# Appendix A:
# Project Scoping Session Minutes

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# Scoping Meeting Notes
# Keyport Area 8 Supplemental RI
20F4176
November 18, 2020
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## Project Team

| | |
|---|---|
| Ms. Cellucci | Naval Facilities Engineering Systems Command (NFESC) Northwest |
| Mr. Craig | US EPA Region 10, Project Manager |
| Mr. Alam | Dept, of Ecology Project Manager |
| Denice Taylor | Suquamish Tribe, Project Manager |

## Support Personnel

| | |
|---|---|
| JoAnn Grady | Grady & Associates, Team Facilitator |
| Travis Lewis | NAVFESC |
| Sophia Lee | NFEXWC |
| Mr. Palmieri | AECOM |
| Josie Smith | AECOM |
| Greg Burgess | AECOM |

## Introductory Discussion

Ms. Grady began the meeting with introductions and asked the project team for any additions or changes to the agenda. Mr. Craig asked Ms. Cellucci to clarify Navy's goal for the use of the RA as he feels that will help to identify the needed scope. Ms. Cellucci asked if he was asking about the potential range of alternatives. Mr. Craig said yes, and in addition it is helpful to discuss the degree of maintenance the Navy is considering, i.e. does Navy want to excavate, treat insitu, put in place a permeable reactive barrier remedy, etc. Mr. Alam agreed that it would be helpful to have that discussion. He added the ROD indicates groundwater control but further discussion regarding the specifics of that control would be helpful.

Ms. Cellucci stated that groundwater control is not an option with the high tidal influence. The three-options Mr. Craig lined out are in play. She added this is not a chlorinated problem, this is a problem of metals reaching the marine environment. The question is, will insitu or permeable reactive barriers (PRB) work in marine waters. Ms. Cellucci stated she has researched the issue and has found no one that has operated these solutions in a marine environment. She added that bench-scale testing being planned.

Mr. Craig noted the site appears to have metals, in addition to PFAS with some VOCs, so it is important to keep this in mind as there is a lot of characterization needed. Ms. Cellucci added that she has indicated to the vendors that PFAS will need to be addressed as well. Mr. Craig offered that there is a new study for solidification of PFAS, which appears to work well, and is it known to work for metals. He added this is the type of information needed to be included. Ms. Cellucci agreed and added that regarding PRBs, there is freshwater on one side of the site and marine water on the other, which will likely pose a bit of a problem for both engineers and geologists.

Mr. Palmieri offered an AECOM Safety moment regarding Fall driving safety.

Mr. Palmieri then provided a slide presentation of the site to the team (attached meeting materials) which included a brief review of:

### The purpose and objective of the meeting

**Details of the initial Remedial Investigation (RI) and Record of Decision (ROD)**
**A review of the contaminants of concern (COC) and RG (remedial Goals) and the**
**A geologic Cross section of the site:**
The team asked to an additional few boring to confirm or refute a deep erosional feature

**Past remedial actions, including:**
- **Post Remedial Actions**
- **Past excavation extent**
- **Post-excavation sample results**

Mr. Alam questioned the red-boxed results (Slide 13) and asked if they were above MTCA level B, and if the results were pre or post removal. Mr. Burgess stated the results are for left-in-place material, post-excavation. Mr. Craig asked if Navy thought these would be part of the groundwater control component of the remedy. Ms. Cellucci said she did not know as no one on the current team was there when this happened. Ms. Smith noted a Hart Crowser document NIRIS number is N00253_000033 that mentioned the sampling.

Action Item – Ms. Smith will distribute the NIRIS document to the team

Mr. Craig asked why they put in the slurry walls, how they were constructed, and if they are keyed into anything. He said he would like to understand the rationale behind the work. Ms. Cellucci stated they are for shoring only to keep the water back during UST removal. They are not keyed into anything on the base or the sides. Mr. Craig added that basically they are concrete shoring. Ms. Cellucci agreed.
Mr. Palmieri offered the speculation that it is possible that the cadmium excavation was stopped because of geotechnical constraints. Ms. Cellucci agreed that is possible due to the area being entirely fill material.
Ms. Grady asked if Ms. Taylor was on the team at the time the work took place. Ms. Taylor said no, it was before her time. No one on the present team knew the rational for the previous work.

**Mr. Palmieri continued the slide show and reviewed:**
**Post-action Cadmium and TCE concentrations in groundwater.**
**1998 soil TPH concentrations.**
**Current and Former Building Locations.**
**Slurry wall information:**
- Southernmost slurry wall is 5 to 17 feet deep
- Western slurry wall is 5 to 15 feet deep

**Utilities and Slurry Wall Locations**
Mr. Palmieri said the preferential pathways may be playing a large role in contaminant migration in groundwater. Ms. Lee asked if the slurry walls may have been installed to funnel or control TCE. Mr. Palmieri said no, the slurry walls were installed strictly for geotechnical considerations during UST removal and excavation.

Mr. Craig asked the meaning of the 'pink line' on the figure: the force main (old south pier). Ms. Cellucci thought this was the main water line to the pier. Mr. Craig asked if any of the subsurface features potentially interfere with a remedy, could they be removed. Ms. Cellucci said yes. Mr. Craig offered if they were removed, that could simplify things greatly. Ms. Cellucci agreed but added she wants to do things concurrently, adding if the slurry wall is removed now, it could possibly release TCE towards the marine environment. Mr. Craig agreed but wanted to make sure removal of these items is on the table to make work more efficient. Mr. Craig also added that sometimes gravels in utility conduits is a preferential pathway and wanted to make sure that was considered moving forward.

### 2017 soil vapor results

Mr. Palmieri continue stating the highest TCE concentrations in soil vapor are south of Building 98. The VI report indicated utility corridors could be playing a role in migration. Ms. Cellucci asked if the tide could be pushing TCE in that direction. Ms. Lee asked how the utilities could be moving contaminants around. Mr. Palmieri said this is vapor, and there are excavated trenches that change permeability and transmissivity, so it provides a path of least resistance. Mr. Mr. Palmieri asked how deep the utilities are placed. Ms. Cellucci said she does not really know, but based on the outfalls, probably no deeper than 5 feet. Ms. Smith added that some of them come out right at the foot of the seawall, so they could be deep. Ms. Lee noted the installation should have this information. Ms. Smith said the Hart Crowser report shows the utilities to be shallow. Ms. Cellucci said she still believes that the utility corridors could be preferential pathways. Most of the area is fill and relatively fine grained and that would make the utility corridors a preferential pathway. Mr. Craig noted there is no Vashon Till at this site, which is very impermeable, hence the fill material is likely not as impermeable as the Vashon Till. Ms. Cellucci added she does not believe that there is an erosional feature to 150 feet as indicated by the current cross-section and Navy may be redefining the geology.

### Area 8 monitoring wells

Mr. Palmieri noted the need to confirm wells that are present or have been abandoned.

### Area 8 2018 Groundwater Surface Elevation Contours

Mr. Palmieri offered these contours need to be refined during next phase of investigation

### 2018 LTM Results VOCs in Groundwater and Seep Water

### 2018 LTM Results Metals in Groundwater and Seep Water

Mr. Palmieri noted the highest concentration is in 8MW-11, which looks like the general area of where the elevated cadmium was left in place.

Ms. Taylor asked if the team is confident of the delineation, so we know where background exists. Mr. Palmieri said he is not sure about that yet. He added they have a couple of upgradient locations that might be informational. Ms. Cellucci agreed that Navy does not know what the current magnitude and extent of the impacts and said that is why she is looking to the West and the North. She added there is also a VI issue which may indicate another separate site.
Ms. Taylor asked if PFAS will be included in that analysis. Ms. Cellucci said yes.

### 2019 Indoor Air/SS Vapor Results BLDG 98

Mr. Palmieri noted there are VI exceedances across the entire footprint of building 98. This does not mean conclusively that there is a source under the entire building, but that there could be.

## 2019 Seep and Sediment Sample Results

Ms. Smith noted a diagram that showed a compilation of several studies that looked out farther into the subtidal area. Some impacts were to the north, but she said the most mass is in seeps around building 72. She added there is no risk to human health for tissue ingestion, but there is ecological risk based on metals. She said the team was assuming that the water daylighting on the beach is freshwater, but it could be marine water because of tidal flows.

Mr. Craig suggested looking to see if there are edge effects from the slurry wall. Ms. Smith said the team needs to make sure to confirm where these features are because the data has been collected over time, and these locations could be mis-located on the existing figures. She added it is important to know their relative locations. Mr. Craig asked if it would be important to pin these down. Mr. Palmieri said yes, this is the first step. He added they are planning EM, resistivity, and GPR to do this. Ms. Lee asked if the geophysics and water levels need to also be checked upgradient of the site. Mr. Palmieri said he needed to see what wells are available. He added, in tandem with the geophysics, they will deploy data loggers to look at tidal influence and conductivity. Mr. Alam added in additional to the well inventory survey, he suggests making certain the well logs are found so the well construction and lithology of the screened intervals are known. Mr. Palmieri added if it is an important well and they do not have the bore log, they can check the screened interval with a camera. Mr. Burgess added AECOM can also do downhole geophysics if the well construction is amenable.

## Data Gaps

Ms. Cellucci emphasized this is a draft presentation. She said they know there is a sub slab issue, and it will be monitored. She added they have also documented PFAS at the site and are going to delineate the PFAS. Mr. Alam noted another data gap is TPH and added the need to make sure there are not any additional any remaining issues. He also would like to review the previous RI report and see what was measured and what the RLs are for all COCs, to be sure there were no COCs removed based on outdated RLs. Mr. Craig asked if they have looked for 1,4-dioxane and MTBE. Mr. Palmieri said yes, 1,4-dioxane is included in the suite. Mr. Craig asked if MTBE has been investigated. Ms. Cellucci said no, this is not a gasoline site, and petroleum was not included due to it not being a risk driver. She offered to investigate diesel if EPA would like that information. Mr. Craig asked the range on the hydrocarbons. Mr. Palmieri said there is a great deal of hydrocarbon data, and Mr. Craig said the first thing is to make sure the Rls are adequate for that data. Ms. Lee asked if he was referring to things that were non-detect or things that were present at low levels, adding the team may not want to reanalyze for things that were non-detect. Mr. Alam said he is wondering if everything that should have been analyzed, was analyzed, and if some COCs were removed based on non-detect with RLs that were elevated. In groundwater it might be possible for example, to detect Aroclors now that could not be detected at the time due to elevated RLs. He furthered that a review of the previous RI and RLs would give us confidence with the new RI. Ms. Cellucci said in some cases, cleanup levels have increased; TPH for example. Mr. Craig said he is looking at this more from co-contaminants that may not been looked at in the first RI. He is not looking to re-evaluate what has been done already. Ms. Cellucci said the Navy team can review the original RI and put rationale in the QAPP for COCs we are, and are not, including. Mr. Palmieri said they will review the RI and look at the COC evaluation and results.

