October 2003

Milwaukee Nearshore Confined Disposal Facility (NCDF), Groundwater Quality Monitoring
Sitcum Waterway Remediation Project

General Discussion

Section 3.0 of the Sitcum Waterway *Operations, Maintenance, and Monitoring Plan* (OMMP)(Port of Tacoma 1994, updated 1995) presents the Port of Tacoma's groundwater quality monitoring obligations associated with the Milwaukee NCDF, which was filled with contaminated sediments from the Sitcum Waterway (and the non-Superfund Blair Waterway), and completed in 1995. The groundwater monitoring program is designed to detect and evaluate possible long-term changes in groundwater quality in the areas surrounding the disposal site to ensure compliance with the performance standards. The OMMP (p. 3-1) states that the overall performance standard for this monitoring program is marine chronic criteria or ambient surface water quality in adjacent surface water (whichever is greater). The point of compliance for this performance standard is the sediment/surface water interface outside of the berm and peninsulas. The monitoring program is designed around a phased approach that consists of three stages of monitoring. The purpose of Stage 1 monitoring is to provide information to determine if constituents are being leached from the fill material and horizontally transported outside the fill area in groundwater (see p. 3-8 of the OMMP). Stage 1 monitoring is focused on comparing baseline conditions (established in the Port's 1997 Baseline Groundwater Quality Report) to post-construction groundwater quality. Based on the first round of Stage 1 monitoring, which was completed in 2003, constituents are *not* being transported outside the fill area in groundwater. Thus, Stage 2 and Stage 3 monitoring have not been initiated. Stage 2 monitoring would be performed to assess whether increases in chemical concentrations in groundwater are an anomaly or the result of a contaminant plume moving from the NCDF. Stage 3 monitoring would be performed to assess the potential for exceedance of performance standards at the point of compliance.

Baseline Groundwater Conditions

1988

Baseline groundwater data were collected between March ~~1998~~ and November 1996. Wells were sampled in the closure berm, in the areas north and south of the fill in the peninsula, and upgradient of the fill. For all wells, groundwater was analyzed for conventionals, metals, semivolatile organic compounds, and volatile organic compounds (see Table 3-1 of the OMMP).

For post-construction long-term monitoring, the baseline groundwater *metals* data are being used for statistical comparisons with groundwater data collected in the first round of Stage 1 monitoring, which occurred in March 2003. The long-term monitoring program focuses on metals (arsenic, copper, lead, and zinc) because the results of leaching tests on sediments from Sitcum Waterway indicated that metals are the most mobile chemicals leached.

Additionally, well MW-14 is sampled within the fill. However, data from MW-14 are not used to establish baseline conditions for performance monitoring.

Chronology

1988 - 1996	9 years of groundwater data to establish baseline concentrations of chemical concentrations in groundwater. For the baseline, 4 older wells were sampled for 7 years before the fill and 2 years after the fill (i.e., 1988 to 1996) and 2 newer wells were sampled after the fill (i.e., 1995 and 1996).
1995	Milwaukee NCDF completed.
1995, 1996	The 2 newer wells were sampled post-construction.
1997 - 2002	No groundwater sampling occurs (except for MW-14 inside the fill).
2003	First round of Stage 1 groundwater monitoring occurs in March 2003. Data are compared to baseline groundwater metals concentrations. No increases above baseline were found. In fact, most metals concentrations were undetected or were reported at values very close to the MRL.

Monitoring Schedule

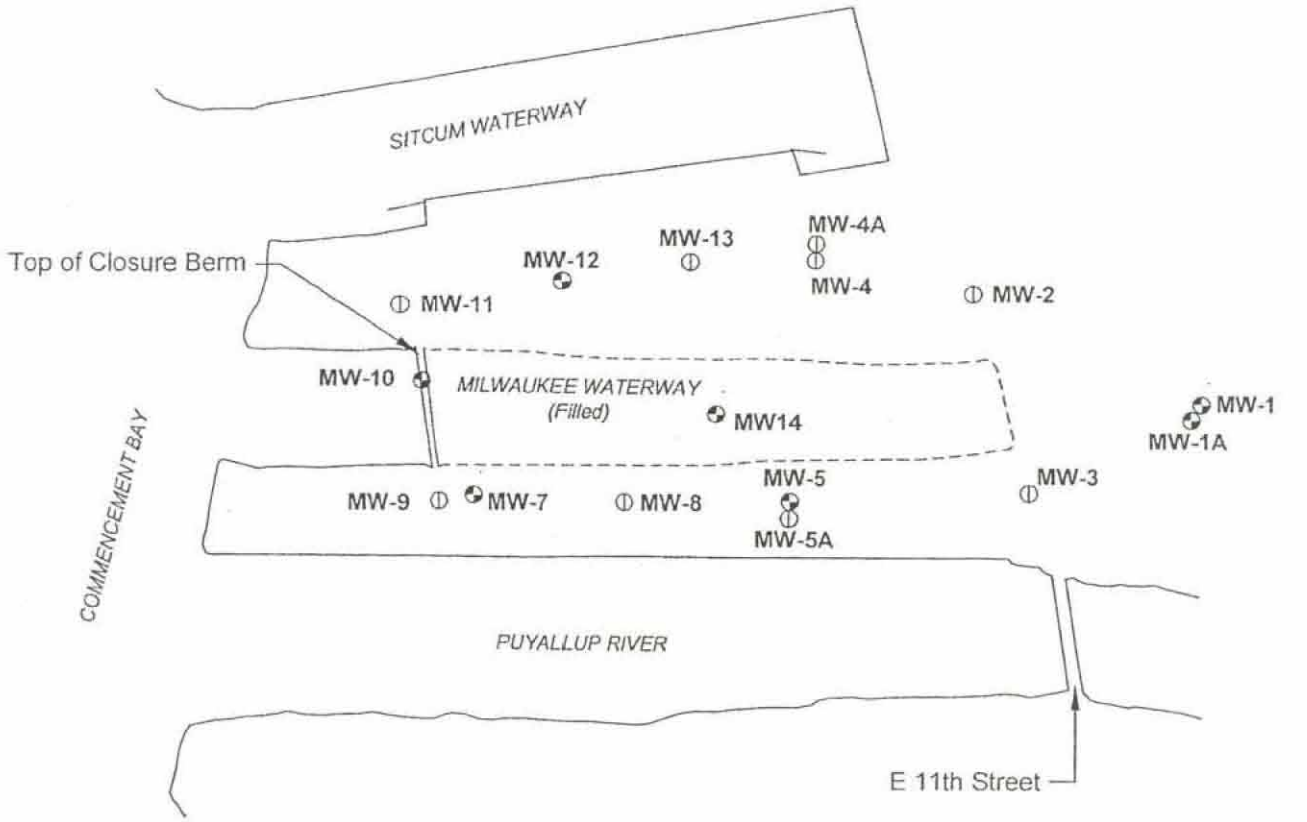
The next groundwater monitoring will occur in March 2008 (see Port letter to EPA in August 2003). The monitoring event will follow the details provided in the Port's letter to EPA in October 2003.

