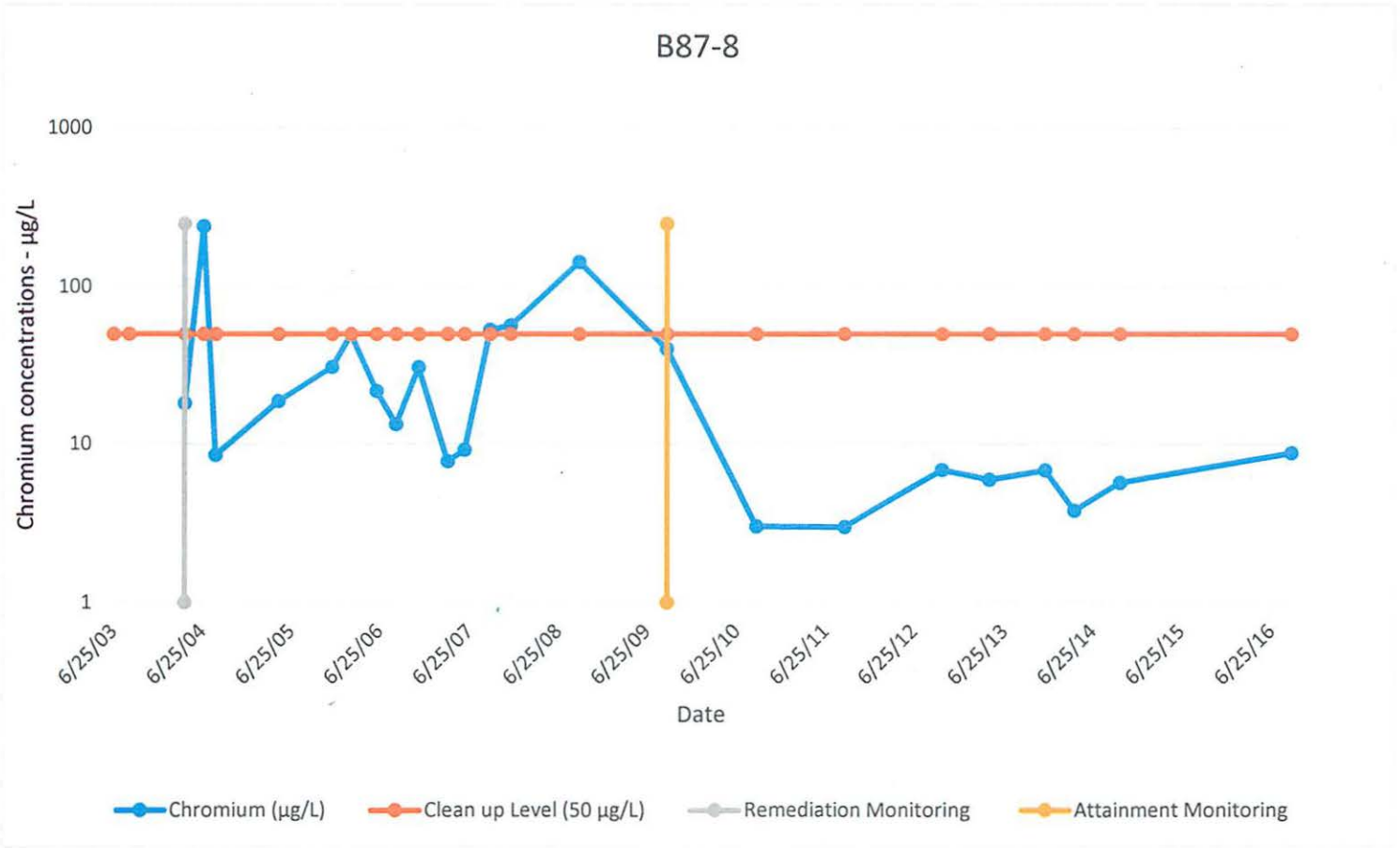
This is the evaluation of the groundwater monitoring network for the Frontier Hard Chrome Superfund Site. This evaluation shows that the groundwater chromium concentration is below the site cleanup level of 50 µg/L or the groundwater remedy has been completed. This monitoring network has 22-monitoring wells. This is a non-statistical approach or visual analysis of the data which can be used if the data is non-detected at the reporting limit or below the cleanup level. Appendix C evaluates monitoring well B87-8 which was the recalcitrant monitoring well. The EPA's Groundwater Statistics Tool used the last nine (9) sampling event to determine the 95% upper confidence limit (UCL) the groundwater concentration was below the cleanup number of 50 µg/L or 26.5 µg/L.

All 22-monitoring wells in the network were evaluated. For each monitoring well location a table was include that contains the station location, the sampling dates, groundwater concentrations and the data qualifier. A concentration plot or chart of the chromium concentration with time was also provided. The chart also shows when remediation monitoring started and when attainment monitoring began along with the cleanup level.

The following are the monitoring wells:

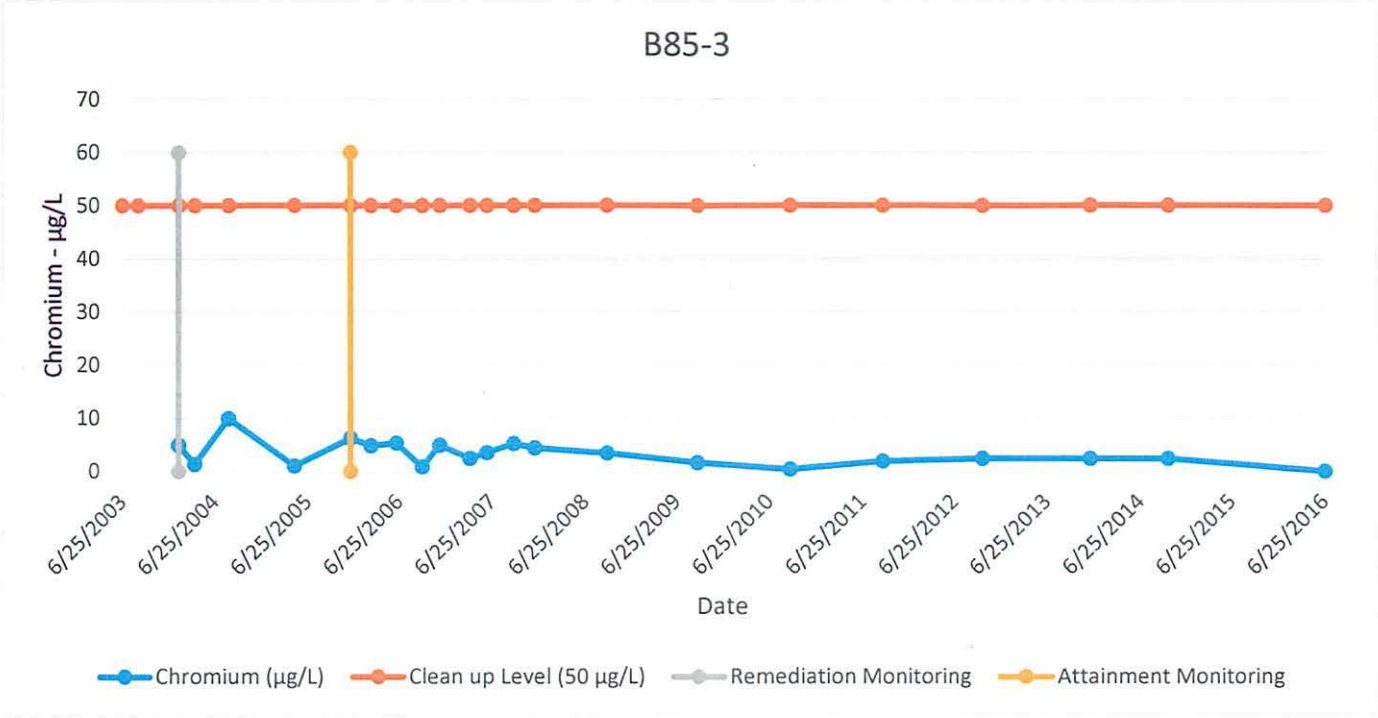
Shallow "A" Zone Wells	Deep "B" Zone Wells
B85-3	**RA-MW-12B**
B85-4	**RA-MW-12C**
B87-8	**RA-MW-15B**
RA-MW-12A	**RA-MW-16B**
RA-MW-15A	**W85-6B**
RA-MW-16A	**W92-16B**
RA-MW-17A	**W97-19B**
W85-6A	**W98-21B**
W92-16A	**W99-R5B**
W97-18A	
W97-19A	
W98-21A	
W99-R5A	

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/03			50	B87-8
8/29/03			50	B87-8
4/15/04	18.2		50	B87-8
7/1/04	241		50	B87-8
8/18/04	8.5	J	50	B87-8
5/4/05	18.8		50	B87-8
12/13/05	31		50	B87-8
3/1/06	50		50	B87-8
6/14/06	21.8		50	B87-8
9/1/06	13.4		50	B87-8
12/2/06	31		50	B87-8
3/30/07	7.8		50	B87-8
6/6/07	9.2		50	B87-8
9/18/07	53.3		50	B87-8
12/11/07	56.9		50	B87-8
9/21/08	144		50	B87-8
9/16/09	40.5		50	B87-8
9/15/10	3.02		50	B87-8
9/14/11	3		50	B87-8
10/17/12	6.86		50	B87-8
4/25/13	5.96		50	B87-8
12/11/13	6.85		50	B87-8
4/10/14	3.79		50	B87-8
10/16/14	5.7		50	B87-8
9/15/16	8.82		50	B87-8



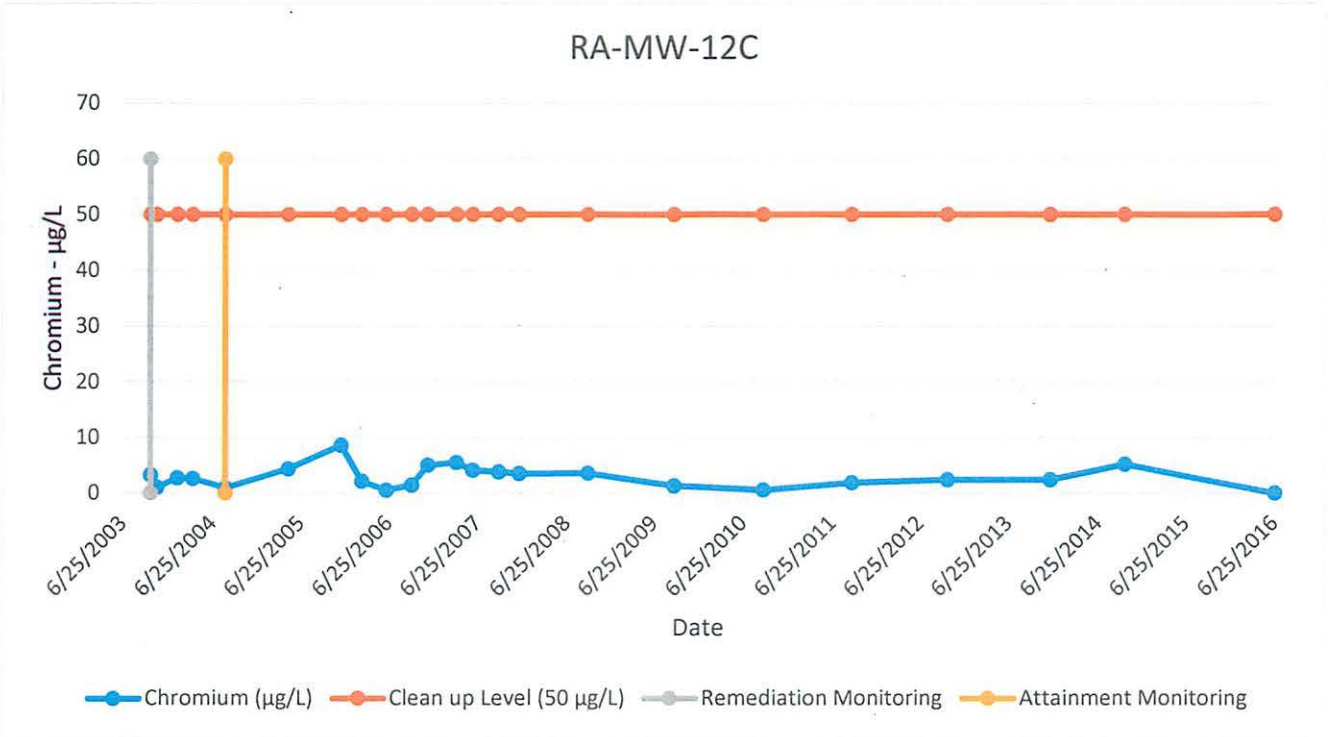
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started April 2004; Attainment monitoring began September 16, 2009

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003			50	B85-3
8/29/2003			50	B85-3
2/5/2004	5	J	50	B85-3
4/7/2004	1.4	U	50	B85-3
8/18/2004	10	U	50	B85-3
5/3/2005	1.1		50	B85-3
12/13/2005	6.3		50	B85-3
3/5/2006	4.9		50	B85-3
6/14/2006	5.4		50	B85-3
9/26/2006	0.9		50	B85-3
12/3/2006	5	U	50	B85-3
4/1/2007	2.5		50	B85-3
6/6/2007	3.6		50	B85-3
9/18/2007	5.3		50	B85-3
12/10/2007	4.5		50	B85-3
9/21/2008	3.5		50	B85-3
9/16/2009	1.73		50	B85-3
9/14/2010	0.5	U	50	B85-3
9/14/2011	2	U	50	B85-3
10/16/2012	2.5	U	50	B85-3
12/11/2013	2.5	U	50	B85-3
10/14/2014	2.5	U	50	B85-3
6/27/2016	0.13		50	B85-3



Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started February 5, 2004; Attainment monitoring began December 13, 2005

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003				
8/29/2003				
10/17/2003	3.3	J	50	RA-MW-12C
11/12/2003	1.1	J	50	RA-MW-12C
2/3/2004	2.8	J	50	RA-MW-12C
4/6/2004	2.7	J	50	RA-MW-12C
8/17/2004	0.98	J	50	RA-MW-12C
5/5/2005	4.4		50	RA-MW-12C
12/12/2005	8.7		50	RA-MW-12C
3/7/2006	2.2		50	RA-MW-12C
6/15/2006	0.6	J	50	RA-MW-12C
9/28/2006	1.5		50	RA-MW-12C
12/4/2006	5.1		50	RA-MW-12C
3/31/2007	5.6		50	RA-MW-12C
6/5/2007	4.2		50	RA-MW-12C
9/19/2007	3.9		50	RA-MW-12C
12-Dec	3.6		50	RA-MW-12C
22-Sep	3.7		50	RA-MW-12C
9/17/2009	1.4		50	RA-MW-12C
9/16/2010	0.66		50	RA-MW-12C
9/15/2011	2	U	50	RA-MW-12C
10/18/2012	2.5	U	50	RA-MW-12C
12/12/2013	2.5	U	50	RA-MW-12C
10/16/2014	5.33		50	RA-MW-12C
6/27/2016	0.1	U	50	RA-MW-12C



Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 10/17/2003; Attainment began 8/17/2004

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/26/2003				
8/29/2003				
10/15/2003	4	U	50	RA-MW-15A
11/11/2003	1.5	J	50	RA-MW-15A
2/4/2004	7.2	J	50	RA-MW-15A
4/5/2004	1.8	J	50	RA-MW-15A
8/17/2004	1.5	J	50	RA-MW-15A
5/4/2005	4.7		50	RA-MW-15A
13-Dec	37		50	RA-MW-15A
3/7/2003	5.3		50	RA-MW-15A
12-Jun	4.6		50	RA-MW-15A
9/26/2006	2.7		50	RA-MW-15A
12/2/2006	5	U	50	RA-MW-15A
3/29/2007	3.7		50	RA-MW-15A
6/4/2007	4		50	RA-MW-15A
9/17/2007	3.1		50	RA-MW-15A
12/12/2007	3.9		50	RA-MW-15A
9/21/2006	2.4		50	RA-MW-15A
9/17/2009	2.62		50	RA-MW-15A
9/16/2010	2.82		50	RA-MW-15A
9/15/2011	2	U	50	RA-MW-15A
10/18/2012	9		50	RA-MW-15A
12/13/2013	2.92		50	RA-MW-15A
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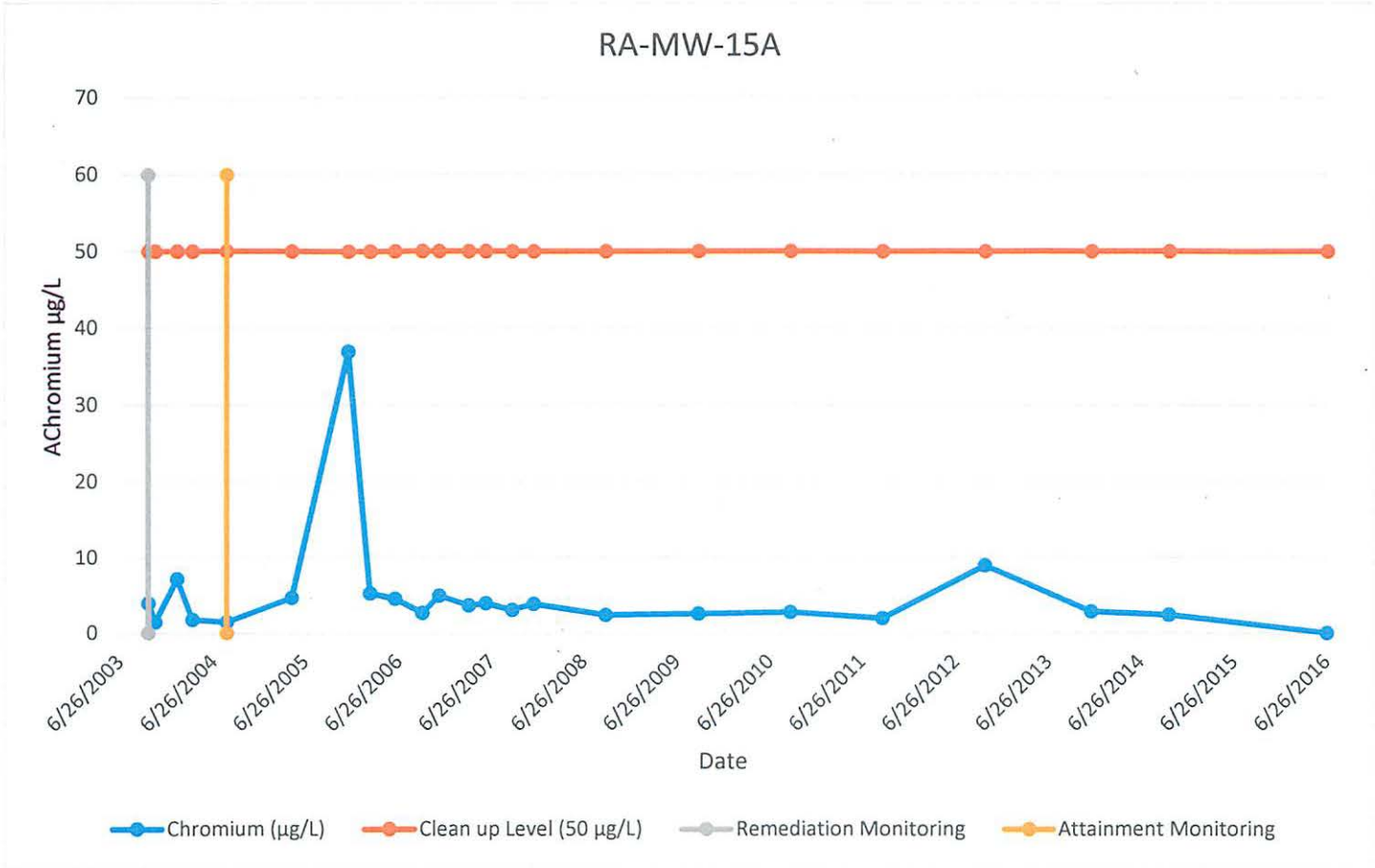
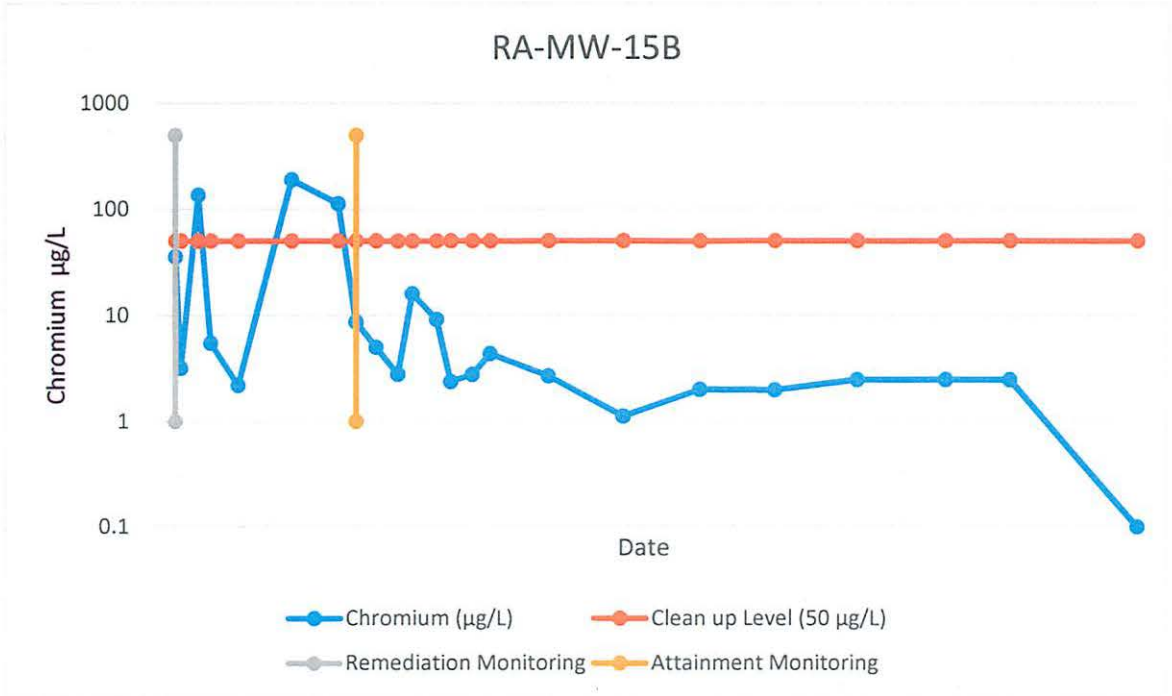
6/27/2016	0.1	U	50	RA-MW-15A



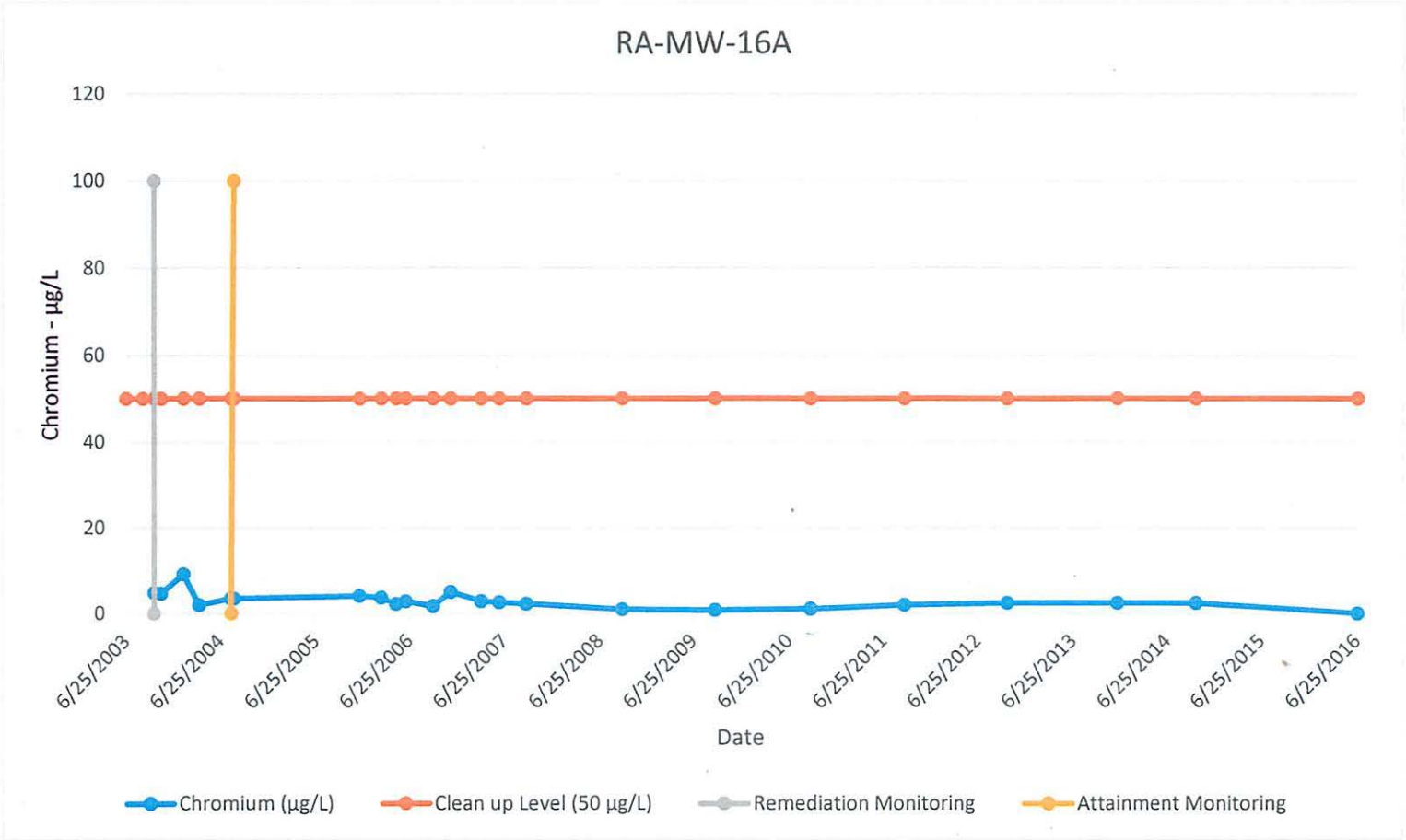
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation Monitoring started 10/15/2003; Attainment Monitoring began 8/17/2004

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003				RA-MW-15B
8/29/2003				RA-MW-15B
10/15/2003			50	
10/15/2003	35.8		50	RA-MW-15B
11/11/2003	3.2	J	50	RA-MW-15B
2/4/2004	136		50	RA-MW-15B
4/5/2004	5.5	J	50	RA-MW-15B
8/17/2004	2.2	J	50	RA-MW-15B
5/4/2005	190		50	RA-MW-15B
12/13/2005	113		50	RA-MW-15B
3/8/2006	8.7		50	
8-Mar	8.7		50	RA-MW-15B
6/12/2006	5	U	50	RA-MW-15B
9/25/2006	2.8		50	RA-MW-15B
12/2/2006	16		50	RA-MW-15B
3/28/2007	9.2		50	RA-MW-15B
6/4/2007	2.4		50	RA-MW-15B
9/17/2007	2.8		50	RA-MW-15B
12/12/2007	4.4		50	RA-MW-15B
9/21/2008	2.7		50	RA-MW-15B
9/17/2009	1.13		50	RA-MW-15B
9/16/2010	2.02		50	RA-MW-15B
9/15/2011	2	U	50	RA-MW-15B
10/18/2012	2.5	U	50	RA-MW-15B
12/13/2013	2.5	U	50	RA-MW-15B
10/15/2014	2.5	U	50	RA-MW-15B
6/27/2016	0.1	U	50	RA-MW-15B