Ms. Cellucci asked her Navy team if ERN funds are used for petroleum sites. Mr. Lewis and Ms. Lee both confirmed that ERN funding has been used for petroleum. Mr. Craig added both JPHC and Bangor have RODs with petroleum and have gone through that program. Mr. Alam also confirmed Bangor and added BNC.

Mr. Craig said there was a need to add a bullet for 1,4-dioxane as a data gap.

Ms. Lee said the Navy team may not address all the different conditions at the site with the same treatment. Ms. Cellucci said the chlorinated, PFAS, metals, and1,4-dioxane are expected as the same source. Mr. Craig offered that petroleum has migrated a great deal at JPHC so there is a need to be careful of over generalization. He added it all needs to be treated as co-contaminants in terms of the overall remedy and, everything needs to be characterized to consider competing effects. What the remedial strategy will be is dependent on the overlay of all these COCs.

## Proposed Scope

Mr. Palmieri continued his presentation and stated the team has flexibility based on penetration depths. Ms. Cellucci said the team should consider expedited analyses to determine depth in the first few days. Ms. Taylor asked if there is an estimate for the second mobilization. Mr. Palmieri confirmed sometime late June or July. Ms. Lee agreed that expedited results can be especially useful and asked how far inland the team is taking the multiple tools. Mr. Palmieri said at present, it is limited to the Area 8 boundary. Mr. Craig asked if the team could get to 50 feet with direct-push tools (DPT) in advanced outwash. Mr. Palmieri's initial response is no, but there is a possibility as it depends on the density. Ms. Cellucci added the scope is based primarily on the trench and fill everywhere else. She said they will use sonic for the drilling for well installation and if they cannot get what they want with DPT, she will consider other options. Mr. Palmier said DPT is viewed as screening level data, and if there becomes a need to go deeper, he can do that with sonic if he cannot reach it with DPT.

Ms. Cellucci said there will be a need to set up a check-in call to adjust the field program in real time based on preceding results. She added the team may want to extend a line of sampling points up the street, east of building 98. Mr. Craig said that on the NE side, he would suggest extending the geophysical to make sure the entire wall is captured as he wants to be able to see edge effects on these walls. Mr. Alam said he had the same comment. Ms. Lee said if the team is suggesting going up that line, they may want to want to do something perpendicular as well.

Ms. Cellucci asked if EPA, Ecology, or Suquamish have access to Arc Viewer. EPA and Suquamish said no, but ecology, yes. Ms. Smith thinks Arc Reader is a free application but could be limited by individual organization security restrictions.

## Google Earth Presentation – Scope Discussion

Mr. Palmieri stated there are 22 DPT locations being considered. The initial distribution was on Google Earth, and showed the relation to elevated residual Cd results, and showed the relation to excavation limits. Samples will be analyzed for VOCs, 1,4-dioxane, and PFAS.

Mr. Craig asked if borings would be on the upgradient, downgradient or both sides of the slurry wall. Mr. Palmieri said upgradient and added that based on current understanding of the slurry wall location, it could be difficult to get a geoprobe rig on the downgradient side. Ms. Smith added that the other side of seawall is basically boulders. Mr. Palmieri said some locations are placed to begin looking at building 98 and could also be used as background info if nothing additional is found.
Several DPT locations are along the corridors to look for potential pathways. Ms. Cellucci said she thinks the team may need to extend a bit to the south along the shoreline as she wants to know what is happening between the two wells being monitored in that area.

Mr. Craig said he assumes all the geophysical data will be collected first so the team can adjust, based on those results. Mr. Palmieri said yes, the geophysical survey will drive a lot of the work. Ms. Cellucci said the utility locations are from their Master map. She continued that the Navy team will write the QAPP based on what they know now, conduct the geophysical survey, and adjust as needed. She said she will then present the revised locations, based on geophysical results, to the team for comment. They will also determine where new wells should be placed based on DPT mobilization, present those findings to the team for comment, and then go out for 3rd mob.

Ms. Cellucci asked if anyone had any other locations needed to be added. She said she needs to pin this down as close as possible because a concurrence letter will be required. She added this information needed to be as accurate as possible. Ms. Smith would like to see more borings along the top of the sea wall as the problem is what is getting on the beach. Ms. Cellucci agreed for two reasons, locating the contamination reaching the beach and evaluating the viability of a PRB.

Mr. Palmieri noted the sample location density is ‘fairly good’ based on the map scale. Mr. Alam said he also thinks the location density is pretty good in the uplands side. He said he is looking to the beach sediment and pore water data as he wants to see if there is any elevated pore water data, especially on the south side. Also, he added the data from MW8-9 is not known. He suggested looking into this before deciding on the upland locations.

Mr. Craig said he needs to look at the flow across the interface from upland to marine and suggested a network along that interface to evaluate flow and mass flux, which will be important decision information. Ms. Smith said she has a lot of data that shows there is not much of an issue south of the stairwell. Ms. Smith asked Mr. Alam to clarify what he means by pore water. Mr. Alam said he means sediment pore water, not seeps. He asked if transect 14 is the furthest south they have tested. Ms. Smith said yes, but there is nothing south of seep B based on seeps and sediments. Mr. Alam asked why the area south of building 803 was not included for sampling. Ms. Cellucci said she was not around when this decision was made but believes that it is based on not finding anything further south or west along the beach. But she added they need to look back into the data. Mr. Alam said the team needs to look at this with fresh eyes to see if there is a need for additional data to the south or west along the beach. Ms. Lee said to Mr. Alam’s point, she has looked at the water level flow directions, and suggested that the team look at that after the first phase and after there is a better handle on flow dynamics. Mr. Alam agreed and suggested the team keep this in mind as he wants to be certain there is not an upland issue in this part of the site. Ms. Taylor suggested it would be a good to check in with Michael Meyer for memory about the characterization. Ms. Cellucci agreed.

## Current Schedule

Mr. Palmieri noted the ideal time to catch a big tidal fluctuation is late May and Early June.
Ms. Smith said there are some exceptionally low tides in June. She emphasized a need to stay on schedule. A below minus 4 tide will take place this year, which has never been seen. Mr. Palmieri agreed and noted the desire to hit the low tides. Ms. Lee asked if COVID quarantine will be an issue with regards to the schedule. Mr. Palmieri said only for the geophysical team, adding all AECOM and drillers are in Washington.
Ms. Smith added she had time to look at NIRIS during the meeting and noted there are some sediment locations south of Area 8. She said she will look at that data and get back to the team at the next meeting.

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NAVFAC
Naval Facilities Engineering Systems Command
NAVFAC Northwest

# NBK Keyport OU2, Area 8 Supplemental Remedial Investigation

***November 18, 2020***

# Outline

- **Introductions**
- **Safety Moment**
- **Purpose and Objectives**
- **Site Background**
- **Summary of Available Data**
- **Data Gaps**
- **Investigation Approach**

# Attendees

**NAVFAC NW**

- **Carlotta Cellucci - RPM**
- **Amanda Rohrbaugh – Alt. RPM**

**NAVFAC EXWC**

- **Sophia Lee**
- **Travis Lewis**

**Suquamish Tribe**

- **Denice Taylor**

**Ecology**

- **Mahbub Alam - PM**

**EPA**

- **Harry Craig - PM**

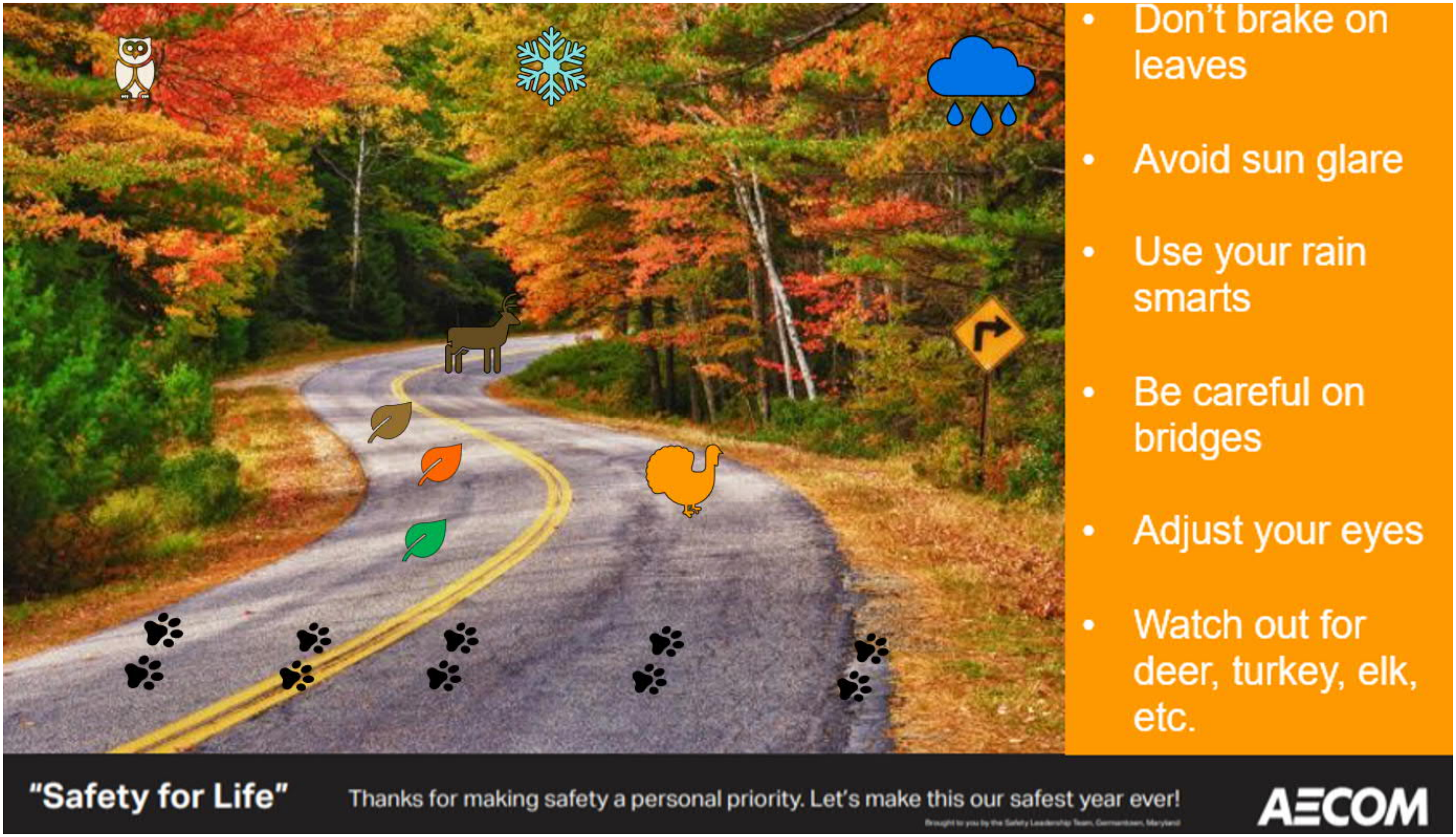
**Moderator**

- **JoAnn Grady**

**AECOM**

- **Anthony Palmieri**
- **Greg Burgess**

# Safety Moment



- Don't brake on leaves
- Avoid sun glare
- Use your rain smarts
- Be careful on bridges
- Adjust your eyes
- Watch out for deer, turkey, elk, etc.