Report Submittal Schedule

The draft groundwater report is due to EPA 60 days after the last day of the sampling event. A final report, including electronic data, is due to EPA within 30 days of receipt of EPA comments.

Pursuant to the CD (as updated), copies of the reports (hard or electronic) will be sent to Robert Taylor (NOAA) and Craig Thompson (Ecology).

Site and Monitoring Well Location Plan
Stage 1 Monitoring



CAS 8/7/03 320332003.DWG

Monitoring Well location and Number

MW-1 for Use in Stage 1 Monitoring

MW-3 not for Use in Stage 1 Monitoring

N

0 800 1600

Scale in Feet

HARTCROWSER

3203-32 *11/03*

Figure 1

2.0 SUMMARY OF OPERATIONS, MAINTENANCE, AND MONITORING ACTIVITIES

This section provides a summary of the OMMP components.

In Binder

2.1 Water Quality Monitoring

The water quality monitoring program, presented in Section 3.0, is designed to evaluate long-term groundwater quality around the Milwaukee Waterway nearshore disposal site and to assess potential impacts to surrounding surface water from groundwater discharge should changes in groundwater quality occur. Groundwater quality will be evaluated to ensure compliance with project-specific performance standards. The program is designed around a phased approach for monitoring and includes collection and analysis of groundwater samples. Figure 2-1 presents the water quality monitoring program master schedule. The objectives of this program are to:

- Monitor local groundwater quality over time, using statistical techniques to identify significant departures from baseline conditions;
- Use the monitoring data and subsequent analyses as an "early warning" system indicative of changes to groundwater quality; and
- Evaluate the potential impact of groundwater discharges to the adjacent surface water by implementing potential contingency actions if significant changes are detected during scheduled monitoring.

2.2 Sediment Quality Monitoring

The sediment quality monitoring program, presented in Section 4.0, is designed to address the effectiveness of sediment removal as part of the Sitcum Waterway Remediation Project. The program addresses sampling of the Phase 1 and Phase 2 areas to assess the quality of sediments remaining after dredging. The sediment quality monitoring program includes sample collection, chemical analysis, and data interpretation. Figure 2-2 presents the sediment quality monitoring program master schedule. The objectives of this program are to:

- Select indicator chemicals;
- Describe the statistical basis for determining the frequency and location of Phase 1 and Phase 2 sediment sampling for the initial post-construction monitoring program;
- Describe the basis for evaluating the effectiveness of remediation with respect to sediment quality objectives (SQOs);

CB/NT ~~18.11.04~~

20.12.3

RECEIVED

MAY 09 1997

Environmental Cleanup Office

PORT of TACOMA U.S.A.

Baseline Groundwater Quality Data Report
Sitcum Waterway Remediation Project

Prepared for
Port of Tacoma

May 9, 1997
J-3203-27
Work Order E-1509

~~18.11.4~~

PORT of TACOMA U.S.A.

RECEIVED
FEB 13 1998
ENVIRONMENTAL DEPT.

RECEIVED
JUN 26 2003
Environmental Cleanup Office

February 11, 1998

Christina Ngo
Remedial Project Manager
Mail Stop ECL-115
EPA Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Re: Stage 1 Groundwater Quality Monitoring Plan
Sitcum Waterway Remediation Project

Dear Ms. Ngo:

This letter provides the Port's Stage 1 groundwater monitoring program for the Sitcum Waterway Remediation Project. This program incorporates EPA's written comments (September 8, 1997) on the Stage 1 monitoring program, and the results of discussions from our February 4, 1998, teleconference.

Wells to be Monitored

The following seven wells will be sampled during Stage 1 groundwater quality monitoring:

- MW-5 and MW-7 located on the Puyallup peninsula (Figure 1);
- MW-12 located on the Sitcum peninsula;
- MW-10 located within the closure berm;
- MW-14 located within the Facility; and
- MW-1 and MW-1A located upgradient of the Facility.

P.O. Box 1837 • Tacoma, Washington 98401-1837 • Telephone: (206) 383-5841
Commissioners: Jack A. Faculich • Richard P. Marzano • Patrick O'Malley • Clare Petrich • Jerry M. Thorpe
Executive Director: John J. Terostra

If you have any questions, please contact me at 383-9464 (Tacoma) or 838-0142 (Seattle).

Sincerely yours,

Richard Gilmur

Richard Gilmur
Director, Environmental Affairs

Enclosures:
References
Figure 1 - Site and Monitoring Well Location Plan, Stage 1 Monitoring

cc: Karen Stash, Weston
Philip Spadaro, Hart Crowser
Steve Germiat, Hart Crowser

Site and Monitoring Well Location Plan

Stage 1 Monitoring

MW-1 Monitoring Well Location and Number for Use in Stage 1 Monitoring

MW-3 Monitoring Well Location and Number not for Use in Stage 1 Monitoring

0 800 1600

Scale in Feet

HARTCROWSER

J-3203-27 2/98

Figure 1

20.12.1.2
4/01/97

WESTON has reviewed the Port of Tacoma's handouts from our 1 April 1997 meeting regarding the long-term groundwater monitoring at the Milwaukee Waterway fill site. Based on the information presented and previous information collected for the Sitcum Waterway Remediation Project, an approach of reduced (e.g., less than every year) monitoring appears appropriate. This is based on the following information:

1) The regression statistics indicate a good correlation between the sediment and water concentrations in the calculation of the distribution coefficients, AND the distribution coefficients (Kd values) are low and therefore environmentally conservative (i.e., the lower the distribution coefficient, the more the contaminants are assumed to migrate, hence creating an "impact" sooner).

2) Other confined disposal facilities in other parts of the country have indicated that contaminants within these facilities tend not to migrate at rapid rates. This is because the contaminated material is placed while being maintained in a saturated condition, and because the contaminated material is placed within a significant amount of uncontaminated or lesser contaminated material. Also, confined disposal facilities tend to "seal" themselves with the finer grained material. The above was confirmed for other sites around the country with S. Lemlich of the COE.

3) Kds in the peninsulas do not exist, but if we assume the worst case, (specifically, that the contaminants are not attenuated at all as they move through the peninsulas). the contaminants would move at the same rate as the groundwater. Based on the groundwater advection rates provided by Hart-Crowser, the contaminants would not reach Commencement Bay for 19 years, at a minimum. To help verify this, WESTON would like to review the Port's calculations for the groundwater advection rates (e.g., what values were used for gradients and hydraulic conductivity).