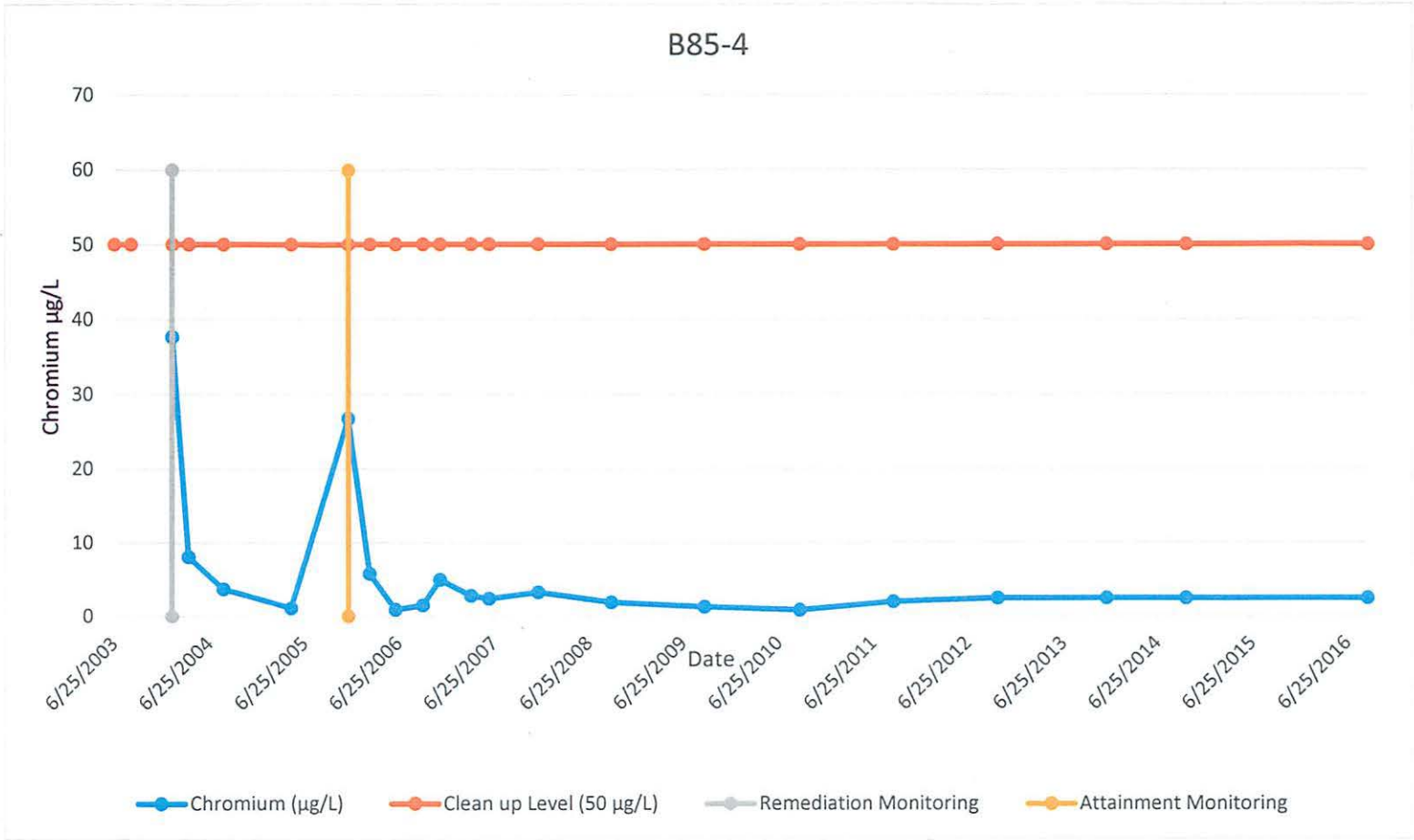
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation Monitoring started 10/15/2003; Attainment Monitoring began 3/08/2006

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003			50	RA-MW-16A
8/29/2003			50	RA-MW-16A
10/14/2003	4.9	J	50	RA-MW-16A
11/10/2003	4.7	J	50	RA-MW-16A
2/4/2004	9.2	J	50	RA-MW-16A
4/5/2004	2	J	50	RA-MW-16A
8/16/2004	3.5	J	50	RA-MW-16A
5/5/2006	2.2		50	RA-MW-16A
12/13/2005	4.1		50	RA-MW-16A
3/7/2006	3.7		50	RA-MW-16A
6/12/2006	2.8		50	RA-MW-16A
9/25/2006	1.7		50	RA-MW-16A
12/2/2006	5	U	50	RA-MW-16A
3/29/2007	2.9		50	RA-MW-16A
6/6/2007	2.6		50	RA-MW-16A
9/18/2007	2.3		50	RA-MW-16A
9/20/2008	1		50	RA-MW-16A
9/16/2009	0.83		50	RA-MW-16A
9/16/2010	1.09		50	RA-MW-16A
9/15/2011	2	U	50	RA-MW-16A
10/18/2012	2.5	U	50	RA-MW-16A
12/13/2013	2.5	U	50	RA-MW-16A
10/16/2014	2.5	U	50	RA-MW-16A
6/27/2016	0.1	U	50	RA-MW-16A



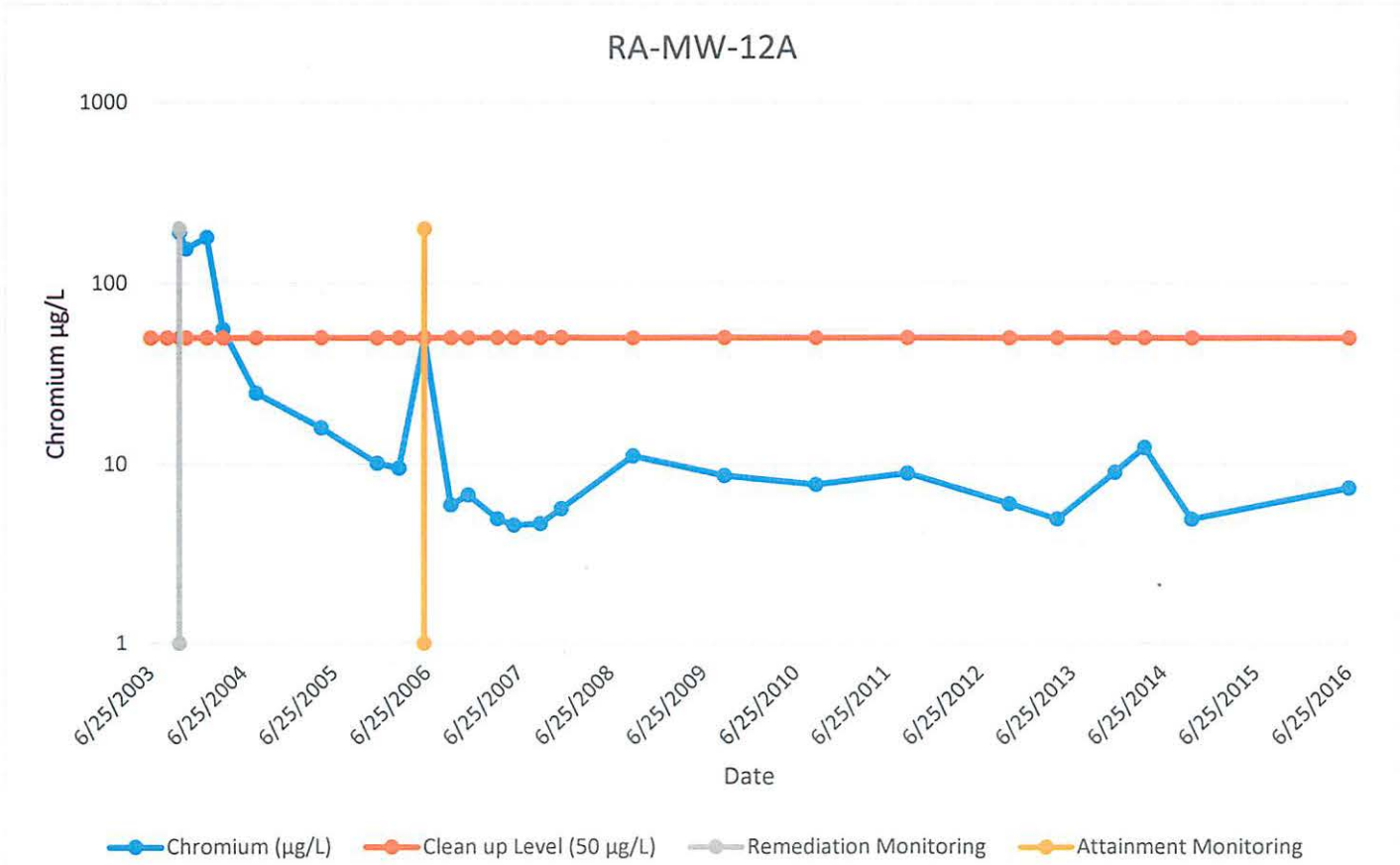
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation Monitoring started 10/14/2003; Attainment Monitoring began 8/06/2004

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003			50	B85-4
8/29/2003			50	B85-4
2/5/2004	37.7		50	B85-4
4/7/2004	8.1	J	50	B85-4
8/18/2004	3.7	J	50	B85-4
5/4/2005	1.1		50	B85-4
12/13/2005	26.8		50	B85-4
3/6/2006	5.8		50	B85-4
6/14/2006	0.9		50	B85-4
9/27/2006	1.5		50	B85-4
12/2/2006	5	U	50	B85-4
3/30/2007	2.8		50	B85-4
6/6/2007	2.4		50	B85-4
12/11/2007	3.3		50	B85-4
9/21/2008	1.9		50	B85-4
9/15/2009	1.31		50	B85-4
9/14/2010	0.86		50	B85-4
9/13/2011	2	U	50	B85-4
10/17/2012	2.5	U	50	B85-4
12/11/2013	2.5	U	50	B85-4
10/15/2014	2.5	U	50	B85-4
9/13/2016	2.5	U	50	B85-4



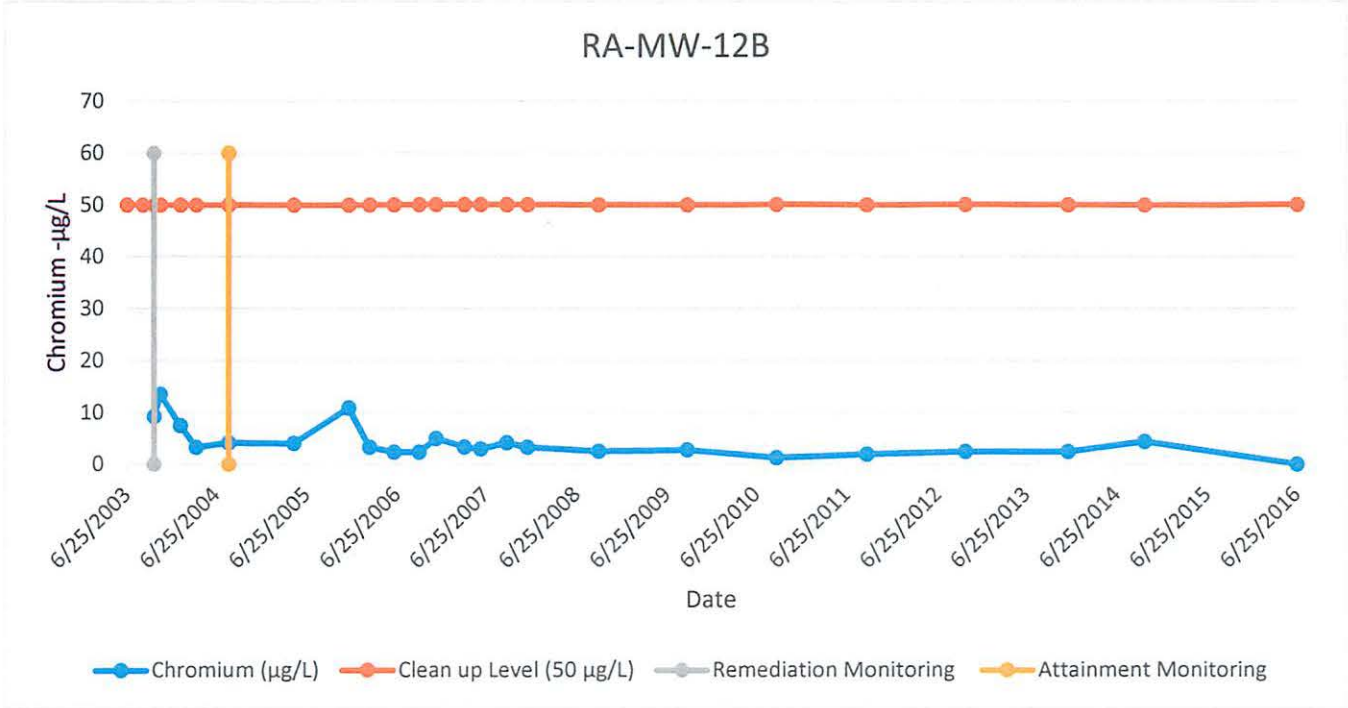
Notes: µg/L = micrograms per liter
J= estimated result
U= analyte not detected above laboratory reporting limit
Treatment ended 8/29/2013; remediation monitoring began 2/5/2004;
attainment monitoring began 12/13/2005

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003			50	RA-MW-12A
8/29/2003			50	
10/17/2003	192		50	
11/12/2003	155		50	
2/2/2004	180		50	
4/6/2004	55.8		50	
8/17/2004	24.9		50	
5/5/2005	16		50	
12/12/2005	10.2		50	
3/7/2006	9.6		50	
6/15/2006	50	U	50	
9/26/2006	6		50	
12/4/2006	6.8		50	
3/30/2007	5		50	
6/5/2007	4.6		50	
9/19/2007	4.7		50	
12/12/2007	5.7		50	
9/22/2008	11.2		50	
9/16/2009	8.68		50	
9/15/2010	7.77		50	
9/15/2011	9		50	
10/18/2012	6.08		50	
4/25/2013	5	U	50	
12/12/2013	9.08		50	
4/10/2014	12.5		50	
10/16/2014	5	U	50	
6/27/2016	7.48	J	50	



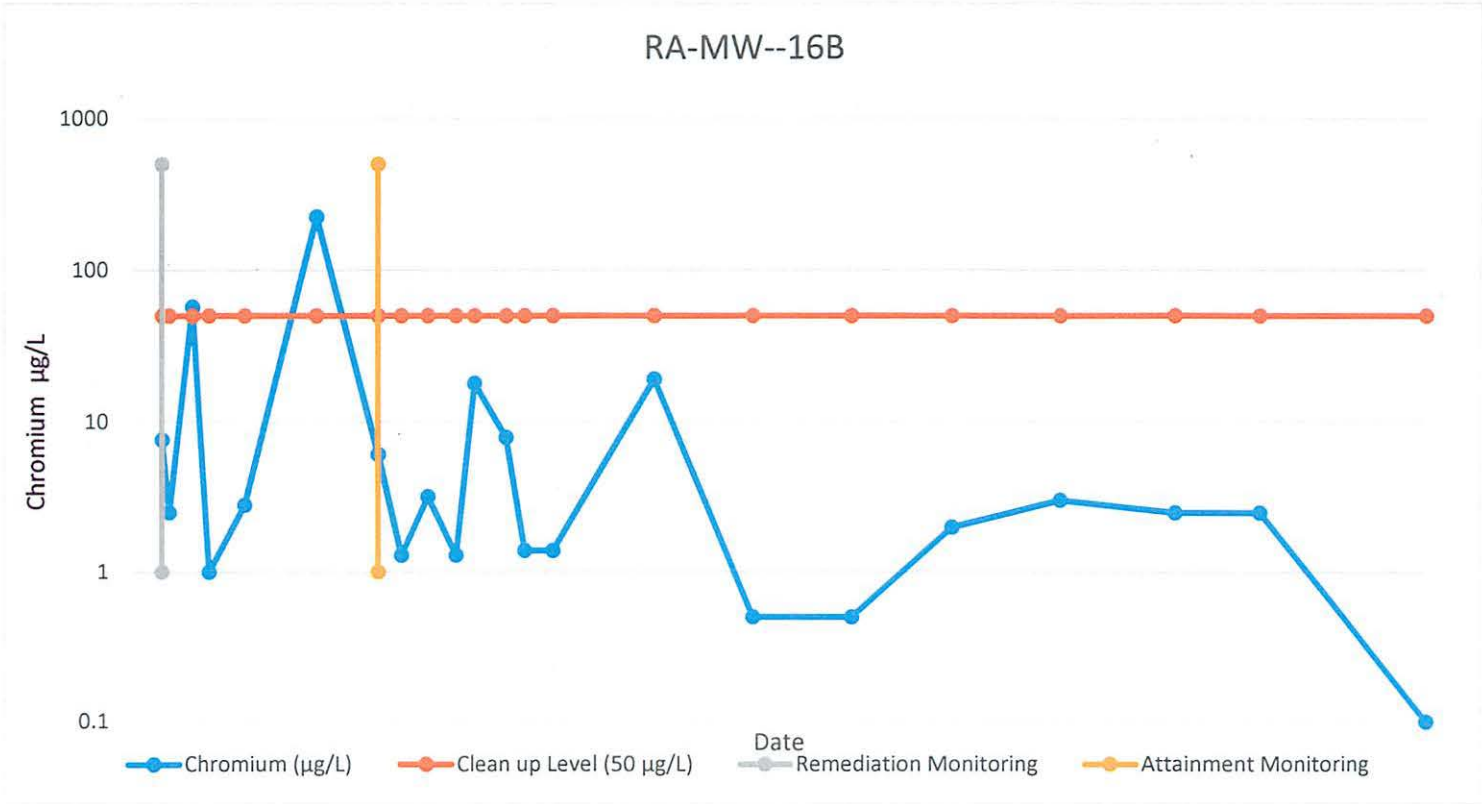
Notes: µg/L = micrograms per liter J= estimated result
U= analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; Treatment ended 8/29/2003; remediation monitoring started 10/17/2003; attainment monitoring started 6/15/2006.