**"Safety for Life"** Thanks for making safety a personal priority. Let's make this our safest year ever!

AECOM

# PURPOSE AND OBJECTIVES

# Purpose and Objective of Area 8 Supplemental RI

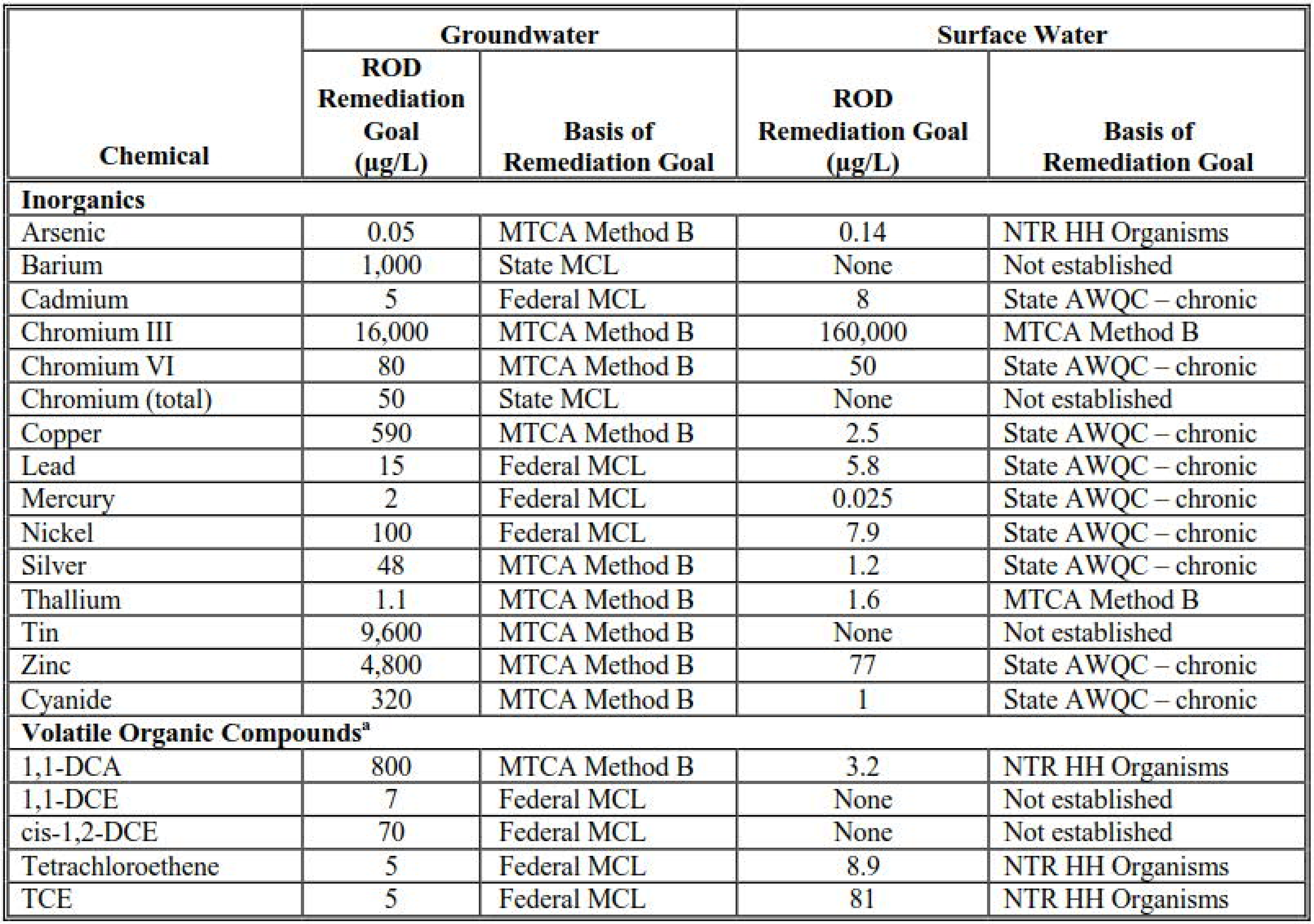
- Purpose:
  - Implement a supplemental RI at NBK Keyport OU 2 Area 8
- Objective:
  - Gain a better understanding of current site conditions and site hydrogeology in support of future remedial alternative selection to stop site contamination from seeping onto the adjacent beach
    - Map salt-water wedge geometry and depth below the terrestrial portion of the site
    - Further delineate the lateral and vertical extent of VOCs, metals, and 1,4-dioxane in soil
    - Assess soil physical properties including TOC, permeability, porosity, density, and grain size to refine aquifer characteristics

# SITE BACKGROUND

# Initial RI and Record of Decision

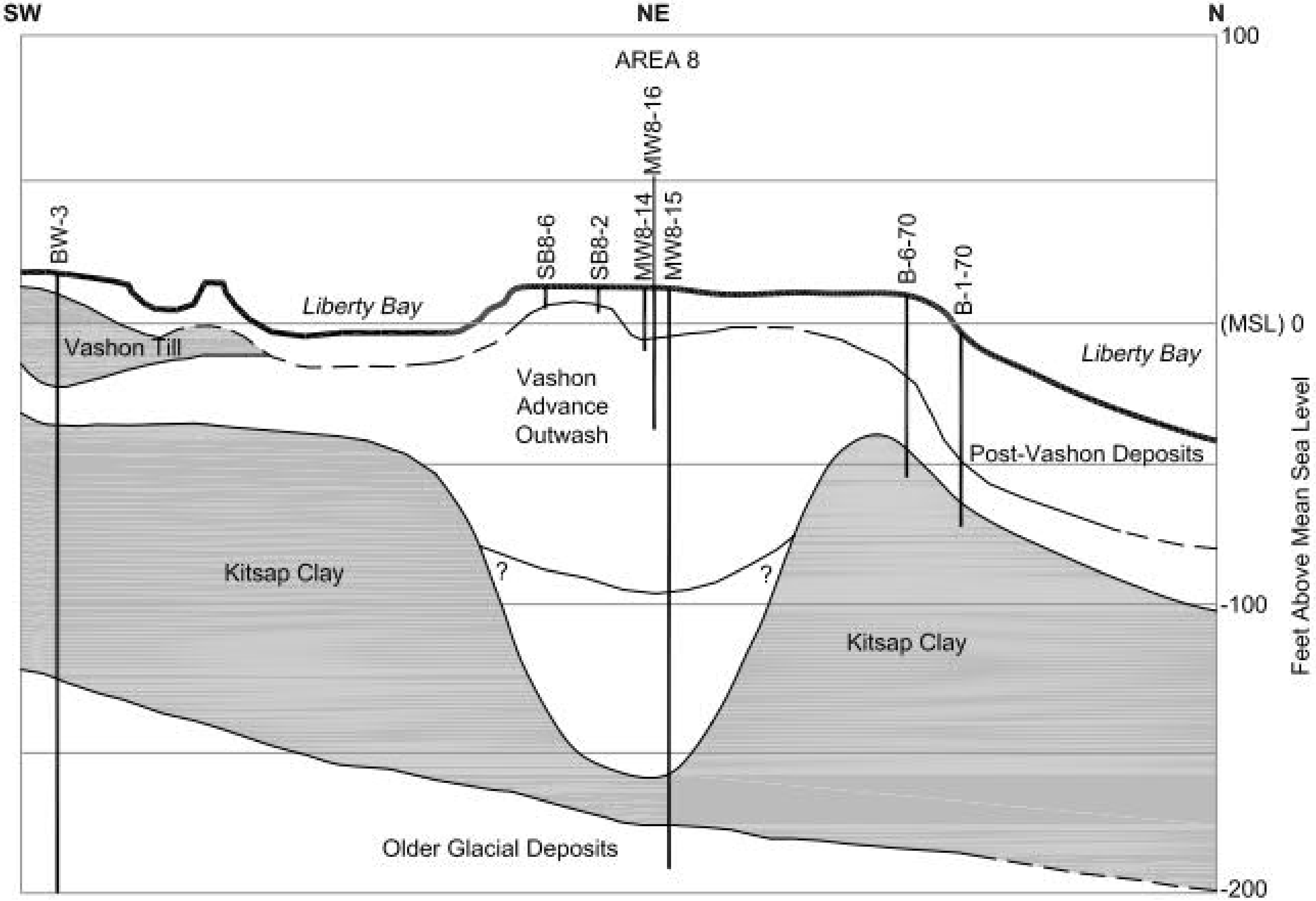
- Area 8 was investigated and characterized together with other areas of Keyport during the 1984
    - Initial assessment study and the remedial investigation (RI) and feasibility study completed in 1993. Media sampled during the RI included subsurface soil and groundwater, in addition to seep and piezometer water at the adjacent beach.
- Past metal and VOC releases associated with former Building 72
    - Chrome plating solutions spilling to ground (1970’s)
    - Plating wastes discharging to a utility trench (discovered in 1988)
    - Plating solutions leaking through cracks in shop floor, waste disposal pipes, and sumps.
- ROD signed in 1994 identified metals and VOCs as chemicals of concern at Area 8