Although the items above indicate slow movement of contaminants from the Facility to Commencement Bay, a verification of the above predictions is suggested. Therefore, the Port's approach for <u>no</u> long-term groundwater monitoring to occur is not appropriate. Since the above are based on models and assumptions, collection of actual data to confirm the predicted results is warranted. Therefore, WESTON recommends some limited long-term groundwater monitoring to occur, in the form of groundwater monitoring, within the next 5 to 10 years (i.e., at Year 10 of the monitoring program, which would be approximately 7.5 years from now). In addition, a limited list of analytes can be considered in order to reduce sampling costs (e.g., analyze for indicator metals only).

lngterm.mem

OMMP
Hart Crowser

3.0 WATER QUALITY MONITORING

The purpose of this monitoring program is to protect water quality in adjacent surface water from contaminants which could potentially migrate in groundwater from the Milwaukee Waterway nearshore confined disposal site. The performance standard for this monitoring program is marine chronic criteria or ambient surface water quality in adjacent surface water (whichever is greater). The point of compliance for this performance standard is the sediment/surface water interface outside of the berm and peninsulas.

The monitoring program is designed to detect and evaluate possible long-term changes in groundwater quality in the areas surrounding the disposal site to ensure compliance with the performance standards. The program includes the collection, analysis, and interpretation of groundwater quality data from five existing and seven proposed monitoring wells installed around the perimeter of and within the Milwaukee Waterway nearshore disposal site (Figure 3-1). The objectives of this program are to:

- Monitor local groundwater quality over time, using statistical techniques to identify significant departures from baseline conditions;
- Use the monitoring data and subsequent analyses as an "early warning" system indicative of changes to groundwater quality; and
- Evaluate the potential impact of groundwater discharges to the adjacent surface water by implementing potential contingency actions if significant changes are detected during scheduled monitoring.

– this refers to sentinel wells, Stage 3 (see p. 3-17)

This program sets forth the location, frequency, and analysis of groundwater samples for monitoring conditions surrounding the Milwaukee Waterway nearshore disposal site. Appropriate health and safety measures and field sampling procedures are presented in Appendix A, Groundwater Sampling Operations Manual.

The water quality monitoring master schedule is shown on Figure 2-1.

3.1 Phased Monitoring Approach

The monitoring program is designed around a phased approach which includes three stages of monitoring. The phased approach provides for flexibility in the monitoring program which will enable the Port and EPA to optimize specific actions (such as location of additional monitoring wells) which may be deemed necessary during the monitoring program. The three stages of monitoring are summarized with decision trees on Figures 3-2, 3-3, and 3-4.

Actions in Stage 1 are designed to answer the question as to whether concentrations of certain constituents demonstrate a statistically significant increase above baseline groundwater quality as a result of placement of fill in the Milwaukee Waterway. Actions that will be accomplished include routine monitoring of groundwater quality and statistical analysis of the results using the Shewhart-CUSUM control chart method. If statistically significant increases are observed, then the Port will propose, and EPA will determine, whether to shift to Stage 2.

The purpose of Stage 2 monitoring is to identify the existence of potential contaminant plumes migrating from the fill area, and to estimate the areal and vertical extent of the plume. Actions in Stage 2 will include refining of transport analyses, establishment of threshold criteria with EPA approval, and installation of additional monitoring wells. Stage 2 actions may also include an increase in monitoring frequency and the list of analytes, if deemed necessary. If Stage 2 threshold criteria are exceeded, then the Port will propose, and EPA will determine, whether to shift to Stage 3. If the existence of a plume is not identified, or if threshold criteria are not exceeded after a period of time, then the Port may propose, and EPA will determine, whether to return to Stage 1.

Stage 3 is designed to identify whether there is the potential for performance standards to be exceeded. Additional wells, including sentinel well(s) will be installed at the beginning of Stage 3 monitoring. Transport analyses may again be refined to optimize the location of additional monitoring wells, including the sentinel wells. Threshold criteria for Stage 3 at the sentinel wells will be marine chronic criteria or ambient surface water quality in adjacent surface water (whichever is greater). If Stage 3 threshold criteria are exceeded, then the Port will propose, and EPA will determine, whether to proceed with contingency plans.

Although implementation of each stage is designed to occur sequentially, a shift to a different stage, or to the contingency plan may occur, if indicated by data collected for the monitoring program.

As part of this monitoring program, EPA and the Port will periodically review the utility of the various monitoring elements. If any of the elements are found to be no longer necessary, the Port and EPA may agree to terminate any or all of the monitoring elements.

3.2 Hydrogeology and Geochemistry

Upon filling, the Milwaukee Waterway nearshore disposal site will become an upland area with a groundwater flow system similar to that observed beneath other Commencement Bay land masses and peninsulas, which are bordered by parallel rivers and waterways. The following discussions briefly summarize the subsurface soil conditions and baseline geochemical

data pertinent to the design and operation of the monitoring program. Additional details, which form the basis for these discussions, are presented in the Phase 1 Pre-Remedial Design Evaluation and Phase 2 Preliminary Evaluation of Remedial Options Report (Evaluation Report; Port, 1992c).

3.2.1 Unconfined Water-Bearing Soils

Subsurface deposits beneath the peninsulas located on each side of the Milwaukee Waterway typically consist of silty sand with non-continuous silt and clay layers, as observed in soil borings extending to depths of 75 feet (about elevation -58 feet Mean Lower Low Water [MLLW] as defined by Port of Tacoma and U.S. Army Corps of Engineers datum). Interpretation of these pre-existing soil conditions are shown in cross section on Figures 3-6 and 3-7. The profile locations are shown on Figure 3-5 along with the locations of wells used in their development. While three soil horizons (Upper, Middle, and Lower) can be identified based on origin and density, groundwater monitoring indicates that the three soil horizons behave as a single unconfined water-bearing zone. Because the anticipated grain size of the fill material is consistent with the adjacent soil types, these deposits will collectively form a single unconfined water-bearing system.

A radial groundwater flow system with both horizontal and vertical components is expected to develop within the newly formed peninsula. The primary direction of groundwater flow (calculated as a net gradient averaged over multiple tidal cycles) will be from the fill (and from uplands south of the site) toward the surrounding water bodies. While the net gradient will be toward the surrounding water bodies, short-term reversals (with groundwater flow from the water bodies toward the fill) will occur during high tide periods.