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003				RA-MW-12B
8/29/2003				
10/17/2003	9.3	J	50	
11/12/2003	13.5		50	
2/2/2004	7.5	J	50	
4/6/2004	3.3	U	50	
8/17/2004	4.2	J	50	
5/5/2005	4.1		50	
12/12/2005	10.9		50	
3/7/2006	3.3		50	
6/15/2006	2.4		50	
9/26/2006	2.4		50	
12/4/2006	5	U	50	
3/30/2007	3.4		50	
6/5/2007	3		50	
9/19/2007	4.2		50	
12/12/2007	3.3		50	
9/22/2008	2.6		50	
9/17/2009	2.84		50	
9/16/2010	1.32		50	
9/15/2011	2	U	50	
10/18/2012	2.5	U	50	
12/12/2013	2.5	U	50	
10/16/2014	4.44		50	
6/27/2016	0.1	U	50	



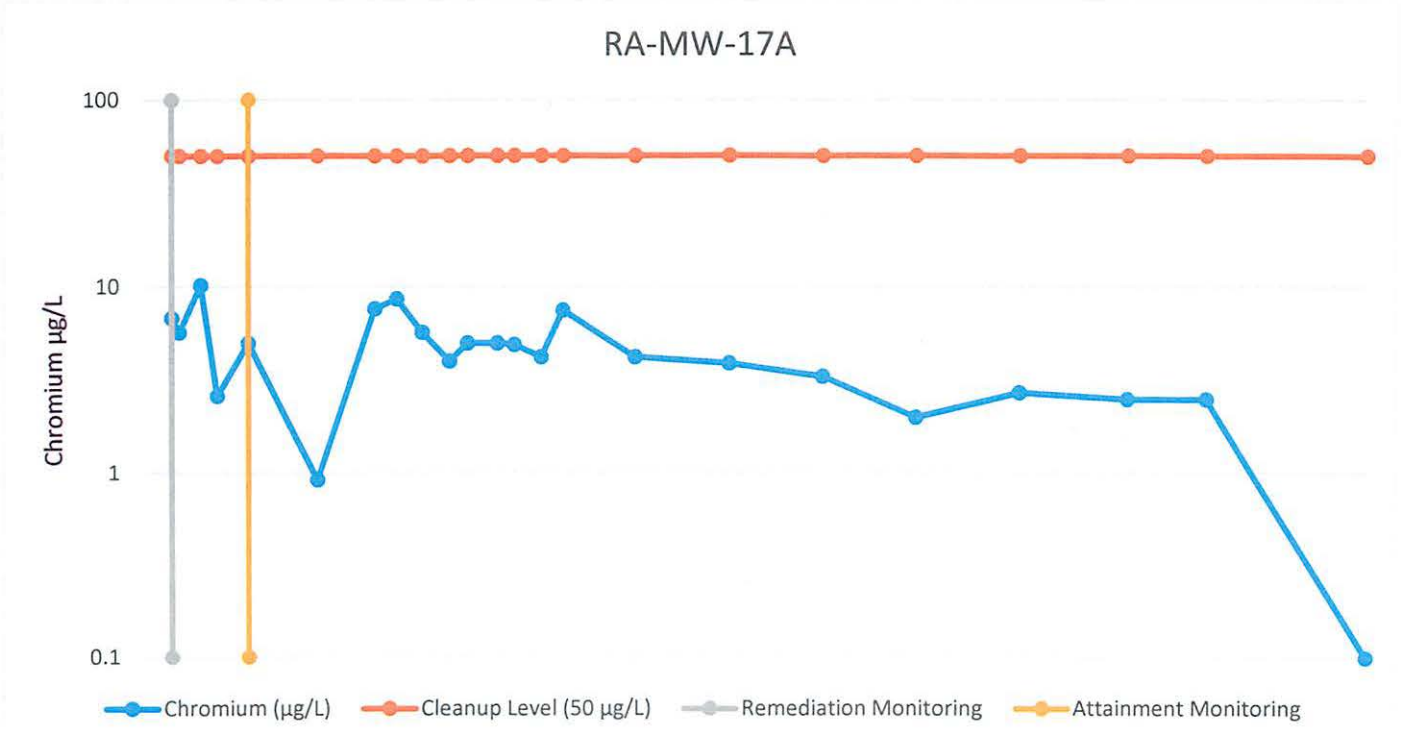
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory
Treatment started 6/25/2003; Treatment ended 8/29/2003
Remediation monitoring started 10/17/2003; Attainment monitoring started 8/17/2004

Date	Chromium (µg/L)	Qualifer	Clean up Level (50 µg/L)	Station Location
6/25/2003				RA-MW-16B
8/29/2003				RA-MW-16B
10/14/2003	7.6	J	50	RA-MW-16B
11/10/2003	2.5	J	50	RA-MW-16B
2/4/2004	57.4	J	50	RA-MW-16B
4/5/2004	1	J	50	RA-MW-16B
8/16/2004	2.8	J	50	RA-MW-16B
5/5/2005	225		50	RA-MW-16B
12/13/2005	6.1		50	RA-MW-16B
3/7/2006	1.3		50	RA-MW-16B
6/12/2006	3.2		50	RA-MW-16B
9/25/2006	1.3		50	RA-MW-16B
12/2/2006	18		50	RA-MW-16B
3/29/2007	7.9		50	RA-MW-16B
6/6/2007	1.4		50	RA-MW-16B
9/18/2007	1.4		50	RA-MW-16B
9/20/2008	19.2		50	RA-MW-16B
9/16/2009	0.5	U	50	RA-MW-16B
9/16/2010	0.5	U	50	RA-MW-16B
9/15/2011	2	U	50	RA-MW-16B
10/18/2012	3.03		50	RA-MW-16B
12/13/2013	2.5	U	50	RA-MW-16B
10/16/2014	2.5	U	50	RA-MW-16B
6/27/2016	0.1	U	50	RA-MW-16B



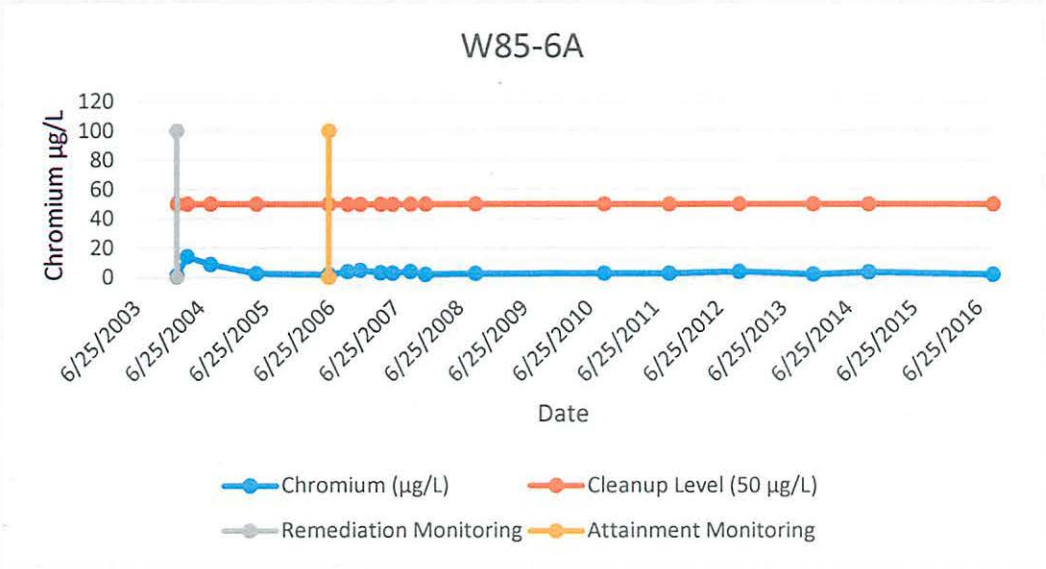
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation Monitoring started 10/14/2003; Attainment Monitoring began 12/13/2005

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				RA-MW-17A
8/29/2003				RA-MW-17A
10/14/2003	6.8	J	50	RA-MW-17A
11/11/2003	5.7	J	50	RA-MW-17A
2/3/2004	10.2	J	50	RA-MW-17A
4/6/2004	2.6	J	50	RA-MW-17A
8/6/2004	5	J	50	RA-MW-17A
5/5/2005	0.92		50	RA-MW-17A
12/13/2005	7.6		50	RA-MW-17A
3/7/2006	8.6		50	RA-MW-17A
6/13/2006	5.7		50	RA-MW-17A
9/26/2006	4		50	RA-MW-17A
12/4/2006	5	U	50	RA-MW-17A
3/29/2007	5		50	RA-MW-17A
6/4/2007	4.9		50	RA-MW-17A
9/17/2007	4.2		50	RA-MW-17A
12/12/2007	7.5		50	RA-MW-17A
9/20/2008	4.2		50	RA-MW-17A
9/17/2009	3.9		50	RA-MW-17A
9/15/2010	3.31		50	RA-MW-17A
9/15/2011	2	U	50	RA-MW-17A
10/17/2012	2.71		50	RA-MW-17A
12/13/2013	2.5	U	50	RA-MW-17A
10/16/2014	2.5	U	50	RA-MW-17A
6/28/2016	0.1	U	50	RA-MW-17A



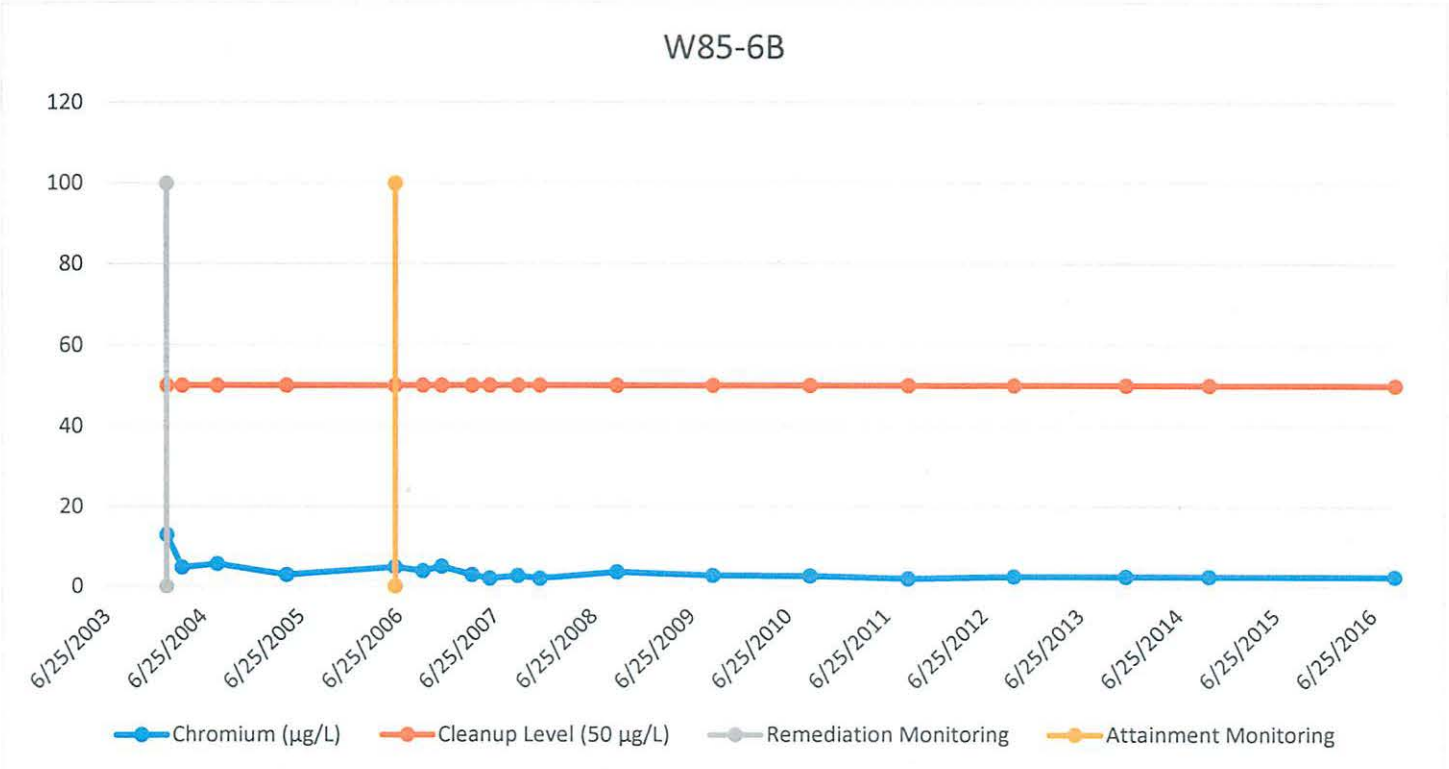
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started on 10/14/2003; Attainment monitoring began 8/6/2004