# ROD COCs and RGs



| Chemical | Groundwater | | Surface Water | |
|---|---|---|---|---|
| | ROD Remediation Goal (µg/L) | Basis of Remediation Goal | ROD Remediation Goal (µg/L) | Basis of Remediation Goal |
| **Inorganics** | | | | |
| Arsenic | 0.05 | MTCA Method B | 0.14 | NTR HH Organisms |
| Barium | 1,000 | State MCL | None | Not established |
| Cadmium | 5 | Federal MCL | 8 | State AWQC – chronic |
| Chromium III | 16,000 | MTCA Method B | 160,000 | MTCA Method B |
| Chromium VI | 80 | MTCA Method B | 50 | State AWQC – chronic |
| Chromium (total) | 50 | State MCL | None | Not established |
| Copper | 590 | MTCA Method B | 2.5 | State AWQC – chronic |
| Lead | 15 | Federal MCL | 5.8 | State AWQC – chronic |
| Mercury | 2 | Federal MCL | 0.025 | State AWQC – chronic |
| Nickel | 100 | Federal MCL | 7.9 | State AWQC – chronic |
| Silver | 48 | MTCA Method B | 1.2 | State AWQC – chronic |
| Thallium | 1.1 | MTCA Method B | 1.6 | MTCA Method B |
| Tin | 9,600 | MTCA Method B | None | Not established |
| Zinc | 4,800 | MTCA Method B | 77 | State AWQC – chronic |
| Cyanide | 320 | MTCA Method B | 1 | State AWQC – chronic |
| **Volatile Organic Compounds**[a] | | | | |
| 1,1-DCA | 800 | MTCA Method B | 3.2 | NTR HH Organisms |
| 1,1-DCE | 7 | Federal MCL | None | Not established |
| cis-1,2-DCE | 70 | Federal MCL | None | Not established |
| Tetrachloroethene | 5 | Federal MCL | 8.9 | NTR HH Organisms |
| TCE | 5 | Federal MCL | 81 | NTR HH Organisms |

# Geologic Cross Section Beneath Area 8



# Past Remedial Actions

- Demolition of Building 72, additional site characterization, and removal of soil hotspots above the groundwater surface conducted in 1998 and 1999
  - Additional site characterization to delineate extent of metals in unsaturated soil resulted in the removal of two areas ~ 50ft x 50ft, down to groundwater interface (~9 feet bgs)
    - Based on Cd and Cr concentrations exceeding 1999 MTCA Method B soil CULs for ingestion (80 mg/kg for Cd and 400 mg/kg for Cr)

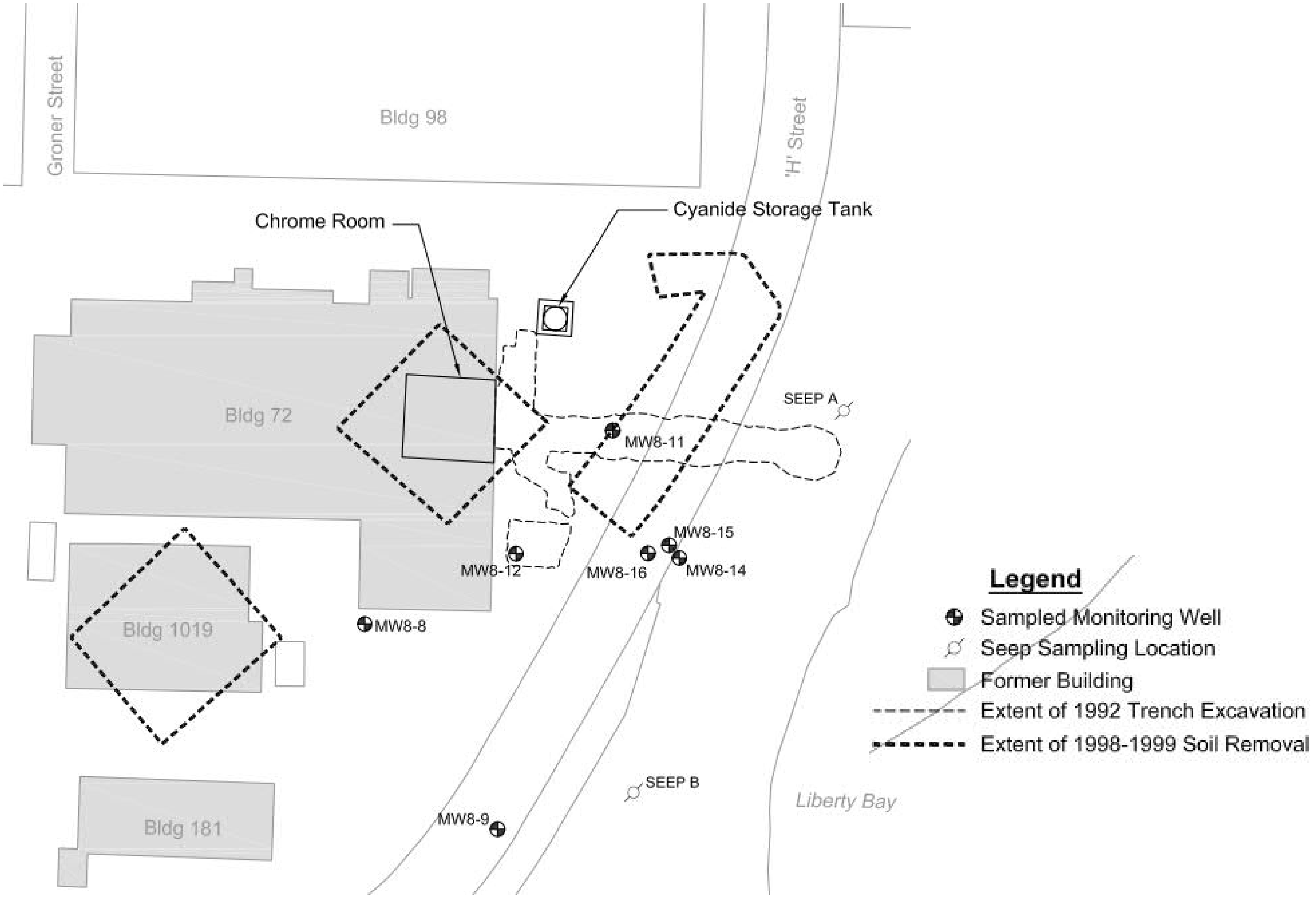
- Removal of USTs and petroleum impacted soils NE and S of former Building 72

- Installation and LTM of four groundwater monitoring wells starting in 1995

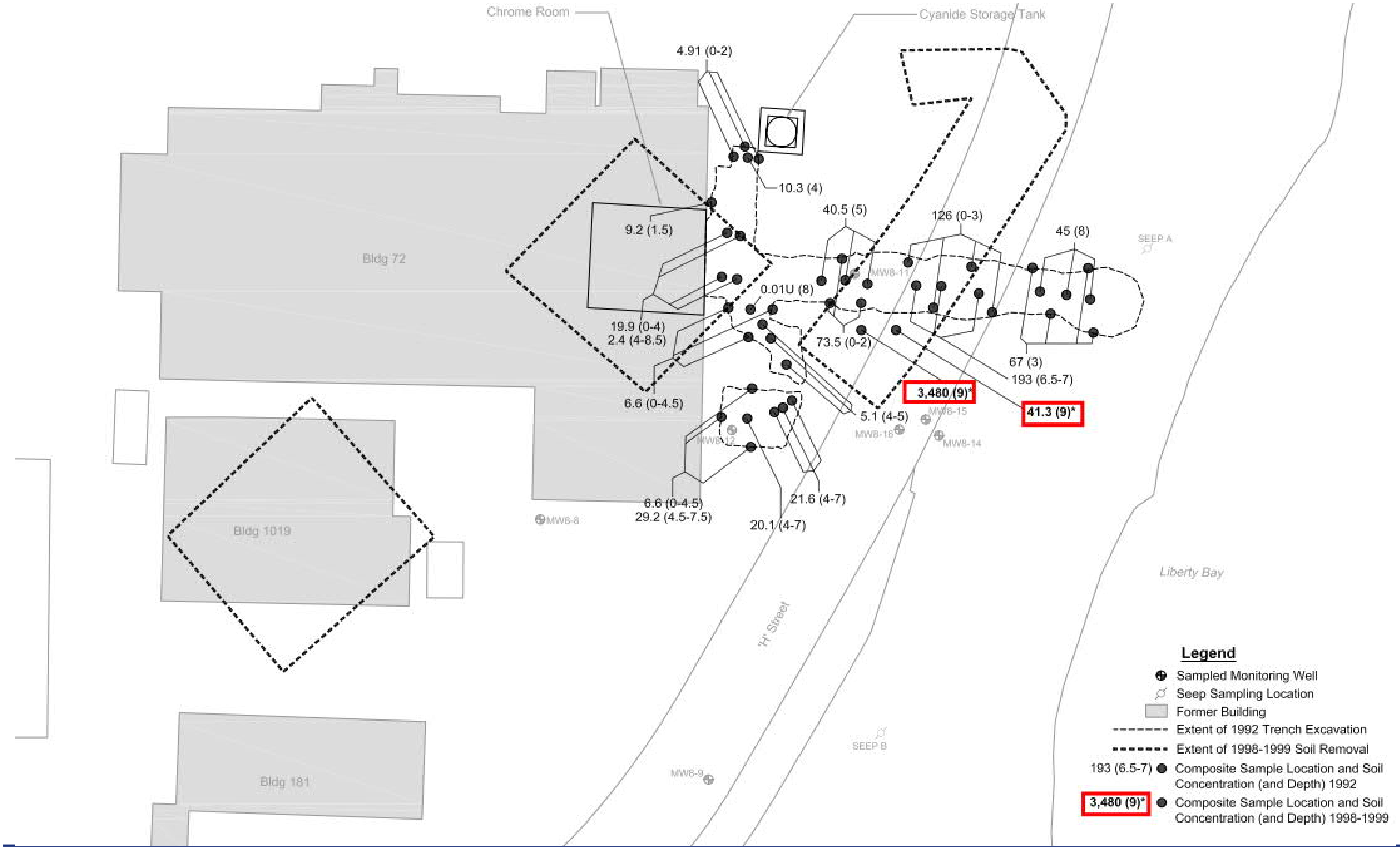
- Implementation of institutional controls, starting in 2000, to prevent exposure to soil and groundwater containing COCs at concentrations exceeding thresholds for residential use

- Sediment and tissue LTM in the intertidal zone of Area 8 starting in 1996, continuing every 4 years, or less thereafter, including 2000, 2004, 2008, 2012, 2015, and 2016.
- Evaluation of human health and ecological risks based on tissue and sediment data