Based on groundwater flow modeling of post-construction conditions conducted during pre-remedial design, net average linear groundwater velocities were estimated to range from 10 to 40 feet per year. This resulted in groundwater travel times of approximately 10 to 80 years between the fill and the adjacent water bodies. Since the monitoring wells on the peninsulas are generally located midway between the fill and the adjacent water bodies, groundwater from the fill should reach the wells in approximately 5 to 40 years.

3.2.2 Sediment Leachability and Existing Groundwater Quality

Over the period from March 1988 to October 1991, six rounds of groundwater samples were collected from the ten existing monitoring wells. These data are presented in Table 3-1. In addition, column leaching tests were performed on sediment samples collected from both the Blair and Sitcum waterways. The leaching tests were conducted by passing

water through the sediment column and collecting leachate samples for chemical analysis. The tests indicate the potential for long-term contaminant releases from dredged material. The results of the Sitcum leaching tests are summarized in the Phase 1 and Phase 2 Data Report (Port, 1992a), and the leaching test technical memorandum dated November 20, 1992 (Hart Crowser, 1992). Leaching tests for the Blair are summarized in Appendix H of the Evaluation Report (Port, 1992c) and in the November 20, 1992, technical memorandum (Hart Crowser, 1992).

The results of the Sitcum sediment column leaching tests were used to identify appropriate analytes for monitoring potential long-term water quality changes in groundwater adjacent to the Milwaukee Waterway nearshore disposal site. The concentrations of selected analytes, which were frequently detected in the leachate samples, are summarized in Table 3-2. All chemicals detected in more than 25 percent of the total number of leachate samples (18) are included in the Table 3-2 summary. Chemicals detected included 8 metals (antimony, arsenic, cadmium, copper, lead, mercury, nickel, and zinc), and 2 organic compounds (pentachlorophenol and bis(2-ethylhexyl)phthalate). Representative conventional parameters (i.e., salinity, organic carbon, and ammonia) are also included in the Table 3-2 summary. Although the results of Blair sediment leaching tests were not considered in the analysis, inclusion of the Blair tests would not change the analytes proposed for monitoring.

A summary of the baseline groundwater monitoring data is presented in Table 3-2 for comparison with the leachate data. Based on this comparison, the chemicals which occur at higher concentrations in the leachate (relative to baseline groundwater) include antimony, arsenic, copper, lead, and nickel.

3.3 Groundwater Sampling and Analysis

3.3.1 Monitoring Locations

The proposed long-term groundwater monitoring network consists of five existing wells and five new wells installed at nine locations on the peninsulas and land around the Milwaukee Waterway, and one well in the closure berm and one well in the fill (Figure 3-1).

Existing wells to be used in the network include monitoring wells MW-1, MW-1A, MW-4, MW-5, and MW-7. Existing monitoring wells MW-2, MW-3, MW-1, and MW-1A are all located slightly upgradient of the site. Monitoring wells MW-2 and MW-3 are not included in the long-term monitoring network but may be used for groundwater elevation measurements. MW-1 and MW-1A will serve as the upgradient monitoring wells for this monitoring program because they are paired wells

which are screened at a shallow depth (MW-1) and a deeper depth (MW-1A).

Seven new wells will be installed around and within the disposal site during and after construction. These include two wells (MW-8 and MW-9) on the peninsula between the Milwaukee Waterway and the Puyallup River, three wells (MW-11, MW-12, and MW-13) on the peninsula between the Milwaukee and Sitcum waterways, a well (MW-10) in the closure berm, and a well (MW-14) installed approximately in the middle of the fill. The locations of the new wells are shown on Figure 3-1.

The new monitoring wells located in the berm (MW-10) and the fill (MW-14) will be installed after the upland improvements (e.g., ballast, paving, drainage, and lighting) have been completed. This is anticipated to occur from 6 to 12 months following completion of the fill; however, additional time may be required. The fill well will be sampled only to provide additional data and will not be used to evaluate performance. Data collected will be used to verify the results of leaching tests and to calibrate additional transport analyses, as may be necessary.

The new wells will be constructed in a similar manner as the existing wells using 15-foot screens. The new wells will be screened approximately from -15 to -30 feet elevation (MLLW) as shown in subsurface profiles on Figure 3-8. The screens will be installed at elevations which take into account the contaminated sediments placed in the Milwaukee Waterway confined disposal site and soil conditions encountered during drilling, as well as the horizontal groundwater flow gradients to monitor potentially contaminated groundwater moving away from the fill. In addition, EPA will be consulted prior to final screen placement.

Collectively, these wells will provide groundwater samples representative of horizontal groundwater flow anticipated from the fill material toward the Sitcum Waterway, the mouth of the Milwaukee Waterway, and the Puyallup River.

After installation of the new wells, the Port will collect data to evaluate the horizontal groundwater flow regime. This data collection will include a 7-day program of continuous (every 15 minute) transducer-based water level measurements in all wells to evaluate the effects of tidal fluctuations on water levels. In addition, a water level measurement will be taken in each well within a one hour period to confirm the 7-day study. This will be done twice; once during wet-season and once during dry-season. The Port will evaluate the data and may propose to EPA for approval to no longer monitor certain wells that may be found to be upgradient of the fill.

Hydraulic conductivity testing of all new wells will be done by either slug testing or possibly time series analysis of water level response to tidal fluctuations. Should additional consolidation occur after paving and

installation of monitoring wells in the fill or berm, additional hydraulic conductivity testing of these wells may be done.

3.3.2 Monitoring Parameters

Groundwater samples collected during routine monitoring events will be analyzed for a series of field parameters, cations, anions, and metals, except for samples from well MW-14 in the fill which will be analyzed for the suite of constituents analyzed in the Sitcum leaching tests. Analyses will be performed in accordance with sampling procedures and quality assurance protocols presented in the Groundwater Sampling Operations Manual (Appendix A). The analytical parameters were selected based on an evaluation of sediment column leaching tests and the baseline groundwater quality data set.

The parameters proposed for long-term routine monitoring include most constituents detected in more than 25 percent of the leachate samples (Table 3-2). Two organic chemicals (pentachlorophenol and bis[2-ethylhexyl]phthalate), which were detected in more than 25 percent the leachate test samples, will not be analyzed. Specifically, pentachlorophenol was detected in only 8 of 18 leachate samples at a maximum concentration (0.95 μg/L) below surface water quality criteria (the most restrictive marine water quality criterion under 40 CFR 121-125, WAC 173-201 and WAC 173-340 is 5 μg/L). Additionally, pentachlorophenol is not considered a sediment quality issue for the Sitcum and Blair waterway sediments. Bis(2-ethylhexyl)phthalate is a common field and laboratory contaminant.