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W85-6A
8/29/2003				W85-6A
2/9/2004	1.4	J	50	W85-6A
4/8/2004	14.3		50	W85-6A
8/19/2004	9.1	J	50	W85-6A
5/4/2005	2.9		50	W85-6A
6/12/2006	2.2		50	W85-6A
25-Sep	4.1		50	W85-6A
12/5/2006	5	U	50	W85-6A
3/30/2007	3.4		50	W85-6A
6/5/2007	3.2		50	W85-6A
9/16/2007	4.1		50	W85-6A
12/10/2007	2.1		50	W85-6A
9/20/2008	2.9		50	W85-6A
9/15/2010	3.06		50	W85-6A
9/13/2011	3		50	W85-6A
10/16/2012	4.21		50	W85-6A
10-Dec	2.5	U	50	W85-6A
10/14/2014	3.99		50	W85-6A
9/12/2016	2.5	U	50	W85-6A



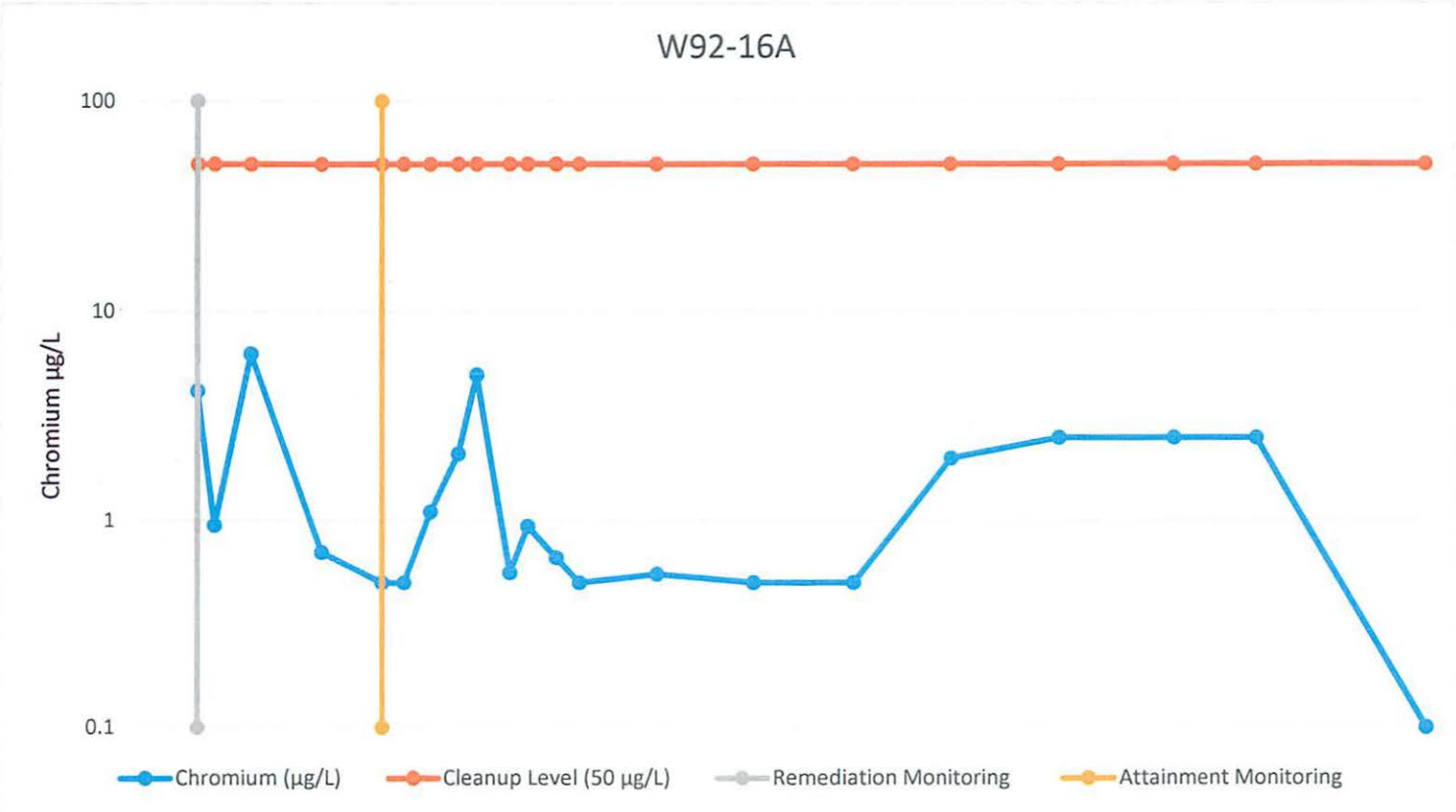
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/9/2004; Attainment monitoring began 6/12/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W85-6B
8/29/2003				W85-6B
2/9/2004	12.9		50	W85-6B
4/8/2004	4.7	J	50	W85-6B
8/19/2004	5.6	J	50	W85-6B
5/4/2005	2.9		50	W85-6B
6/12/2006	4.8		50	W85-6B
9/25/2006	3.8		50	W85-6B
12/5/2006	5	U	50	W85-6B
3/30/2007	2.9		50	W85-6B
6/5/2007	2		50	W85-6B
9/18/2007	2.6		50	W85-6B
10-Dec	2		50	W85-6B
9/20/2008	3.6		50	W85-6B
9/15/2009	2.69		50	W85-6B
9/14/2010	2.65		50	W85-6B
9/13/2011	2	U	50	W85-6B
10/16/2012	2.5		50	W85-6B
12/10/2013	2.5	U	50	W85-6B
10/14/2014	2.5	U	50	W85-6B
9/13/2016	2.5	U	50	W85-6B



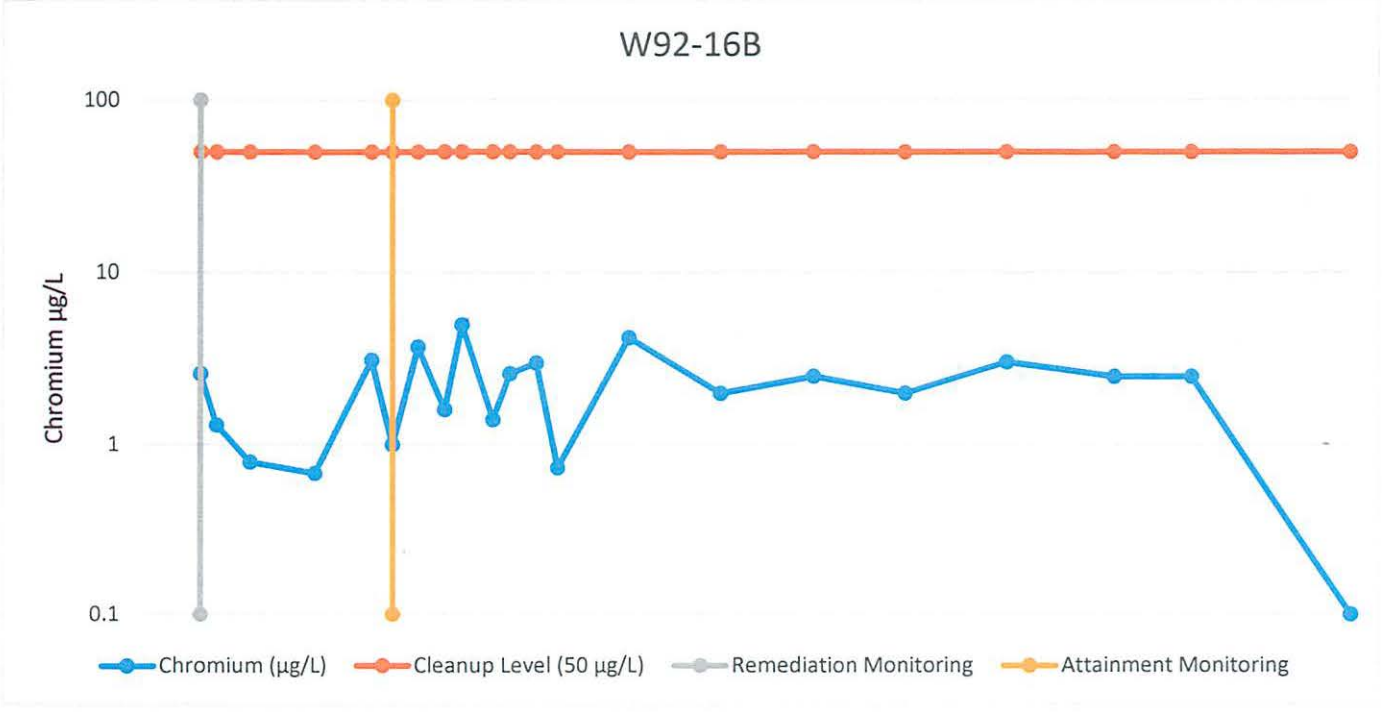
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/9/2004; Attainment monitoring began 6/12/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W92-16A
8/29/2003				W92-16A
2/5/2004	4.2	J	50	W92-16A
4/7/2004	0.95	U	50	W92-16A
8/18/2004	6.3	J	50	W92-16A
5/3/2005	0.7		50	W92-16A
12/14/2005	0.5	U	50	W92-16A
3/6/2006	0.5	U	50	W92-16A
6/14/2006	1.1		50	W92-16A
9/26/2006	2.1		50	W92-16A
12/2/2006	5	U	50	W92-16A
4/1/2007	0.56		50	W92-16A
6/6/2007	0.94		50	W92-16A
9/18/2007	0.66		50	W92-16A
12/11/2007	0.5	U	50	W92-16A
9/22/2008	0.55		50	W92-16A
9/16/2009	0.5	U	50	W92-16A
9/16/2010	0.5	U	50	W92-16A
9/14/2011	2	U	50	W92-16A
10/17/2012	2.5	U	50	W92-16A
12/12/2013	2.5	U	50	W92-16A
10/15/2014	2.5	U	50	W92-16A
6/27/2016	0.1	U	50	W92-16A



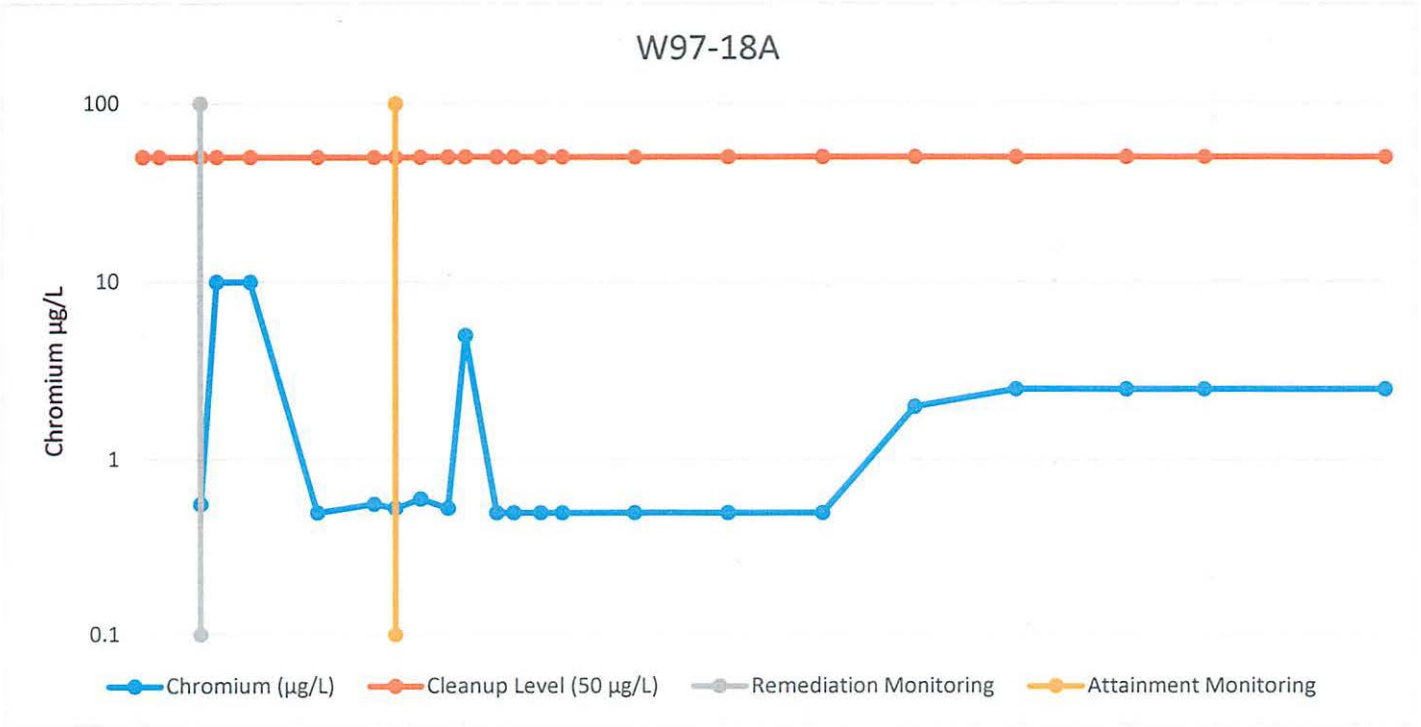
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/05/2004; Attainment monitoring began 12/14/2005

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W92-16B
8/29/2003				W92-16B
2/5/2004	2.6	J	50	W92-16B
4/7/2004	1.3	U	50	W92-16B
8/18/2004	0.79	J	50	W92-16B
5/3/2005	0.68		50	W92-16B
12/14/2005	3.1		50	W92-16B
3/6/2006	1		50	W92-16B
6/14/2006	3.7		50	W92-16B
9/26/2006	1.6		50	W92-16B
12/2/2006	5	U	50	W92-16B
4/1/2007	1.4		50	W92-16B
6/6/2007	2.6		50	W92-16B
9/18/2007	3		50	W92-16B
12/11/2007	0.73		50	W92-16B
9/22/2008	4.2		50	W92-16B
9/16/2009	1.99		50	W92-16B
9/15/2010	2.51		50	W92-16B
9/14/2011	2	U	50	W92-16B
10/17/2012	3.03		50	W92-16B
12/12/2013	2.5	U	50	W92-16B
10/15/2014	2.5	U	50	W92-16B
6/27/2016	0.1	U	50	W92-16B