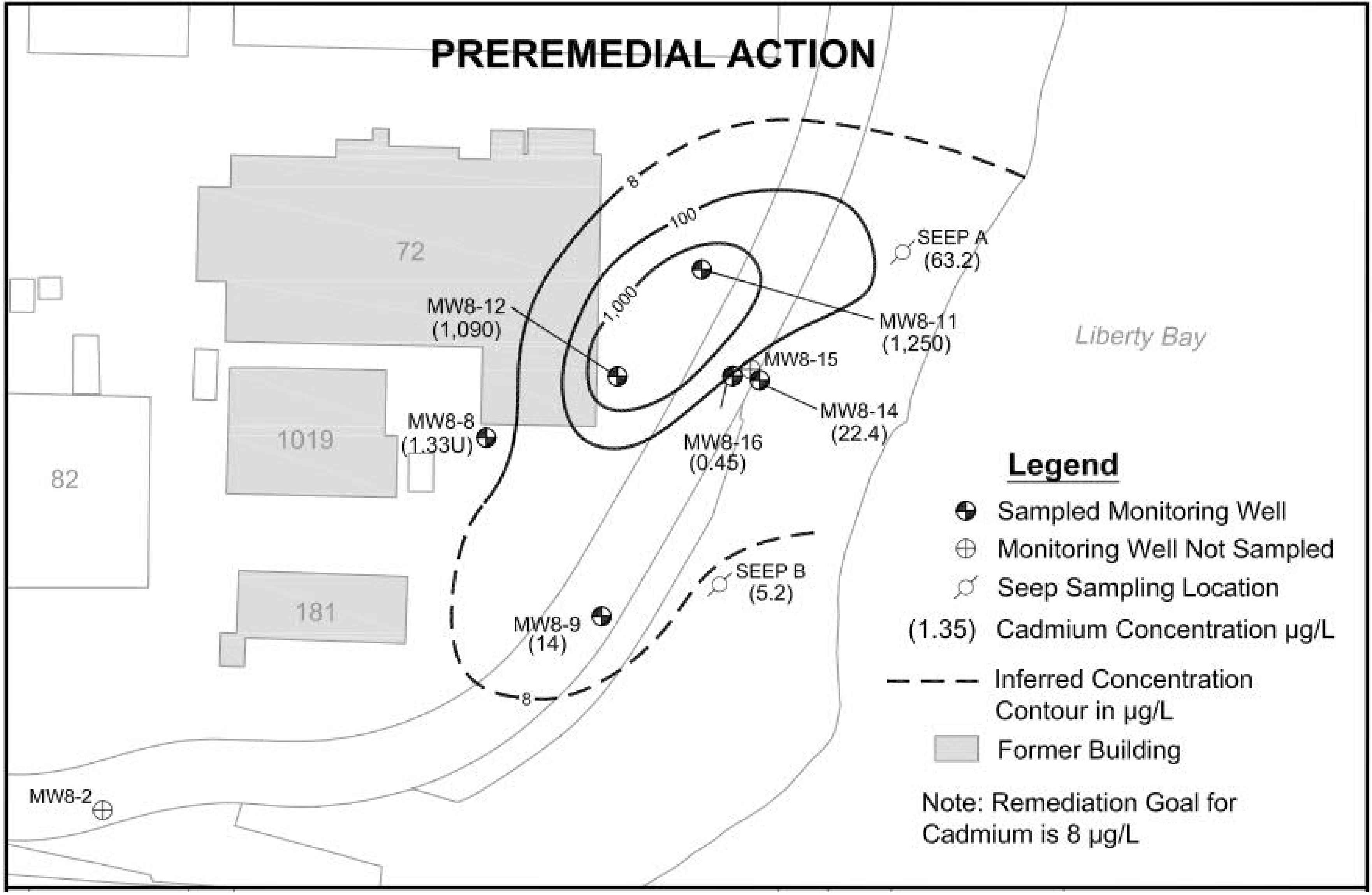
# Approx. Extent of 1992 and 1998-1999 Soil Removal Actions



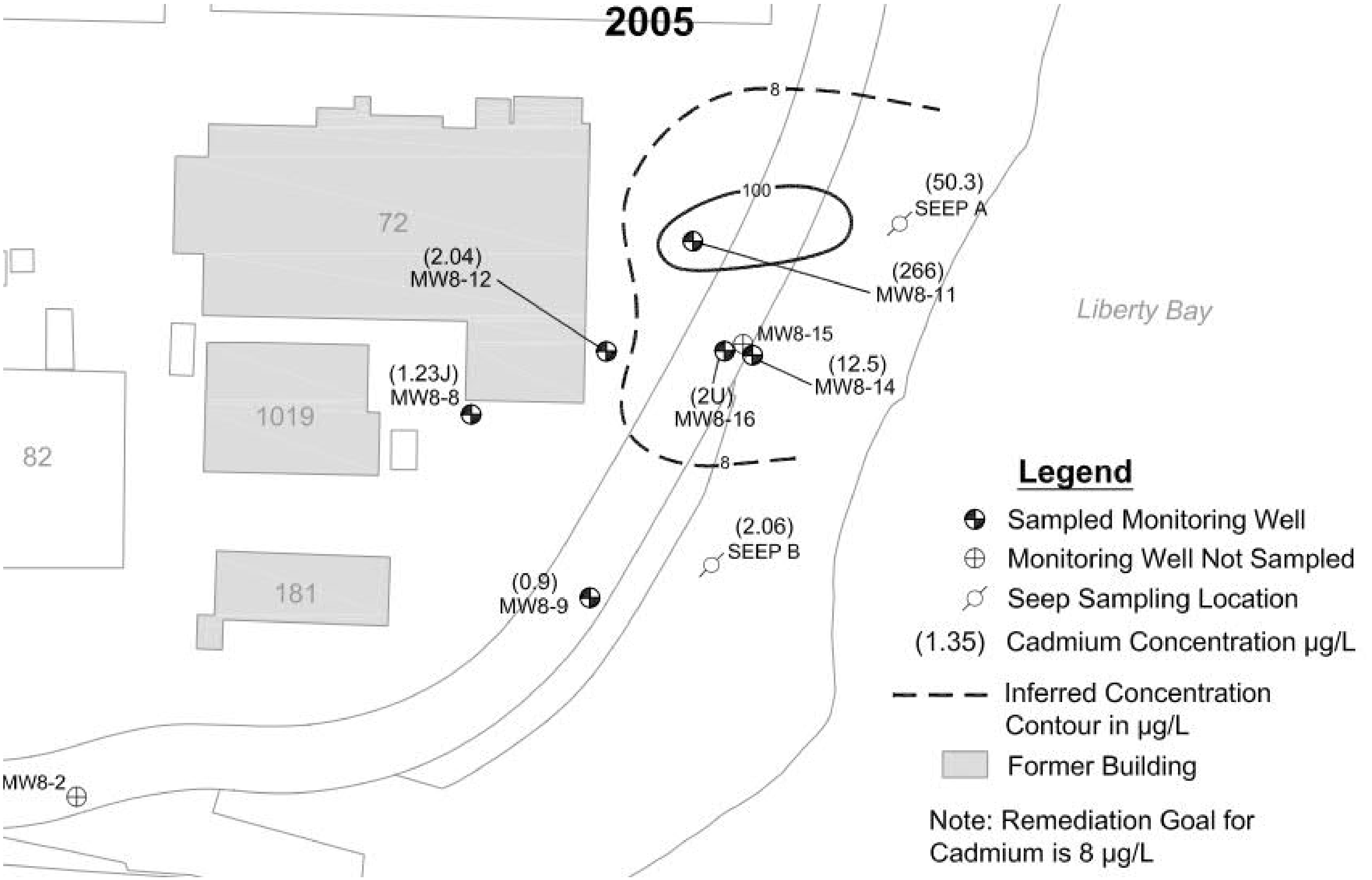
# Distribution of Cd in Soil – Post 1992 Removal Actions