In addition to metals, the proposed long-term monitoring program includes determination of conventional field and inorganic parameters. The list of analytes proposed for analysis includes the following:

- Field Parameters (pH, Temperature, Turbidity, and Specific Conductance and Dissolved Oxygen. This list may be modified with EPA approval based on the results obtained during baseline monitoring;
- Major Cation and Anions; and
- Dissolved Metals (Arsenic, Copper, Lead, Manganese, Mercury, later accepted Nickel, and Zinc).

Analysis of metals is appropriate as the results of the leaching tests indicate that metals are the most mobile chemicals leached. Therefore, metals will serve as indicators of contaminant migration from the nearshore disposal site.

Although cadmium was detected in more than 25 percent of the leaching test samples, the average concentrations detected were less than those

detected in baseline groundwater results and, therefore, will not be analyzed. Antimony will not be analyzed because of matrix interference, which has resulted in highly qualified data in previous stages of this project, and concentrations detected in the leaching tests were well below marine chronic criteria.

If analysis of groundwater samples from well MW-14 in the fill indicate significantly different constituents or concentrations than those observed in the leaching test results, the Port may propose for EPA approval whether to increase the list of analytes for routine monitoring.

Analytical methods and detection limit goals for routine groundwater monitoring and for samples taken from well MW-14 in the fill are given in Tables 3-3 and 3-4, respectively.

3.3.3 Baseline Conditions

Examination of historical data collected from the existing wells suggest that groundwater quality varies by both location and depth, and therefore, comparisons with baseline data will need to be made on an intra-well basis. Examination of existing historical data does not show wet season/dry season concentration variations in groundwater quality; however, historical data to date are insufficient to confirm this statistically. In general, more constituents are detected in wet season samples.

To better establish a baseline of groundwater quality for existing wells and to establish baseline groundwater quality in new monitoring wells, and to confirm the lack of wet season/dry season groundwater quality trends, the following baseline monitoring program will be implemented:

- New wells will be sampled quarterly until a sufficient number of samples have been obtained to establish a statistically significant baseline (see Section 3.4.2); and

- Existing wells will be sampled semi-annually to supplement existing baseline data until a sufficient number of samples have been obtained to establish a statistically significant baseline (see Section 3.4.2).

The baseline monitoring period will end when the Port and EPA agree that statistically significant baseline conditions have been established in the wells. It is anticipated that this would take approximately two years. Additional samples may be required if the first 8 samples indicate seasonality. Although this baseline will be established after construction, average groundwater velocities are such that groundwater moving from the fill would not reach the wells until after the baseline monitoring is complete. The monitoring well installed in the fill will be sampled twice a year for the first two years.

3.4 Stage 1 Groundwater Monitoring

The primary focus of Stage 1 monitoring is to compare post-construction groundwater quality to baseline conditions. This stage of monitoring will provide information to determine if constituents are being leached from the fill material and horizontally transported outside the fill area in groundwater.

Stage 1 groundwater quality monitoring will involve:

- Sampling of groundwater for selected analytes identified in Table 3-3 in the existing and new monitoring wells around the Milwaukee Waterway nearshore disposal site; and
- Statistical comparison of sampling results to baseline conditions to assess changes in groundwater quality.

The Stage 1 decision framework is depicted on Figure 3-2.

3.4.1 Monitoring Schedule

After completion of the baseline sampling program (Section 3.3.3), initial Stage 1 groundwater quality monitoring will be conducted on an annual basis, commencing one year after baseline sampling is completed. Given the estimated hydraulic travel times between the fill and the monitoring wells (5 to 40 years), this sampling schedule is sufficient for detecting potential changes in groundwater quality during Stage 1. These travel time estimates assume advective groundwater flow, which does not account for the adsorption/desorption affects that are expected to further slow constituent migration.

As discussed above, examination of data suggests a lack of wet season/dry season variation in concentrations. This is further supported by low groundwater velocities and observations of regional groundwater quality fluctuations. However, existing baseline data suggest there is a tendency for more constituents to be detected during wet season sampling. Therefore, routine monitoring will occur within the period from November to June as the detection frequency may be higher during the wet season. If future baseline sampling results indicate different trends than existing results, the Port may propose, and EPA will determine, to adjust to a more appropriate monitoring schedule. Based on the results of annual groundwater monitoring, the Port may propose, and EPA will determine, whether to require monitoring at a reduced frequency.

3.4.2 Statistical Methods

Appropriate procedures for statistical interpretation of groundwater monitoring data are described in EPA's Interim Final Guidance document entitled "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities" (EPA, 1989). For situations where significant differences occur between wells with a sufficiently comprehensive baseline data set, which is the case here, construction of a Shewhart-CUSUM control chart for each well is recommended for monitoring analyte levels over time. The control chart procedure is explained in detail in Section 7 of the EPA document.

Specific procedures proposed for the statistical analysis include the following:

- Examination of existing baseline data suggests that concentrations of each analyte are approximated by the log-normal distribution, therefore, all analyte data will be log-transformed prior to statistical analysis;

- Examination of data, coupled with low groundwater velocities suggests a lack of wet season/dry season variations, which will be able to be confirmed during post-construction baseline sampling. Therefore, if confirmed, adjustments for wet season/dry season variation will not be necessary;

- After post-construction baseline sampling, serial correlation between sampling events will be analyzed to confirm the independence of the data sets; and

- Standard statistical parameters for the Shewhart-CUSUM control chart will include the following: "h" (decision internal value) = 5; "k" (reference value) = 1; "SCL" (Shewhart control limit) = 4.5. These values are generally regarded as most appropriate for the application of combined Shewhart-CUSUM charts to groundwater monitoring (Starks, 1988; EPA, 1989).

If the results of these analyses indicate no statistically significant increase in analyte concentrations at a given monitoring well, Stage 1 groundwater quality monitoring will continue on an annual or less than annual basis, as proposed by the Port and determined by EPA. However, if statistically significant increases do occur, the Port will evaluate the data and propose to EPA to either continue with Stage 1 or to move to Stage 2. EPA will make a final determination based on a review of the Port's proposal.

3.5 Stage 2 Groundwater Monitoring

Stage 2 groundwater monitoring is designed to assess whether the increase in concentrations of analytes above baseline, identified in Stage 1, is an

anomaly or the result of a contaminant plume moving from the nearshore disposal site. Stage 2 actions to answer this question include but are not limited to the following:

- Installation of additional monitoring wells around the existing well(s) of concern;
- Refinement of existing groundwater transport analyses; and
- Establishment of Stage 2 threshold criteria.

The decision framework for Stage 2 is depicted on Figure 3-3.