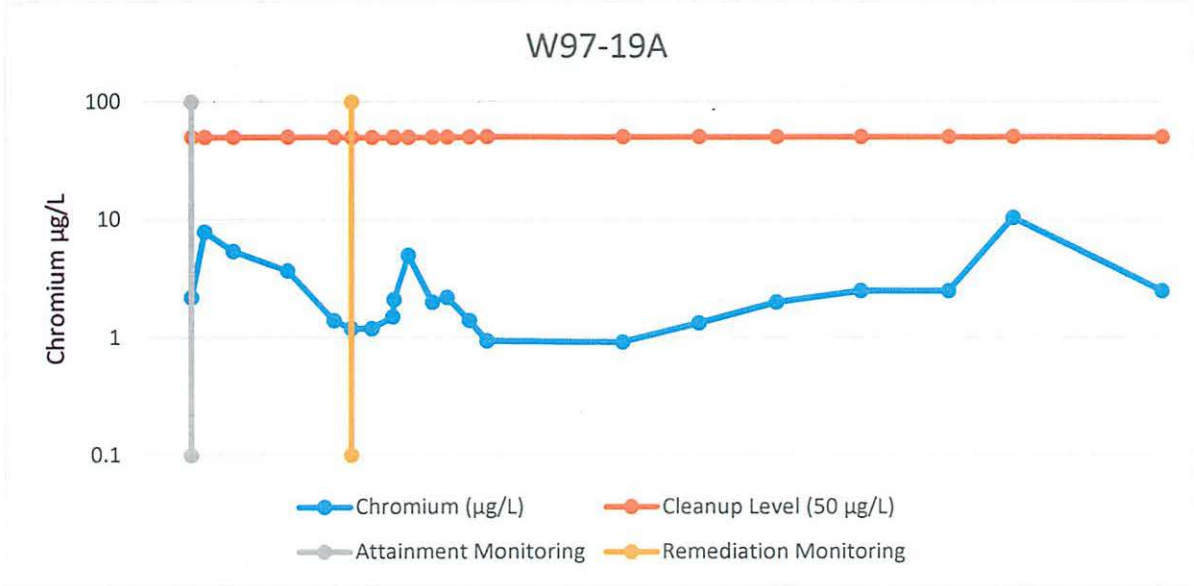
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/5/2004; Attainment monitoring began 3/6/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W97-18A
8/29/2003				W97-18A
2/5/2004	0.56	J	50	W97-18A
4/7/2004	10	U	50	W97-18A
8/15/2004	10	U	50	W97-18A
5/4/2005	0.5		50	W97-18A
12/14/2005	0.56		50	W97-18A
3/8/2006	0.53		50	W97-18A
6/13/2006	0.6		50	W97-18A
9/27/2006	0.53		50	W97-18A
12/2/2006	5	U	50	W97-18A
4/1/2007	0.5	U	50	W97-18A
6/6/2007	0.5	U	50	W97-18A
9/18/2007	0.5	U	50	W97-18A
12/11/2007	0.5	U	50	W97-18A
9/21/2008	0.5	U	50	W97-18A
9/21/2009	0.5	U	50	W97-18A
9/16/2010	0.5	U	50	W97-18A
9/13/2011	2	U	50	W97-18A
10/12/2012	2.5	U	50	W97-18A
12/11/2013	2.5	U	50	W97-18A
10/15/2014	2.5	U	50	W97-18A
9/14/2016	2.5	U	50	W97-18A



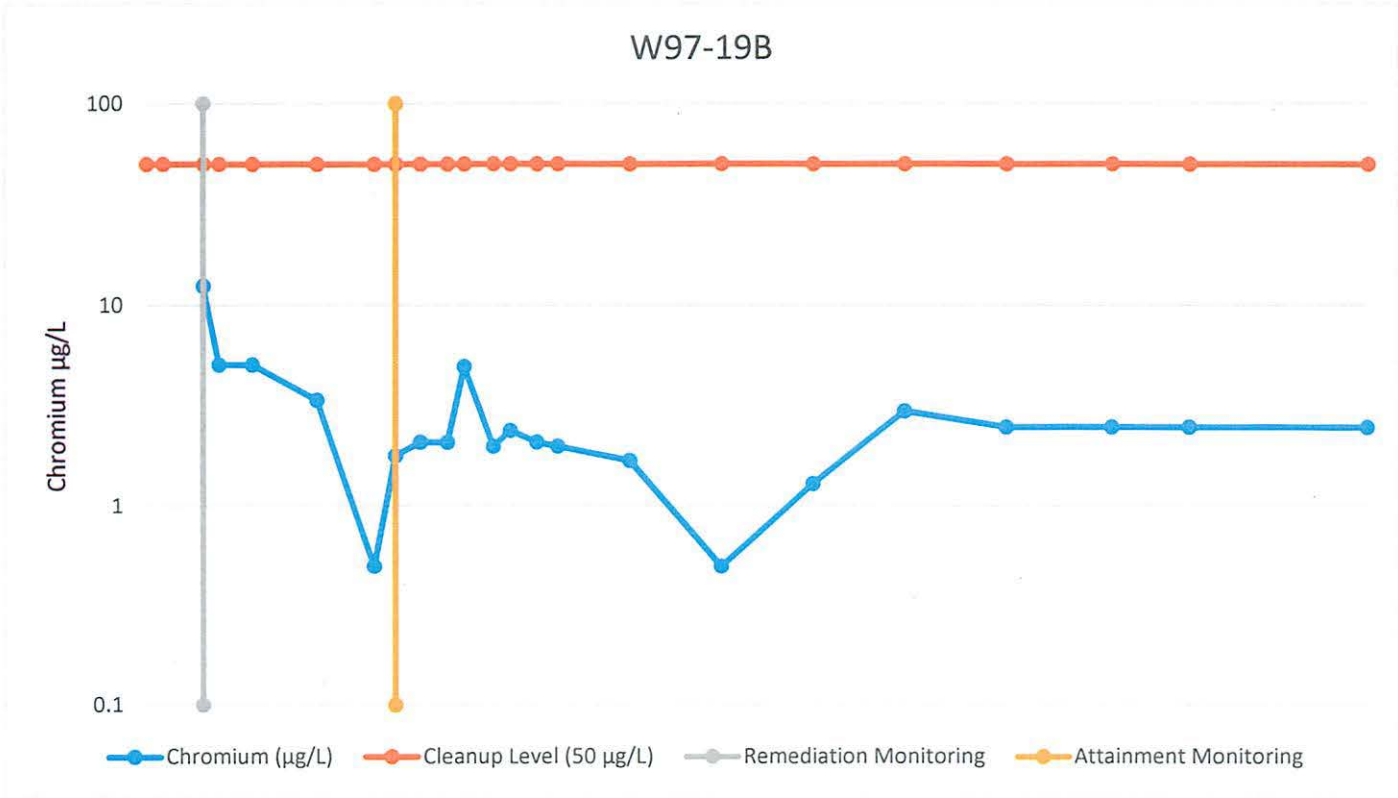
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/5/2004; Attainment monitoring began 3/8/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W97-19A
8/29/2003				
2/6/2004	2.2	J	50	W97-19A
4/8/2004	7.9	J	50	W97-19A
8/19/2004	5.4	J	50	W97-19A
5/4/2005	3.7		50	W97-19A
12/14/2005	1.4		50	W97-19A
3/6/2006	1.2		50	W97-19A
6/13/2006	1.2		50	W97-19A
9/27/2006	2.1		50	W97-19A
12/3/2006	5	U	50	W97-19A
3/29/2007	2		50	W97-19A
6/5/2007	2.2		50	W97-19A
9/19/2007	1.4		50	W97-19A
12/11/2007	0.94		50	W97-19A
9/20/2006	1.5		50	W97-19A
9/14/2009	0.92		50	W97-19A
9/14/2010	1.33		50	W97-19A
9/12/2011	2	U	50	W97-19A
10/15/2012	2.5	U	50	W97-19A
12/10/2013	2.5	U	50	W97-19A
10/13/2014	10.4		50	W97-19A
9/14/2016	2.5	U	50	W97-19A



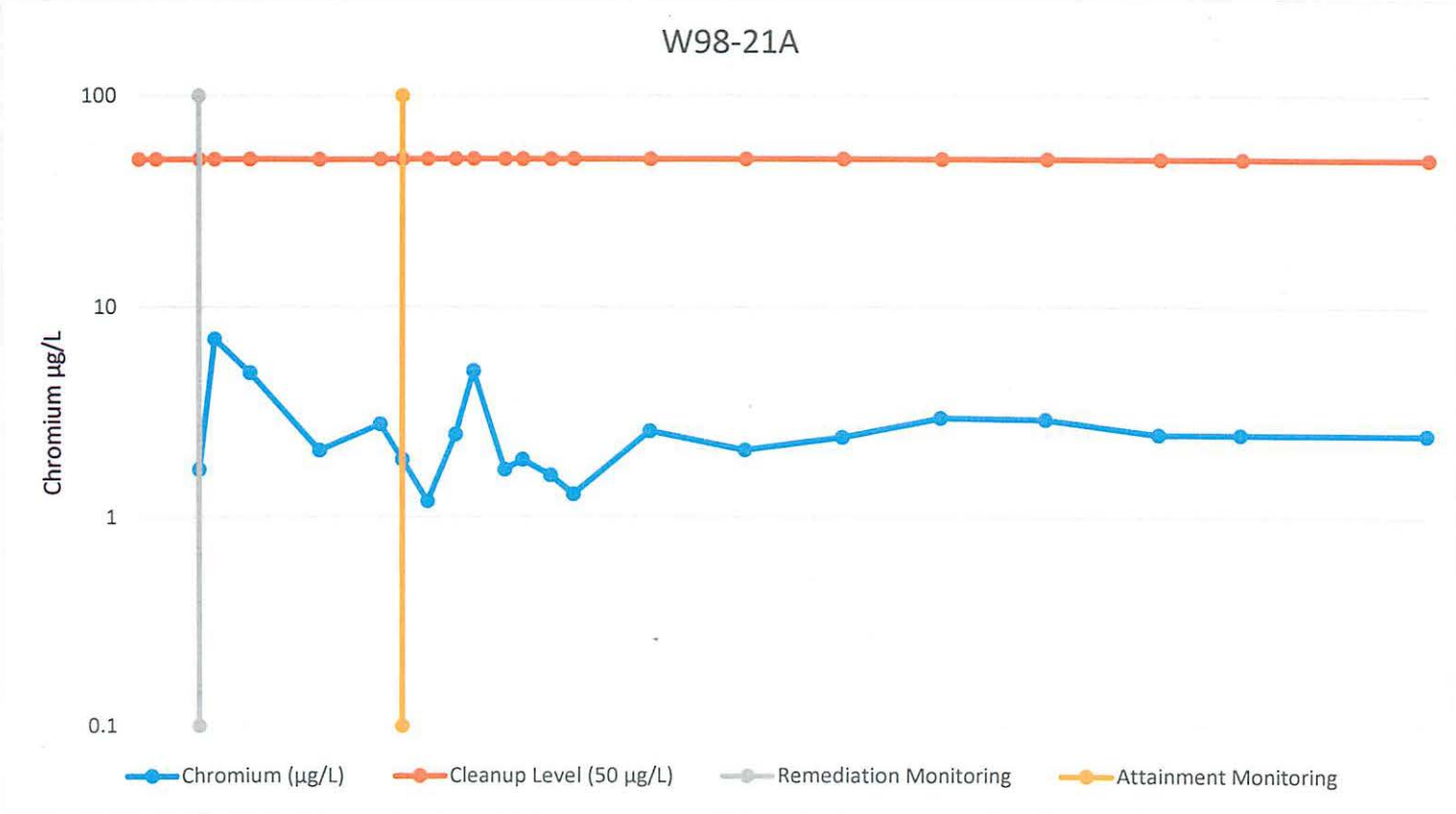
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/6/2004; Attainment monitoring began 3/6/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W97-19B
8/29/2003				
2/5/2004	12.5	J	50	W97-19B
4/8/2004	5.1	J	50	W97-19B
8/19/2004	5.1	J	50	W97-19B
5/4/2005	3.4		50	W97-19B
12/14/2005	0.5	U	50	W97-19B
3/8/2006	1.8		50	W97-19B
6/13/2006	2.1		50	W97-19B
9/27/2006	2.1		50	W97-19B
12/3/2006	5	U	50	W97-19B
3/29/2007	2		50	W97-19B
6/5/2007	2.4		50	W97-19B
9/19/2007	2.1		50	W97-19B
12/11/2007	2		50	W97-19B
9/20/2008	1.7		50	W97-19B
9/14/2009	0.5	U	50	W97-19B
9/14/2010	1.3		50	W97-19B
9/12/2011	3		50	W97-19B
10/15/2012	2.5	U	50	W97-19B
12/10/2013	2.5	U	50	W97-19B
10/13/2014	2.5	U	50	W97-19B
9/14/2016	2.5	U	50	W97-19B