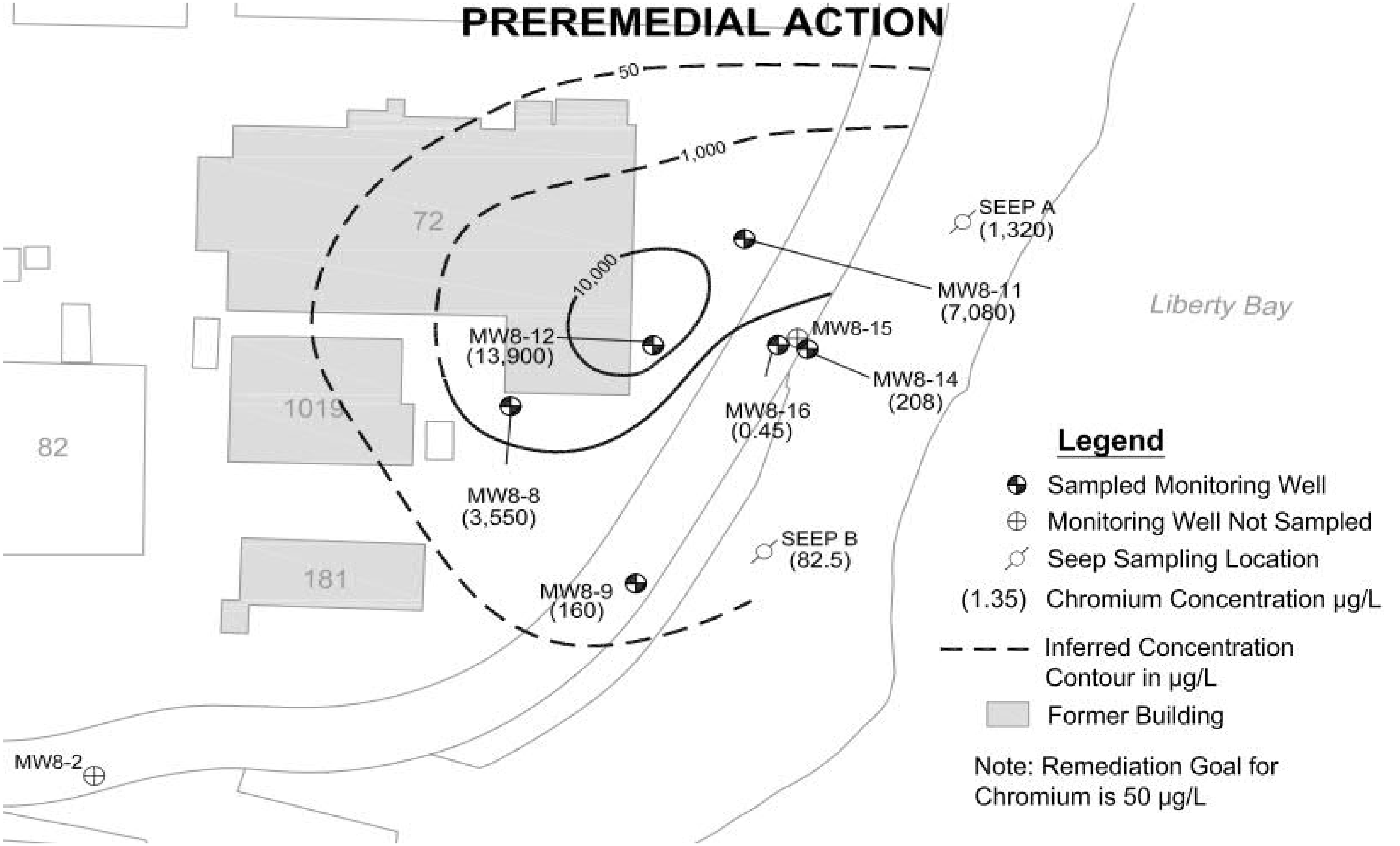
# Cadmium in GW Pre-Remedial Action



# Cadmium in GW - 2005



# Chromium in GW Pre-Remedial Action

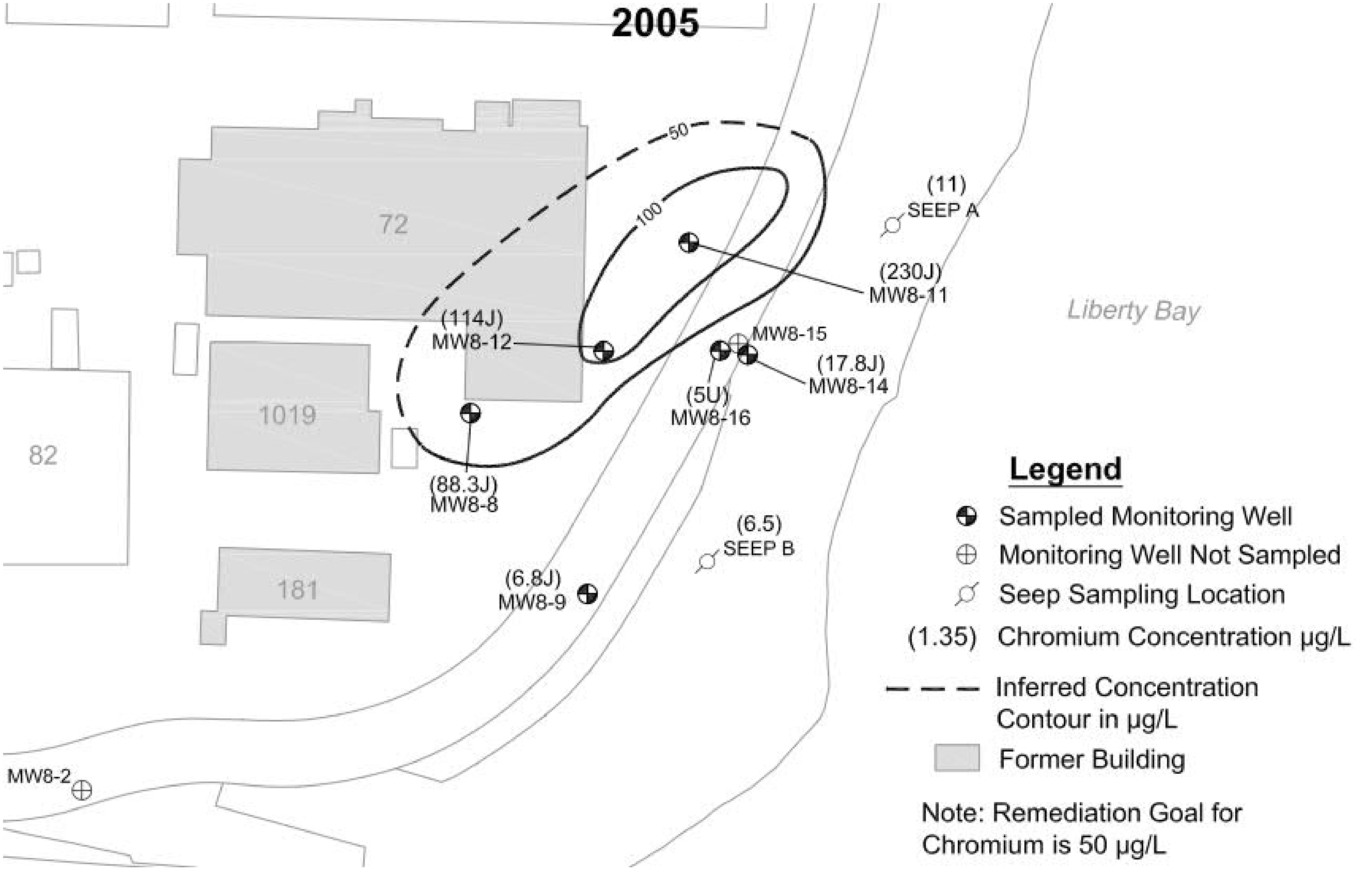


**Legend**

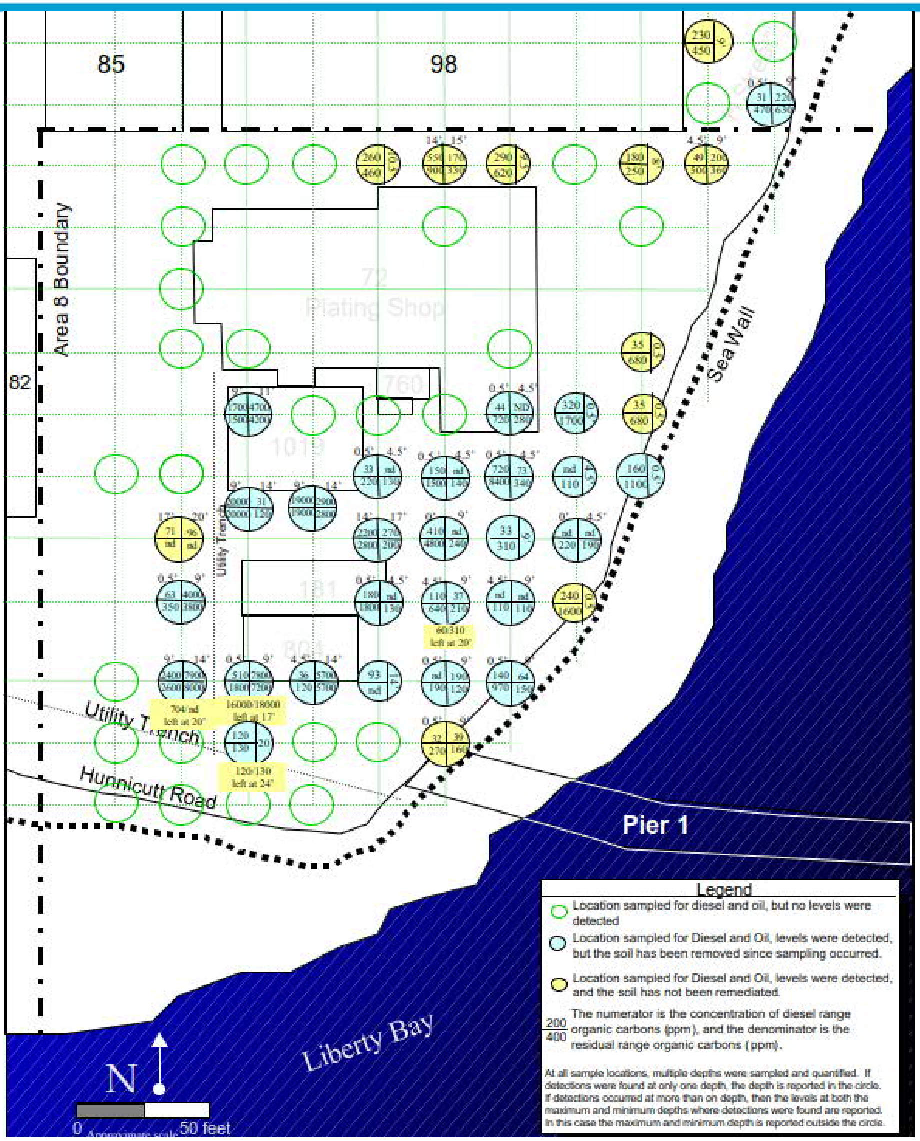
- ⊕ Sampled Monitoring Well
- ⊕ Monitoring Well Not Sampled
- Seep Sampling Location
- (1.35) Chromium Concentration µg/L
- – – – Inferred Concentration Contour in µg/L
- ▨ Former Building