3.5.1 Installation of Additional Monitoring Wells

At least two new wells will be installed to identify and evaluate the magnitude of concentration gradients around the well of concern. One well will be located between the existing well and the nearshore disposal site and the other well will be installed between the existing well and downgradient surface water. The Port may install additional wells around the existing monitoring well to assess the lateral and vertical extent of potential contaminant plumes.

The Port will evaluate the data and propose to EPA the number, location, and depth of any new wells in this stage. EPA will review the Port's proposal and make a determination regarding the monitoring wells.

3.5.2 Refinement of Transport Analyses

Groundwater transport analyses were done previously to assess potential impacts of filling the Milwaukee Waterway on surface water. Discussion of transport analyses and results are in the design calculations document which is part of the remedial design plans and specifications. The analyses were based on typical site conditions and did not consider in detail the effects of chemical reactions, tidal mixing, and dilution of groundwater at the surface water/aquifer interface.

If Stage 2 of the groundwater monitoring program is reached, the transport analyses will be refined to include localized groundwater conditions and the transport parameters mentioned above. The analyses will consider the monitoring data collected and will be used to assess potential impacts to surface water and establish threshold criteria for Stage 2.

3.5.3 Stage 2 Threshold Criteria

The Port will use the results of groundwater monitoring and refined transport analyses to propose Stage 2 threshold criteria to EPA. The criteria may be based on monitoring to determine if concentrations of selected analytes statistically increase (see Section 3.4.2) above baseline. Stage 2 threshold criteria will be proposed such that exceedence of the criteria would not indicate an exceedence of performance standards at the point of compliance and would allow sufficient time for implementation of Stage 3 monitoring or contingency planning, if necessary. EPA will review the Port's proposal and make the final determination of Stage 2 threshold criteria.

3.5.4 Data Analysis

Groundwater quality data from the Stage 2 monitoring program will be evaluated to determine if elevated concentrations of analytes in groundwater are point anomalies or if they appear to be areal in extent. The data will also be analyzed over time to evaluate if the groundwater impacts are transient or long-term.

Methods of analyses may include statistical evaluation of the data, evaluation of transport analysis results, and comparison to threshold criteria depending on the groundwater quality data generated.

If the analysis indicates the potential existence of a plume, and the Stage 2 monitoring well(s) indicate concentrations of selected analytes in groundwater exceed Stage 2 threshold criteria, the Port will evaluate the data and propose to EPA either to continue with Stage 2 or to move to Stage 3. EPA will make a final determination based on a review of the Port's proposal.

3.6 Stage 3 Groundwater Monitoring

Stage 3 is designed to assess the potential for exceedence of performance standards at the point of compliance. Stage 3 monitoring would include but not be limited to the following:

- Further refinement of transport analyses;
- Installation of sentinel well(s) near the surface water;
- Sampling of surface water for ambient water quality; and
- Site-specific study of tidal mixing and dilution at the point of compliance.

It may be necessary to re-evaluate analytical methods and detection limits at this time.

Figure 3-4 shows the Stage 3 decision framework.

3.6.2 Refinement of Transport Analyses

Data collected during Stage 2 monitoring will be used to further refine transport analyses. The analyses will be used to assess the potential for impacts to surface water and to optimize the location of the sentinel well(s). The analyses may also be used to assess the effects of tidal mixing in the aquifer and mixing with surface waters at the sediment-water interface.

3.6.3 Installation of Sentinel Well(s)

The sentinel well or wells will provide early warning of potential impacts to adjacent surface water. The results of the Stage 3 transport analyses will be used to optimize the location of the well(s) such that exceedence of threshold criteria at the sentinel well(s) would not indicate an exceedence of performance standards at the point of compliance and would allow sufficient time for implementation of contingency actions if deemed necessary. The Port will evaluate the data and propose to EPA the number and location of sentinel wells. EPA will review the Port's proposal and determine the appropriate action for installation of the well(s).

3.6.4 Surface Water Sampling

Sampling of surface water will be done at the beginning of Stage 3 to evaluate ambient surface water quality. The results of this sampling and analysis will be used to establish performance standards (see Section 3.1). Prior to surface water sampling, the Port will submit for EPA approval a surface water sampling and analysis plan.

3.6.5 Stage 3 Threshold Criteria

Stage 3 threshold criteria will be implemented at the sentinel well(s). The threshold criteria will be marine chronic criteria or ambient surface water quality in adjacent surface water (whichever is greater). Exceedence of the threshold criteria at the sentinel well does not imply exceedence of the performance standards because tidal mixing and tidal dilution will cause exit concentrations to be below the concentrations measured at the sentinel well. This affect was discussed in the modeling described in Section J of the Sitcum Waterway Remediation Project, Remedial Design Calculations Document.

3.6.6 Evaluation of Tidal Mixing and Tidal Dilution

To assess the potential for impacts to surface water, the Port will study the processes of tidal mixing and tidal dilution near the sediment/surface water interface. This study may include numerical simulation of tidal mixing and statistical analysis of salinity sampling results over a tidal cycle. Prior to the study, the Port will propose for EPA approval a plan describing the details of the tidal mixing and dilution study.

3.6.7 Exceedence of Threshold Criteria

Exceedence of threshold criteria at the sentinel well(s) would indicate that the contaminant plume has migrated near the surface water. Should an exceedence occur, the Port may elect to perform appropriate bioassays during Stage 3 to evaluate potential environmental impacts to surface water. The Port will evaluate all data collected and propose to EPA whether or not to shift to contingency plans. EPA will review the Port's proposal and will make the final determination whether to shift to contingency plans.

3.7 Contingency Plan

As indicated above, if Stage 3 groundwater threshold criteria are exceeded, there is a potential for impacts to adjacent surface water and EPA may determine that it is appropriate for the monitoring program to shift to the contingency plan.

The specific problem that causes the shift to contingency plans will dictate what actions may be most appropriate. Actions may include but will not be limited to the following:

- Further study of specific problem;
- Performance of bioassays to evaluate environmental impacts; and
- Implementation of remediation techniques such as in-ground barriers, bioremediation, groundwater pumping and treatment or reinjection, or other appropriate remediation technologies.

It should be noted that although implementation of each stage is designed to occur sequentially, a shift to the contingency plan may occur from any of the monitoring stages if data collected indicate such a shift is appropriate.

3.8 Schedule for Monitoring and Reporting

The water quality monitoring master schedule is shown on Figure 2-1. The schedule shows the time relationship between various activities for the water quality monitoring program.

Installation of new monitoring wells for Stage 1 monitoring will occur during construction of the nearshore confined fill except for the wells in the berm and the fill. The new monitoring wells located in the berm and the fill will be installed after the upland improvements (e.g. ballast, paving, and lighting) have been completed. This is anticipated to occur 6 to 12 months following completion of the fill,however, additional time may be required.