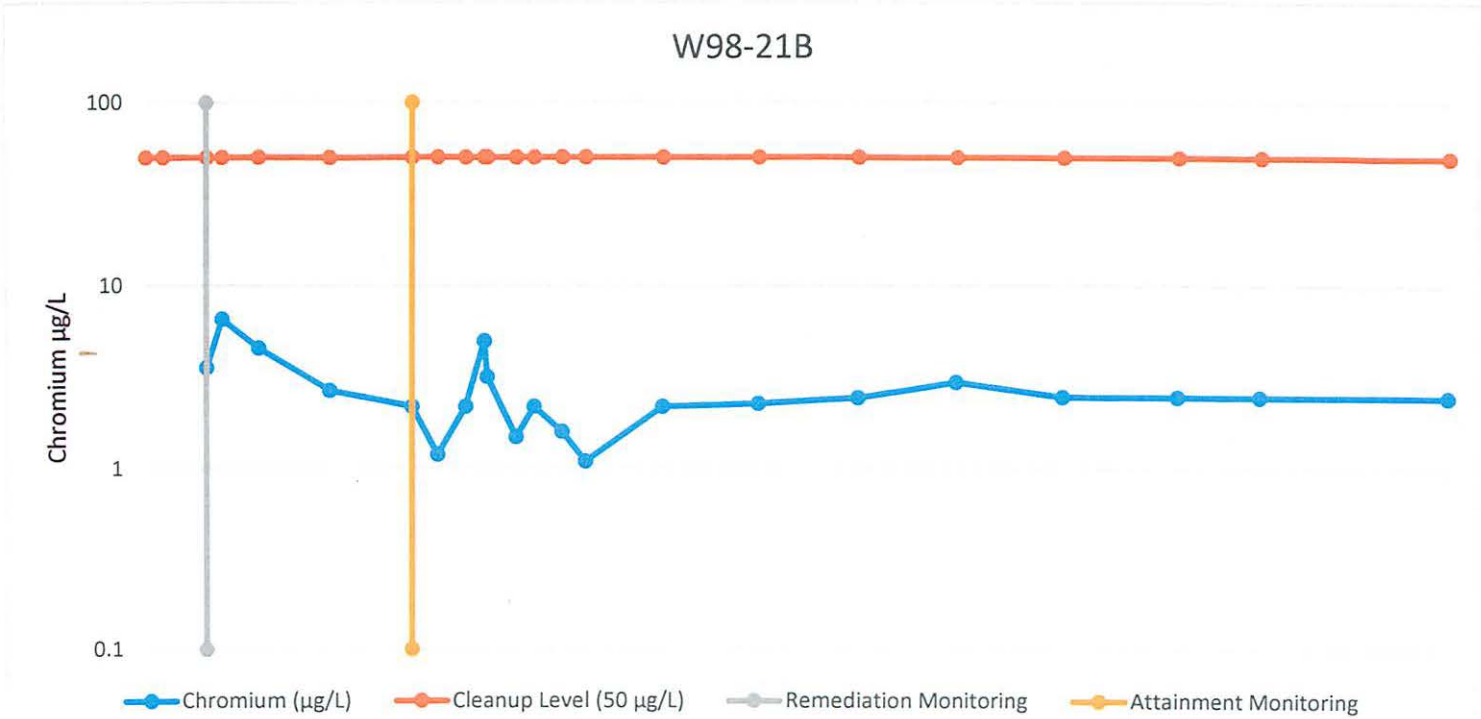
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/5/2004; Attainment monitoring began 3/8/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W98-21A
8/29/2003				W98-21A
2/9/2004	1.7	J	50	W98-21A
4/8/2004	7.1	J	50	W98-21A
8/19/2004	4.9	J	50	W98-21A
5/4/2005	2.1		50	W98-21A
12/14/2005	2.8		50	W98-21A
3/8/2006	1.9		50	W98-21A
6/12/2006	1.2		50	W98-21A
9/25/2006	2.5		50	W98-21A
12/3/2006	5	U	50	W98-21A
3/31/2007	1.7		50	W98-21A
6/5/2007	1.9		50	W98-21A
9/18/2007	1.6		50	W98-21A
12/11/2007	1.3		50	W98-21A
9/20/2008	2.6		50	W98-21A
9/15/2009	2.11		50	W98-21A
9/15/2010	2.43		50	W98-21A
9/14/2011	3		50	W98-21A
10/16/2012	2.95		50	W98-21A
12/11/2013	2.5	U	50	W98-21A
10/14/2014	2.5	U	50	W98-21A
9/14/2016	2.5	U	50	W98-21A



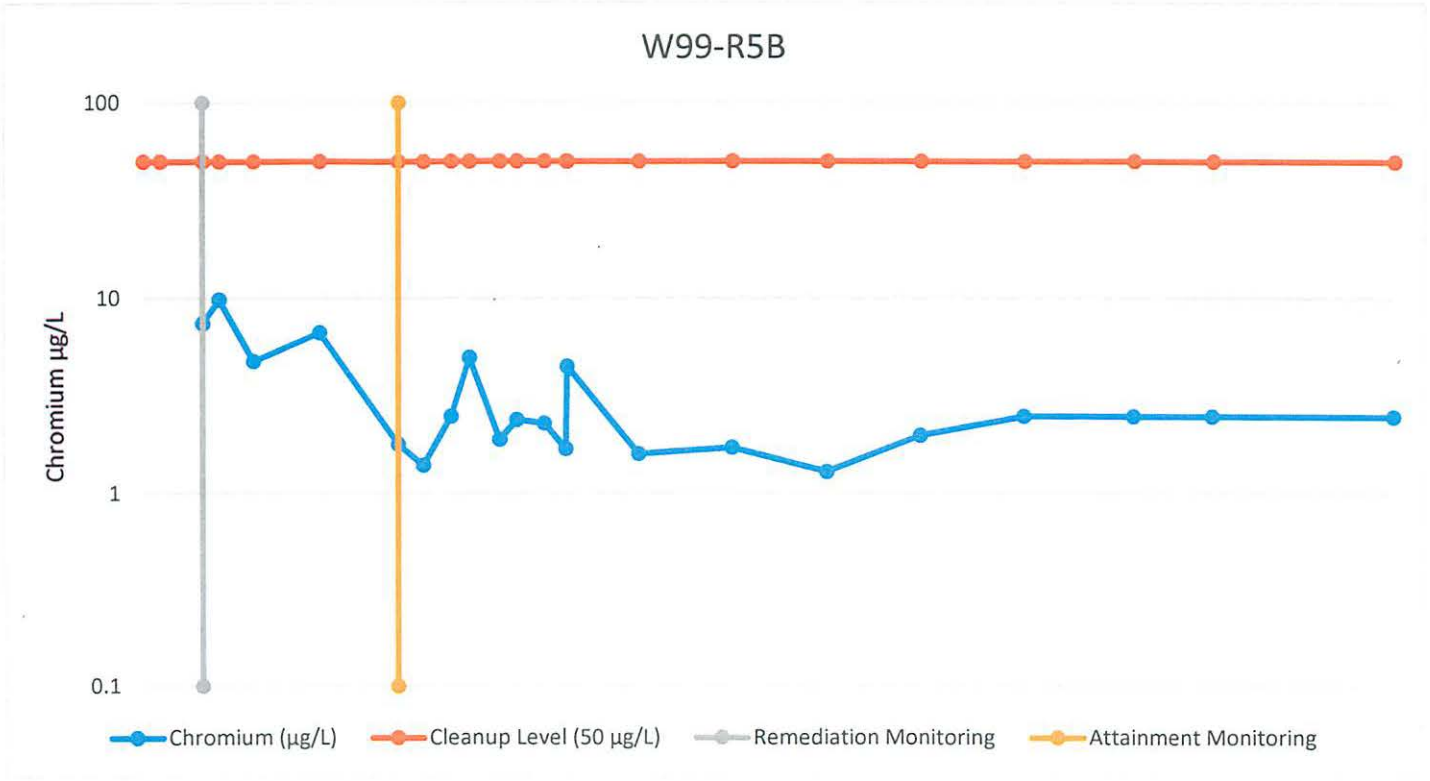
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation started 2/9/2004; Attainment monitoring began 3/8/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W98-21B
8/29/2003				W98-21B
2/9/2004	3.6	J	50	W98-21B
4/6/2004	6.6	J	50	W98-21B
8/19/2004	4.6	J	50	W98-21B
5/4/2005	2.7		50	W98-21B
12/14/2006	3.2		50	W98-21B
3/8/2006	2.2		50	W98-21B
6/12/2006	1.2		50	W98-21B
9/25/2006	2.2		50	W98-21B
12/3/2006	5	U	50	W98-21B
3/31/2007	1.5		50	W98-21B
6/5/2007	2.2		50	W98-21B
9/16/2007	1.6		50	W98-21B
12/11/2007	1.1		50	W98-21B
9/20/2008	2.2		50	W98-21B
9/15/2009	2.28		50	W98-21B
9/15/2010	2.47		50	W98-21B
9/14/2011	3		50	W98-21B
10/16/2012	2.5	U	50	W98-21B
12/11/2013	2.5	U	50	W98-21B
10/14/2014	2.5	U	50	W98-21B
9/14/2016	2.5	U	50	W98-21B



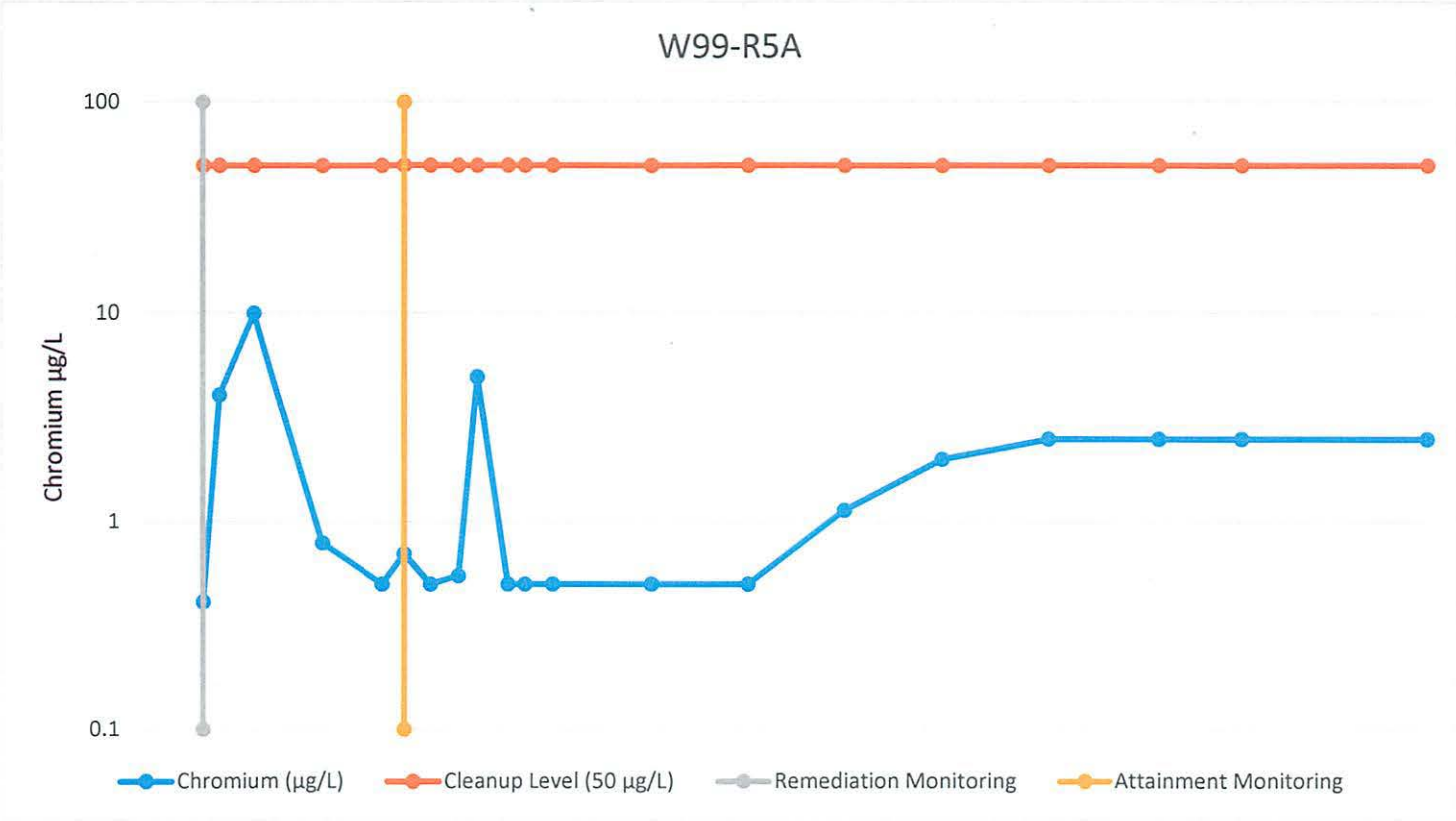
Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/9/2004; Attainment monitoring began 3/8/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W99-R5B
8/29/2003				
2/7/2004	7.5	J	50	W99-R5B
4/9/2004	9.9	J	50	W99-R5B
8/19/2004	4.8	J	50	W99-R5B
5/3/2005	6.7		50	W99-R5B
14-Dec	4.5		50	W99-R5B
3/6/2006	1.8		50	W99-R5B
6/12/2006	1.4		50	W99-R5B
9/26/2006	2.5		50	W99-R5B
12/5/2006	5	U	50	W99-R5B
3/31/2007	1.9		50	W99-R5B
6/4/2007	2.4		50	W99-R5B
9/17/2007	2.3		50	W99-R5B
12/10/2007	1.7		50	W99-R5B
9/20/2008	1.6		50	W99-R5B
9/15/2009	1.73		50	W99-R5B
9/14/2010	1.3		50	W99-R5B
9/13/2011	2	U	50	W99-R5B
10/16/2012	2.5	U	50	W99-R5B
12/10/2013	2.5	U	50	W99-R5B
10/14/2014	2.5	U	50	W99-R5B
9/13/2016	2.5	U	50	W99-R5B



Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/7/2004; Attaunment monitoring began 3/6/2006

Date	Chromium (µg/L)	Qualifer	Cleanup Level (50 µg/L)	Station Location
6/25/2003				W99-R5A
8/29/2003				W99-R5A
2/7/2004	0.41	J	50	W99-R5A
4/9/2004	4.1	J	50	W99-R5A
8/19/2004	10	U	50	W99-R5A
5/3/2005	0.79		50	W99-R5A
12/14/2005	0.5	U	50	W99-R5A
3/6/2006	0.7		50	W99-R5A
6/12/2006	0.5	U	50	W99-R5A
9/25/2006	0.55		50	W99-R5A
12/5/2006	5	U	50	W99-R5A
3/31/2007	0.5	U	50	W99-R5A
6/4/2007	0.5	U	50	W99-R5A
9/17/2007	0.5	U	50	W99-R5A
9/20/2008	0.5	U	50	W99-R5A
9/15/2009	0.5	U	50	W99-R5A
9/14/2010	1.14		50	W99-R5A
9/13/2011	2	U	50	W99-R5A
10/16/2012	2.5	U	50	W99-R5A
12/10/2013	2.5	U	50	W99-R5A
10/14/2014	2.5	U	50	W99-R5A
9/13/2016	2.5	U	50	W99-R5A



Notes: µg/L = micrograms per liter; J = estimated result; U = analyte not detected above laboratory reporting limit
Treatment started 6/25/2003; treatment ended 8/29/2003
Remediation monitoring started 2/7/2004; Attainment monitoring began 3/06/2006

Appendix C

Groundwater Statistic Tool
Evaluation Monitoring Well B87-8

Groundwater Statistics Tool

Data input worksheet

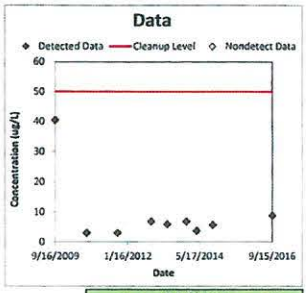
Site Name	Frontier Hard Chrome Superfund Site
Operating Unit (OU)	Groundwater
Type of Evaluation	Attainment
Date of Evaluation	8/25/2017
Person performing analysis	Bernie Zavala

Chemical of Concern	Total Chromium
Well Name/Number	B87-8
Date Units	Date
Concentration Units	ug/L

Confidence Level Desired	95%
Cleanup Level	50
Source of cleanup level (e.g. MCL or risk-based concentration)	Cleanup number
Risk of False Outlier Rejection	10%
Random Seed (may be left blank)	
Significant figures to use	3

Number of data points:	9
Number of detected results:	9
Number of nondetect results:	0
Detection frequency:	1