Note: Remediation Goal for Chromium is 50 µg/L

# Chromium in GW - 2005

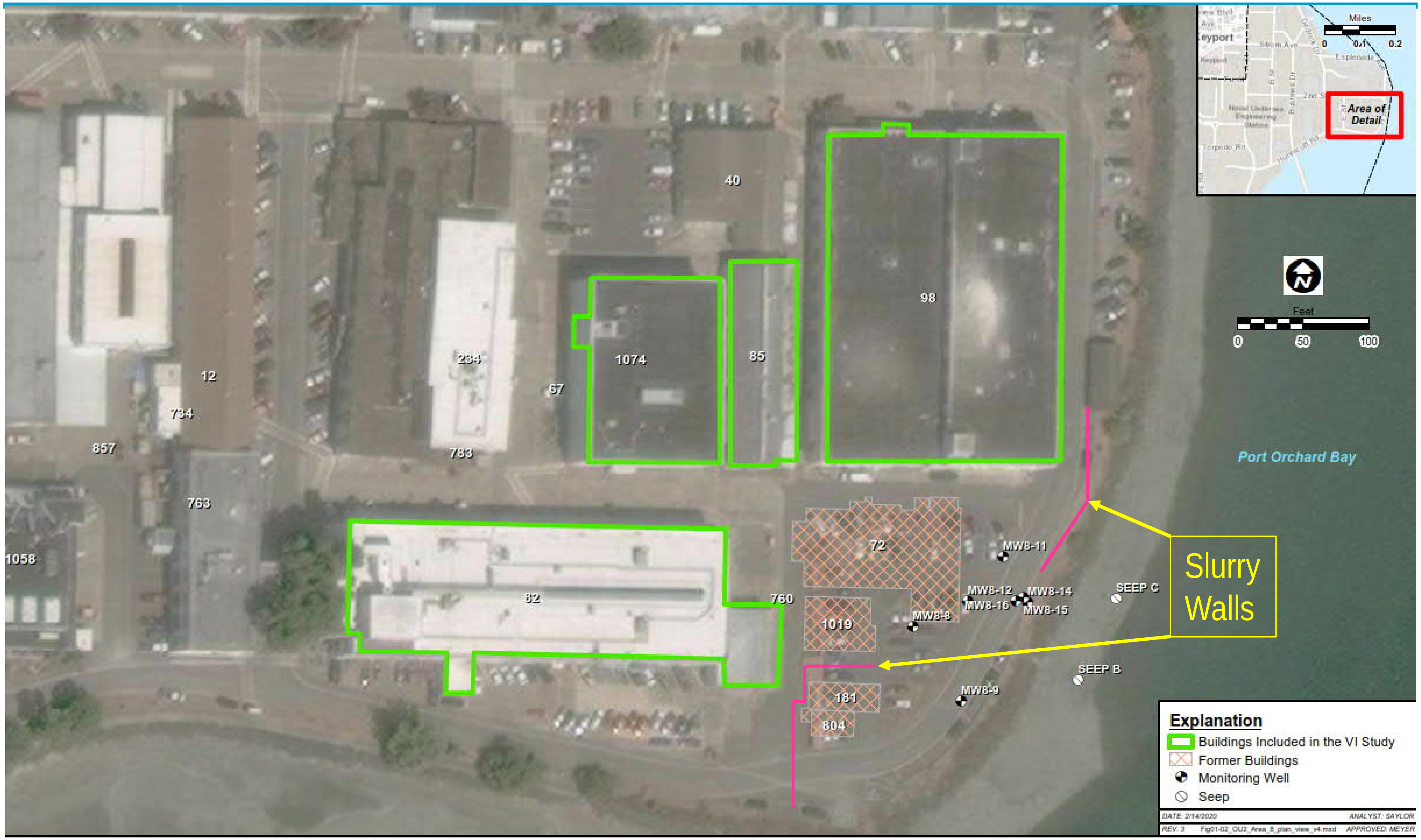


# 1998 Soil TPH Concentrations

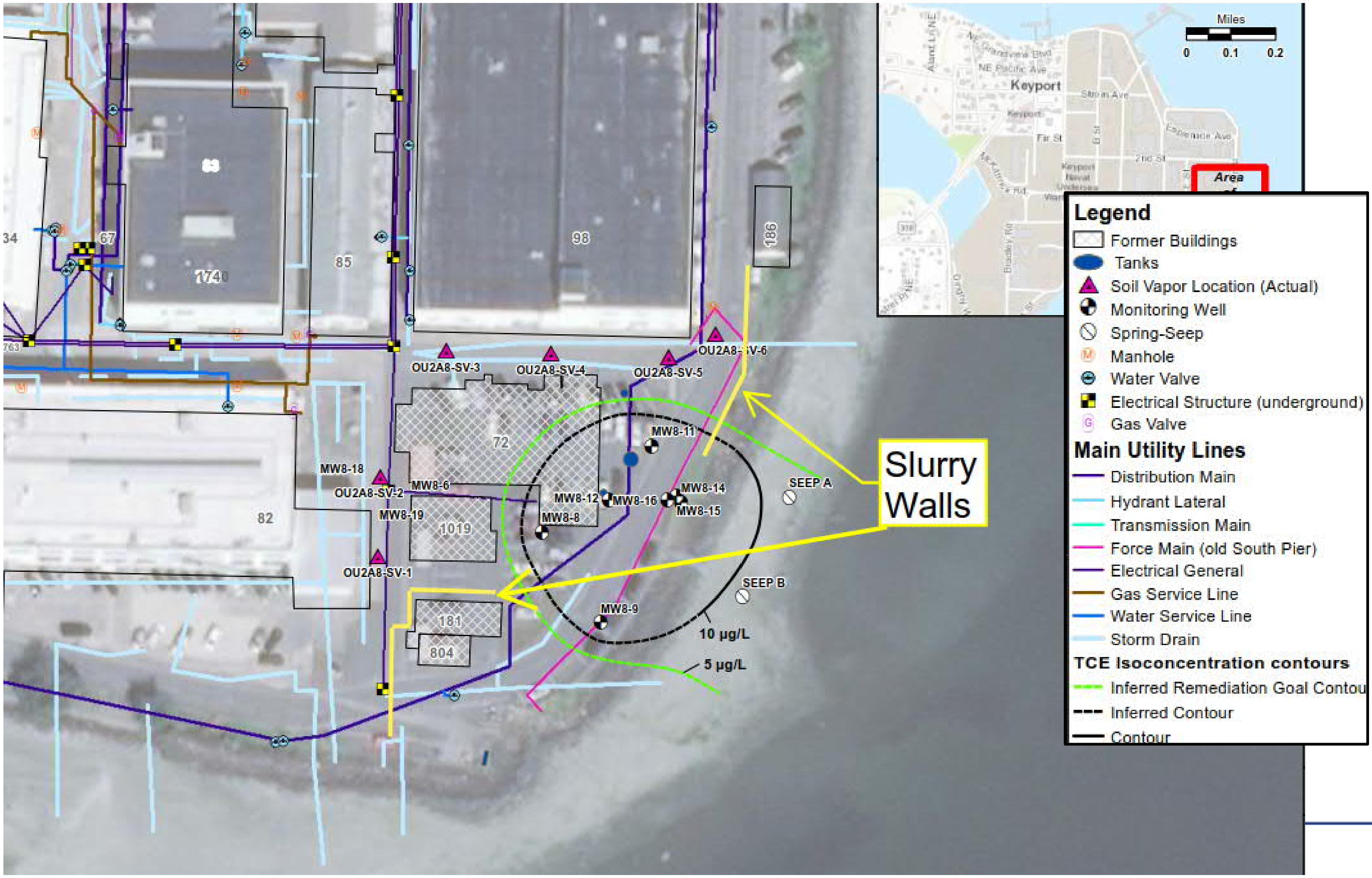


# SUMMARY OF EXISTING DATA

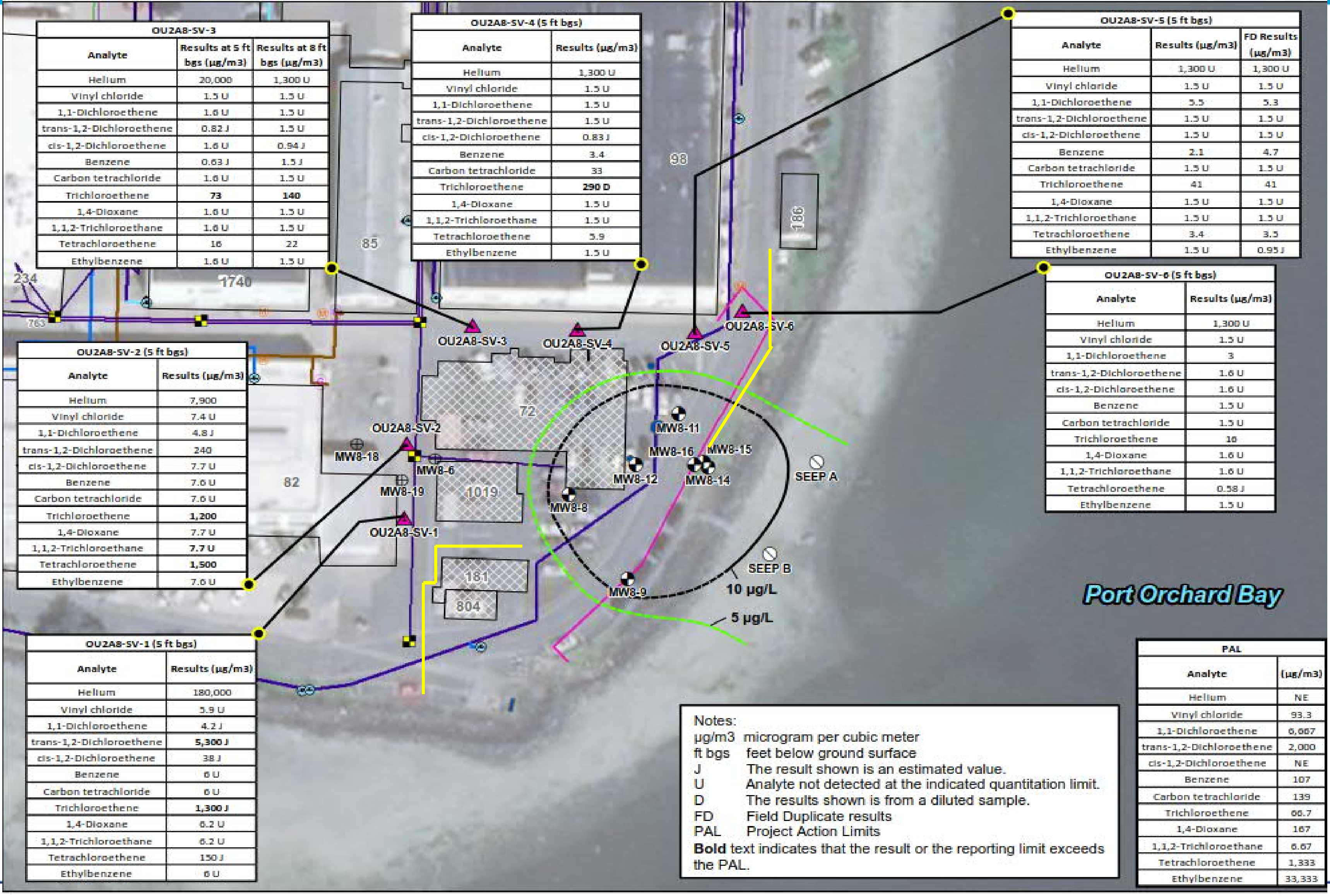
# Current and Former Building Locations



# Utilities and Slurry Wall Locations



# 2017 Soil Vapor Results



| OU2A8-SV-3 | | |
|---|---|---|
| Analyte | Results at 5 ft bgs (µg/m3) | Results at 8 ft bgs (µg/m3) |
| Helium | 20,000 | 1,300 U |
| Vinyl chloride | 1.5 U | 1.5 U |
| 1,1-Dichloroethene | 1.6 U | 1.5 U |
| trans-1,2-Dichloroethene | 0.82 J | 1.5 U |
| cis-1,2-Dichloroethene | 1.6 U | 0.94 J |
| Benzene | 0.63 J | 1.5 J |
| Carbon tetrachloride | 1.6 U | 1.5 U |
| Trichloroethene | **73** | **140** |
| 1,4-Dioxane | 1.6 U | 1.5 U |
| 1,1,2-Trichloroethane | 1.6 U | 1.5 U |
| Tetrachloroethene | 16 | 22 |
| Ethylbenzene | 1.6 U | 1.5 U |

| OU2A8-SV-4 (5 ft bgs) | |
|---|---|
| Analyte | Results (µg/m3) |
| Helium | 1,300 U |
| Vinyl chloride | 1.5 U |
| 1,1-Dichloroethene | 1.5 U |
| trans-1,2-Dichloroethene | 1.5 U |
| cis-1,2-Dichloroethene | 0.83 J |
| Benzene | 3.4 |
| Carbon tetrachloride | 33 |
| Trichloroethene | **290 D** |
| 1,4-Dioxane | 1.5 U |
| 1,1,2-Trichloroethane | 1.5 U |
| Tetrachloroethene | 5.9 |
| Ethylbenzene | 1.5 U |

| OU2A8-SV-5 (5 ft bgs) | | |
|---|---|---|
| Analyte | Results (µg/m3) | FD Results (µg/m3) |
| Helium | 1,300 U | 1,300 U |
| Vinyl chloride | 1.5 U | 1.5 U |
| 1,1-Dichloroethene | 5.5 | 5.3 |
| trans-1,2-Dichloroethene | 1.5 U | 1.5 U |
| cis-1,2-Dichloroethene | 1.5 U | 1.5 U |
| Benzene | 2.1 | 4.7 |
| Carbon tetrachloride | 1.5 U | 1.5 U |
| Trichloroethene | 41 | 41 |
| 1,4-Dioxane | 1.5 U | 1.5 U |
| 1,1,2-Trichloroethane | 1.5 U | 1.5 U |
| Tetrachloroethene | 3.4 | 3.3 |
| Ethylbenzene | 1.5 U | 0.95 J |