Baseline monitoring for each new well will begin immediately after installation. During the baseline monitoring period (see Section 3.3.3), the Port will prepare and submit a report describing the construction of the new wells. Sampling data will be provided to EPA within 60 days after a sampling event. The Port will also provide annual reports of the results of groundwater elevation and chemistry data. Should circumstances dictate a change in this reporting schedule, the Port will propose a refined schedule to EPA. EPA will review the Port's proposal and make a final determination on the schedule.

Appears there is no schedule for the stage 1 data reports... see 2-11-98 letter.

Schedules for other actions that may occur as a result of shifting to different stages of monitoring will be proposed to EPA by the Port at the beginning of that stage of monitoring. EPA will review the Port's proposal and make the final determination of the schedule.

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JAN 08 2004

Environmental Cleanup Office

January 6, 2004

Karen Keeley
Remedial Project Manager
U.S. EPA Region 10, ECL-111
1200 Sixth Avenue
Seattle, Washington 98101

Re: Revisions to Stage 1 Groundwater Quality Monitoring QAPP
Sitcum Waterway Remediation Project

Dear Ms. Keeley:

This letter presents proposed changes to be incorporated by reference into the OMMP (Port 1994) for Stage 1 groundwater quality monitoring for the Sitcum Waterway Remediation Project. The proposed changes to the sampling and analysis protocols are consistent with the OMMP as modified by the following correspondence:

- Port's letter to EPA dated February 11, 1998;
- EPA's e-mail/letter dated September 24, 2003, approving change in the analytical method for metals from CLP methodology to EPA Methods 200.8 and 6010B; and
- EPA's e-mail/letter dated October 14, 2003, clarifying sampling and analysis procedures for future Stage 1 groundwater quality monitoring.

The existing QAPP and subsequent letter modifications will not be revised because of the following:

- Low frequency of sampling (once per 5 years);
- Small number of monitoring wells and analytes (seven wells and four metals); and
- Lack of statistically significant differences between the baseline groundwater data and the 2003 Stage 1 groundwater quality results (Port 2003a).

Data interpretation will remain consistent with the OMMP and the 1997 Baseline Groundwater Quality Monitoring Report (Port 1997).

P.O. Box 1837 • Tacoma, Washington 98401-1837 • Telephone: (253) 383-5841

Wells to be Monitored

The following seven monitoring wells (Figure 1) will be sampled during Stage 1 groundwater quality monitoring events:

- MW-1 and MW-1A located upgradient of the containment facility;
- MW-5 and MW-7 located on the Puyallup peninsula;
- MW-10 located within the closure berm;
- MW-12 located on the Sitcum peninsula; and
- MW-14 located within the containment facility.

Sampling Procedures

The groundwater sampling protocol for Stage 1 monitoring will remain consistent with the Groundwater Sampling Operations Manual (Appendix A) of the OMMP as modified by this letter and the correspondence listed above with the added option of verification resampling at wells where analytical results appear to be outliers.

Water levels will be measured, and monitoring well condition will be recorded for each well. Monitoring wells will be purged and sampled using low flow techniques, and field parameters including pH, temperature, turbidity, specific conductance, and dissolved oxygen will be measured using a flow-through cell during well purging prior to sample collection. In accordance with the OMMP (Port 1994) and modifications agreed to by the Port and EPA, purging will be conducted until DO, EC, and turbidity measurements are stable (three successive measurements within ± 10 percent, or DO fluctuations less than ±1 mg/L when DO is less than 5 mg/L). Temperature and pH readings will also be recorded during purging. Samples will be filtered using a dedicated in-line 0.45 micron filter cartridge for each well. The filters will be flushed with approximately 100 ml of well water prior to sample collection.

Analytes

Stage 1 groundwater monitoring will include analysis for the following parameters:

- Field parameters including pH, temperature, turbidity, specific conductance (EC), and dissolved oxygen measured using a flow-through cell during well purging prior to sample collection;
- Dissolved metals (arsenic, copper, lead, and nickel) that serve as indicators of potential contaminant migration from the containment facility; and
- Salinity and total organic carbon (TOC).

Groundwater samples collected from MW-14, within the containment facility, will also be analyzed for the following general water quality parameters to provide additional data on geochemical conditions within the containment facility:

- Bicarbonate alkalinity as $CaCO_3$;
- Major cations including calcium, iron, magnesium, manganese, potassium, and sodium; and
- Anions to include chloride, sulfate, sulfide, and total phosphate as phosphorus (P).

Sample containers and volumes required, preservation, and holding times are listed in Table 1, which replaces Table A-4-5 of the QAPP (OMMP Appendix A).

Analytical Methods

The OMMP originally specified the use of EPA Contract Laboratory Program (CLP) analytical methods for analysis of indicator metals (arsenic, copper, lead, and nickel). The Port had proposed analysis of indicator metals using extraction by reductive precipitation (EPA Method 1640 modified) and analysis by EPA Method 200.8, ICP-mass spectrometry to achieve lower detection limits (Port 2003b). EPA (2003) has reviewed the standard operating procedure and additional method performance information provided by Columbia Analytical Services (CAS) and has approved the use of Method 200.8 for this project. In the event that CAS is not selected to perform future groundwater analysis, the Port will provide the EPA with the SOP from the laboratory that will be analyzing samples.

The major cations (calcium, iron, magnesium, manganese, potassium, and sodium) to be analyzed in samples collected from MW-14 will be determined by EPA Method 6010B.

Bicarbonate alkalinity will be determined by Standard Methods 2320B rather than EPA Method 310.1. The two methods are essentially identical but Method 2320B addresses the calculation of bicarbonate alkalinity from the titration analysis in more detail than Method 310.1.

Analytical methods for other parameters specified in the OMMP will remain unchanged.

Analytical methods and laboratory reporting limits are summarized in Table 2, which replaces OMMP Tables 3-3 and 3-4 and Table A-4-2 of the QAPP.

The level of laboratory quality control and documentation will be similar to that of the CLP. Precision and accuracy measurements will be performed using site-specific samples for each sampling event at a minimum frequency of 5 percent. Accuracy will be assessed by analysis of matrix spike (MS) samples and standard reference materials (per Table A-4-4 of OMMP or similar sources) and/or independently purchased laboratory control samples (LCS). Precision

will be assessed by analysis of laboratory and field duplicate samples or MS/MS duplicate samples. Laboratory quality control criteria are presented in Table 3, which replaces Table A-4-3 of the QAPP.

Schedule and Reporting

Round 2 of Stage 1 groundwater quality monitoring is scheduled for March 2008. Based on the results from round 2 of Stage 1 monitoring, the Port will propose, and EPA will determine, an appropriate schedule and scope for additional Stage 1 monitoring.