Date (Date)	Total Chromium Concentration (ug/L)	Data Qualifier	Detected? (Yes or No)
9/16/2009	40.5		Yes
9/15/2010	3.02		Yes
9/14/2011	3		Yes
10/17/2012	6.86		Yes
4/25/2013	5.96		Yes
12/11/2013	6.85		Yes
4/10/2014	3.79		Yes
10/16/2014	5.7		Yes
9/15/2016	8.82		Yes



Axis Values			
Time		Concentration	
Min	Max	Min	Max
Auto	Auto	Auto	Auto

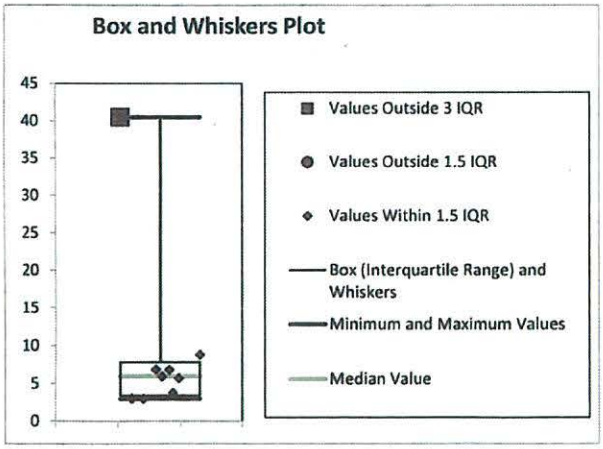
Reset Concentration Axis

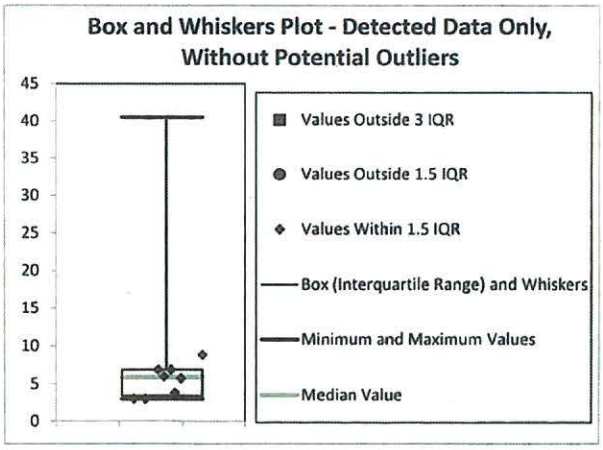
Data Review		Recommendations
Are all necessary data fields entered, and in proper format?	Yes	None
Are at least 4 data points present for statistical analysis?	Yes	None
Are detection limits for nondetects ≤ maximum detected value?	Yes	None
Are all data within chart axis limits?	Yes	None

Groundwater Statistics Tool

Outlier testing worksheet

Dixon's Outlier Test Results		
Number of data points	9	
Risk of false rejection	10%	
Critical value	0.441	
Outlier type	**Low**	**High**
Test statistic	0.0034	0.8453
Potential Outlier?	No	Yes
Validity of Dixon'sTest	Valid	

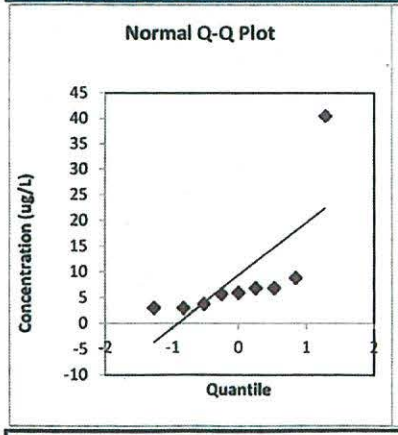


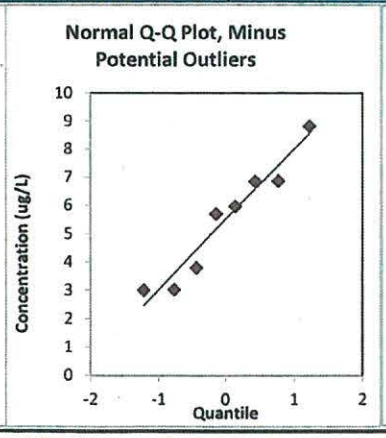


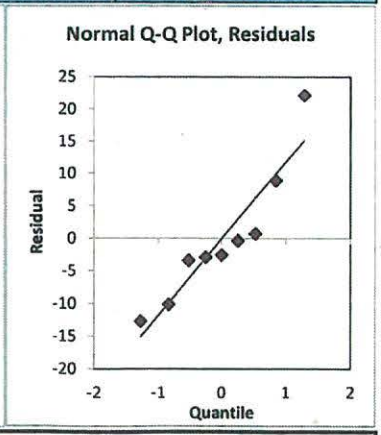
Groundwater Statistics Tool

Normality Testing Worksheet

Normality Test Results			
Parameter	All Data	Minus Outliers	Residuals
Number of data points	9	8	9
Shapiro-Wilk alpha value	10%	10%	10%
Slope	10.19391529	2.499126803	11.79691507
Intercept	9.388888889	5.5	-3.22655E-14
Correlation, R	0.706767533	0.969929293	0.932998386
Exact Test Value	0.544120072	0.922782169	0.894773322
Critical Value	0.859	0.851	0.859
Conclude sample distribution:	Does not appear normal	Appears normal	Appears normal







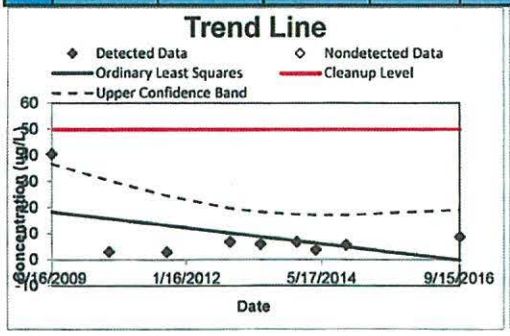
Previous Step: Outliers Screen | Next Step: Trend Screen | Skip Step: UCL Screen

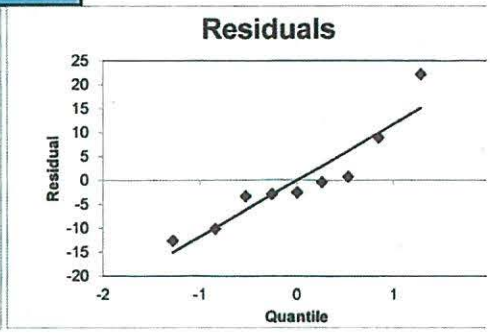
Groundwater Statistics Tool

Trend test results for datasets with normally distributed residuals (with our without transformation)

i	t (Date)	C (ug/L)	C Predicted	Fit residual	Upper Confidence Band
1	9/16/2009	40.5	18.3	22.2	36.7
2	9/15/2010	3.02	15.7	-12.68	30.3
3	9/14/2011	3	13.1	-10.1	24.5
4	10/17/2012	6.86	10.2	-3.34	19.7
5	4/25/2013	5.96	8.83	-2.87	18.3
6	12/11/2013	6.85	7.17	-0.32	17.4
7	4/10/2014	3.79	6.31	-2.52	17.2
8	10/16/2014	5.7	4.94	0.76	17.2
9	9/15/2016	8.82	-0.108	8.928	19.1
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Ordinary Least Squares	
Slope	-0.007217344
Intercept	307.553403
Correlation, R^2	0.2315
Test Result	No trend
Test Statistic	-1.452
Critical Value	1.895
When is the concentration predicted to exceed the cleanup level?	Not applicable - slope is not statistically increasing





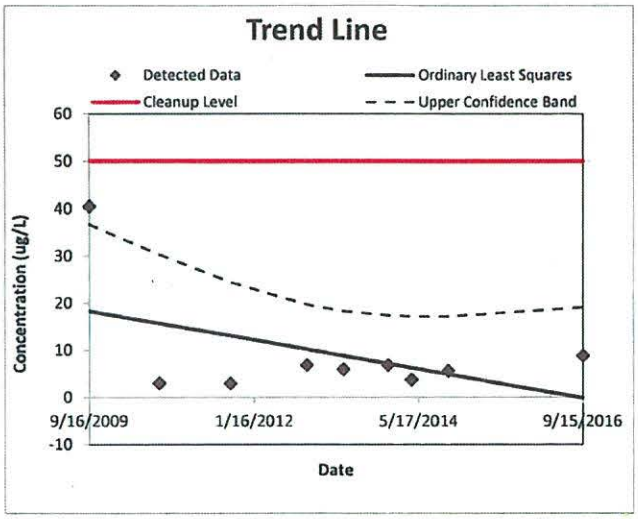
Groundwater Statistics Tool

UCL calculations and summary statistics for nonparametric data sets

Site Name	Frontier Hard Chrome
Operating Unit (OU)	Groundwater
Type of Evaluation	Attainment
Date of Evaluation	8/25/2017
Person performing analysis	Bernie Zavala

Chemical of Concern	Total Chromium
Well Name/Number	B87-8
Date Units	Date
Concentration Units	ug/L

Confidence Level	95%
Number of results	9
Number < cleanup level	9
Are any potential outliers present?	Yes
Mean of concentration	9.39
Standard deviation of concentration	11.8



95% Upper Confidence Limit (UCL)	26.5
Method for calculating UCL	Chebyshev UCL
Value of 95% Upper Confidence Band value at final sampling event	#N/A
Trend calculation method	Theil-Sen/Mann-Kendall
Cleanup level	50
Source of cleanup level	Cleanup number
Is the trend decreasing or statistically insignificant?	Yes

When is the concentration predicted to exceed the MCL?	Not applicable - slope is not statistically increasing
Random Seed Used	0
Message: None.	

Appendix D

Groundwater Travel Time Calculations

In order to determine the groundwater travel time or the time it takes a particle of groundwater to move from site boundary at the Superfund Site, to the Columbia River. The first is to determine the groundwater velocity and then the distance of travel. The distance is approximately three quarters of a mile in a southwest direction. The groundwater velocity can be determined by using the equation:

$$\bar{V} = \frac{K * i}{n}$$

Where:

$\bar{V}$ = average linear velocity of groundwater (feet/day)
K= horizontal hydraulic conductivity (feet/day); i= horizontal hydraulic gradient (ft/ft)
n= porosity (percent)

Site specific data was collected at the Frontier Hard Chrome Site by Battelle Pacific Northwest Laboratory in December 2002 using a downhole flow meter ([1]BNWL, 2004). The A-zone aquifer had three different conductivities (K) A_1 - 190 ft/day, A_2 – 1900 ft/day and A_3 – 14000 ft/day. A_2 and A_3 had the highest chromium concentrations and these two different values of hydraulic conductivities will give us a range of travel times, it should be noted that the majority of the plume is traveling at the depth of A_2.

The horizontal gradient (i) did vary over the many years of data collection but the average was 0.00005 ft/ft and this value will be used to determine the linear groundwater velocity.

The porosity for this geologic unit was determined to be 12 % and this value will be used to determine the linear velocity.

Using the K for A_2 (1900 ft/day) and a distance of 3,750 feet with a horizontal hydraulic gradient of 0.00005 ft/ft and a porosity of 0.12 gives an **average linear groundwater velocity of 0.791 ft/day. The travel time would be 13 years**

Using the K for A_3 (14000 ft/day) and a distance of 3,750 feet using the same (i) 0.00005 and porosity 0.12 gives an **average linear groundwater velocity of 5.8 feet per day or 1.77 years.**

1- In Situ Redox Manipulation Permeable Reactive Barrier Emplacement: Final Report, Frontier Hard Chrome Superfund Site, Vancouver, WA January 2004, Battelle-Pacific Northwest Division Richland, WA 99352

Appendix E FRONTIER HARD CHROME SITE PHOTOS

Photo 1: West Side of the New Building and Employee Parking Lot – From Northwest (from "Y" Street)

Photo 2: West Side of the New Building – From Southwest (from East 1st Street)

Photo 3: Existing Office Building and Eastern Portion of the Site – From Northeast

Photo 4: New Building and Eastern Portion of the Site, Future Storage Area – From the East

Photo 5: Connecting Corridor, New Building and the Existing Office Building–From the North

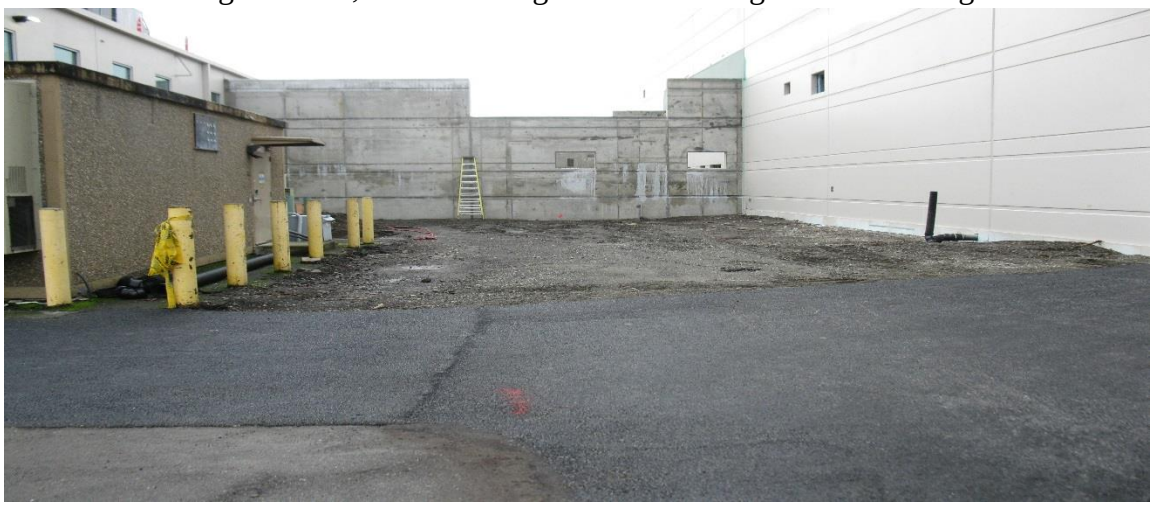


Photo 6: Construction of Bioretention Area next to the "Y" Street – From the North

Photo 7: Construction of Bioretention Area next to the "Y" Street – From the West

Photo 8: Construction In-side the New Building – From the South

Photo 9: Construction In-side the New Building – From the Northeast

Photo 10: Groundwater Monitoring Wells W85-6A and W85-6B identified for decommissioning

Photo 11: Groundwater Monitoring Wells W85-5A and W85-5B identified for decommissioning

Photo 12: Groundwater Monitoring Well W98-21A & B identified for decommissioning next to Highway-14