The draft report is due to EPA 60 days after the sampling event and will include sampling information and field logs (including a summary of well conditions), analytical results, a data validation report, and a comparison of the data to the 1997 Baseline Groundwater Quality Report by adding the data to the established Shewhart-CUSUM Control Charts, consistent with the 1994 OMMP and modifications agreed to by the Port and EPA. The draft report will be revised in response to EPA comments and a final report (including electronic data as specified on page A-4-18 of the QAPP) will be submitted to EPA within 30 days of receipt of EPA comments. Copies of the draft and final reports will also be sent to NOAA and Ecology contacts pursuant to the Sitcum Waterway Consent Decree.

If you have any questions, please contact me at (253) 383-9464.

Sincerely,

Richard Gilmur

Richard Gilmur
Director, Environmental Affairs

Enclosures:

References
Table 1 - Sample Preservation, Holding Times, and Containers
Table 2 - Analytical Methods and Laboratory Reporting Limits
Table 3 - Laboratory Quality Control Criteria
Figure 1 - Site and Monitoring Well Location Plan

REFERENCES

EPA 2003. Letter from Karen Keeley (Chris Pace), EPA Remedial Project Manager, to Richard Gilmur, Port of Tacoma. September 24, 2003.

Port 1994. Operations, Maintenance, and Monitoring Plan, Sitcum Waterway Remediation Project, Port of Tacoma, June 3, 1994.

Port 1997. Baseline Water Quality Data Report, Sitcum Waterway Remediation Project, Tacoma, Washington. May 9, 1997.

Port 1998. Letter from Richard Gilmur to Christina Ngo, EPA Remedial Project Manager. February 11, 1998.

Port 2003a. Stage 1 Groundwater Quality Monitoring Report (Round 1), Port of Tacoma, Washington. November 20, 2003.

Port 2003b. Teleconference with Richard Gilmur (Port), Roger McGinnis (Hart Crowser), Karen Keeley (EPA Remedial Project Manager), and Dr. Bruce Woods (EPA QA). April 2003.

Table 1 – Sample Preservation, Holding Times, and Containers[a]

Water Analysis	Preservation	Holding Time[b]	Container
Dissolved Metals (All wells) (arsenic, copper, lead, nickel)	Field filter HNO_3 to pH < 2 cool to 4°C	6 months	Two 1 L polyc
Dissolved Metals (MW-14 only) (calcium, iron, magnesium, manganese, potassium, sodium)	Field filter HNO_3 to pH < 2 cool to 4°C	6 months	One 1 L poly
Total organic carbon (All wells)	H_2SO_4 to pH < 2 cool to 4°C	28 days	One 1 L poly
Salinity (All wells)	cool to 4°C	28 days	One 1 L poly
Bicarbonate alkalinity (MW-14 only)	No headspace cool to 4°C	14 days	One 1 L poly
Chloride, sulfate (MW-14 only)	cool to 4°C	28 days	One 1 L poly
Sulfide (MW-14 only)	No headspace NaOH to pH > 12 2 ml of 2 N zinc acetate cool to 4°C	7 days	One 1 L poly
Total phosphate (MW-14 only)	H_2SO_4 to pH < 2 cool to 4°C	28 days	One 1 L poly

a – Replaces QAPP Table A-4-5 (Appendix A of OMMP)
b – Holding times are from date of sample collection.
c – One liter is required for analysis; extra volume for reanalysis if required; collect three liters for the field sample selected for laboratory QC (1 per lab batch).

Table 2 – Analytical Methods and Laboratory Reporting Limits[a]

Analyte	Analytical Method	Quantitation Limit[b]	Method Detection Limit
Metals in µg/L			
Arsenic	EPA 1640 mod[c]/EPA 200.8	0.5	0.2
Copper	EPA 1640 mod[c]/EPA 200.8	0.1	0.04
Lead	EPA 1640 mod[c]/EPA 200.8	0.02	0.01
Nickel	EPA 1640 mod[c]/EPA 200.8	0.2	0.04
Calcium	EPA 6010B	50	30
Iron	EPA 6010B	20	6
Magnesium	EPA 6010B	20	20
Manganese	EPA 6010B	5.0	1
Potassium	EPA 6010B	2,000	700
Sodium	EPA 6010B	100	70
Conventional Parameters in mg/L			
Bicarbonate alkalinity as $CaCO_3$	SM 2320B	2	1
Chloride	EPA 300.0	0.2	0.04
Phosphate, total as P	EPA 365.2	0.01	0.003
Salinity in ppt	SM 2520B	2	2
Sulfate	EPA 300.0	0.2	0.04
Sulfide	EPA 376.1	2	0.5
Total organic carbon	EPA 415.1	0.5	0.07
Field Measurements[d]			
Temperature in °C		± 0.1	
Turbidity in NTU		1	
pH		± 0.01	
Conductivity in mS/cm		1	
Dissolved oxygen in mg/L		0.02	

a – Replaces OMMP Tables 3-3 and 3-4 and QAPP Table A-4-2 (Appendix A of OMMP)
b – Quantitation limits may be higher if analytical interferences are present or if dilutions are required.
c – Columbia Analytical Services SOP MET-RPMS, Reductive Precipitation
d – Purging will be conducted until DO, EC, and turbidity measurements are stable (three successive measurements within ± 10 percent, or DO fluctuations less than ±1 mg/L when DO is less than 5 mg/L)

Table 3 – Laboratory Quality Control Criteria[a]

Analyte	Matrix Spike Percent Recovery	Duplicate Relative Percent Difference	Laboratory Control Sample Percent Recovery
Metals			
Arsenic	75 – 125	20	80 – 120
Copper	75 – 125	20	80 – 120
Lead	75 – 125	20	80 – 120
Nickel	75 – 125	20	80 – 120
Calcium	75 – 125	20	80 – 120
Iron	75 – 125	20	80 – 120
Magnesium	75 – 125	20	80 – 120
Manganese	75 – 125	20	80 – 120
Potassium	75 – 125	20	80 – 120
Sodium	75 – 125	20	80 – 120
Conventional Parameters			
Bicarbonate alkalinity as $CaCO_3$	75 – 125	20	80 – 120
Chloride	75 – 125	20	80 – 120
Phosphate, total as P	75 – 125	20	80 – 120
Salinity in ppt	na	20	80 – 120
Sulfate	75 – 125	20	80 – 120
Sulfide	75 – 125	20	80 – 120
Total organic carbon	75 – 125	20	80 – 120

a - Replaces QAPP Table A-4-3 (Appendix A of OMMP)