| OU2A8-SV-6 (5 ft bgs) | |
|---|---|
| Analyte | Results (µg/m3) |
| Helium | 1,300 U |
| Vinyl chloride | 1.5 U |
| 1,1-Dichloroethene | 3 |
| trans-1,2-Dichloroethene | 1.6 U |
| cis-1,2-Dichloroethene | 1.6 U |
| Benzene | 1.5 U |
| Carbon tetrachloride | 1.5 U |
| Trichloroethene | 16 |
| 1,4-Dioxane | 1.6 U |
| 1,1,2-Trichloroethane | 1.6 U |
| Tetrachloroethene | 0.58 J |
| Ethylbenzene | 1.5 U |

| OU2A8-SV-2 (5 ft bgs) | |
|---|---|
| Analyte | Results (µg/m3) |
| Helium | 7,900 |
| Vinyl chloride | 7.4 U |
| 1,1-Dichloroethene | 4.8 J |
| trans-1,2-Dichloroethene | 240 |
| cis-1,2-Dichloroethene | 7.7 U |
| Benzene | 7.6 U |
| Carbon tetrachloride | 7.6 U |
| Trichloroethene | **1,200** |
| 1,4-Dioxane | 7.7 U |
| 1,1,2-Trichloroethane | **7.7 U** |
| Tetrachloroethene | **1,500** |
| Ethylbenzene | 7.6 U |

| OU2A8-SV-1 (5 ft bgs) | |
|---|---|
| Analyte | Results (µg/m3) |
| Helium | 180,000 |
| Vinyl chloride | 5.9 U |
| 1,1-Dichloroethene | 4.2 J |
| trans-1,2-Dichloroethene | **5,300 J** |
| cis-1,2-Dichloroethene | 38 J |
| Benzene | 6 U |
| Carbon tetrachloride | 6 U |
| Trichloroethene | **1,300 J** |
| 1,4-Dioxane | 6.2 U |
| 1,1,2-Trichloroethane | 6.2 U |
| Tetrachloroethene | 150 J |
| Ethylbenzene | 6 U |

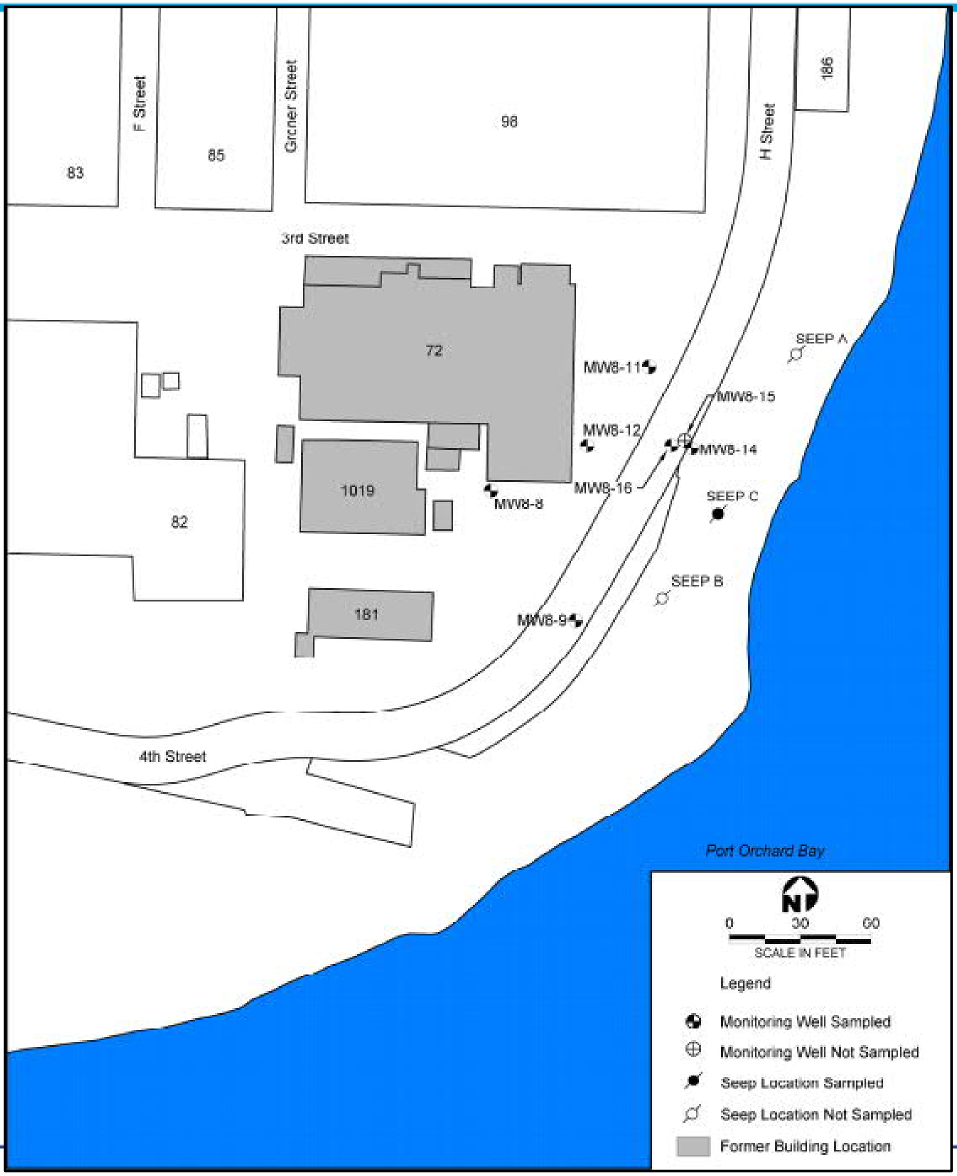
| PAL | |
|---|---|
| Analyte | (µg/m3) |
| Helium | NE |
| Vinyl chloride | 93.3 |
| 1,1-Dichloroethene | 6,667 |
| trans-1,2-Dichloroethene | 2,000 |
| cis-1,2-Dichloroethene | NE |
| Benzene | 107 |
| Carbon tetrachloride | 139 |
| Trichloroethene | 66.7 |
| 1,4-Dioxane | 167 |
| 1,1,2-Trichloroethane | 6.67 |
| Tetrachloroethene | 1,333 |
| Ethylbenzene | 33,333 |

Notes:

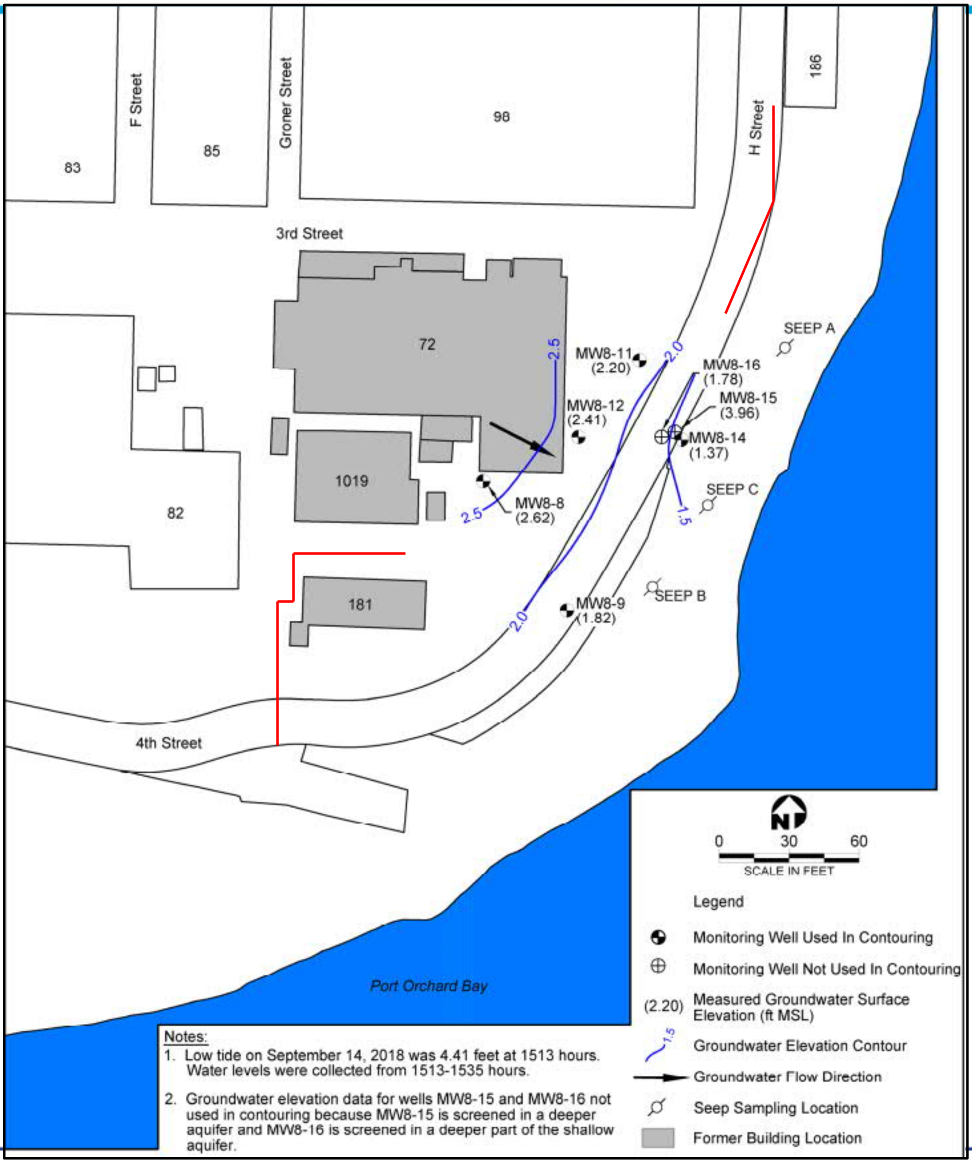
| | |
|---|---|
| µg/m3 | microgram per cubic meter |
| ft bgs | feet below ground surface |
| J | The result shown is an estimated value. |
| U | Analyte not detected at the indicated quantitation limit. |
| D | The results shown is from a diluted sample. |
| FD | Field Duplicate results |
| PAL | Project Action Limits |

**Bold** text indicates that the result or the reporting limit exceeds the PAL.

# Area 8 Monitoring Well Locations



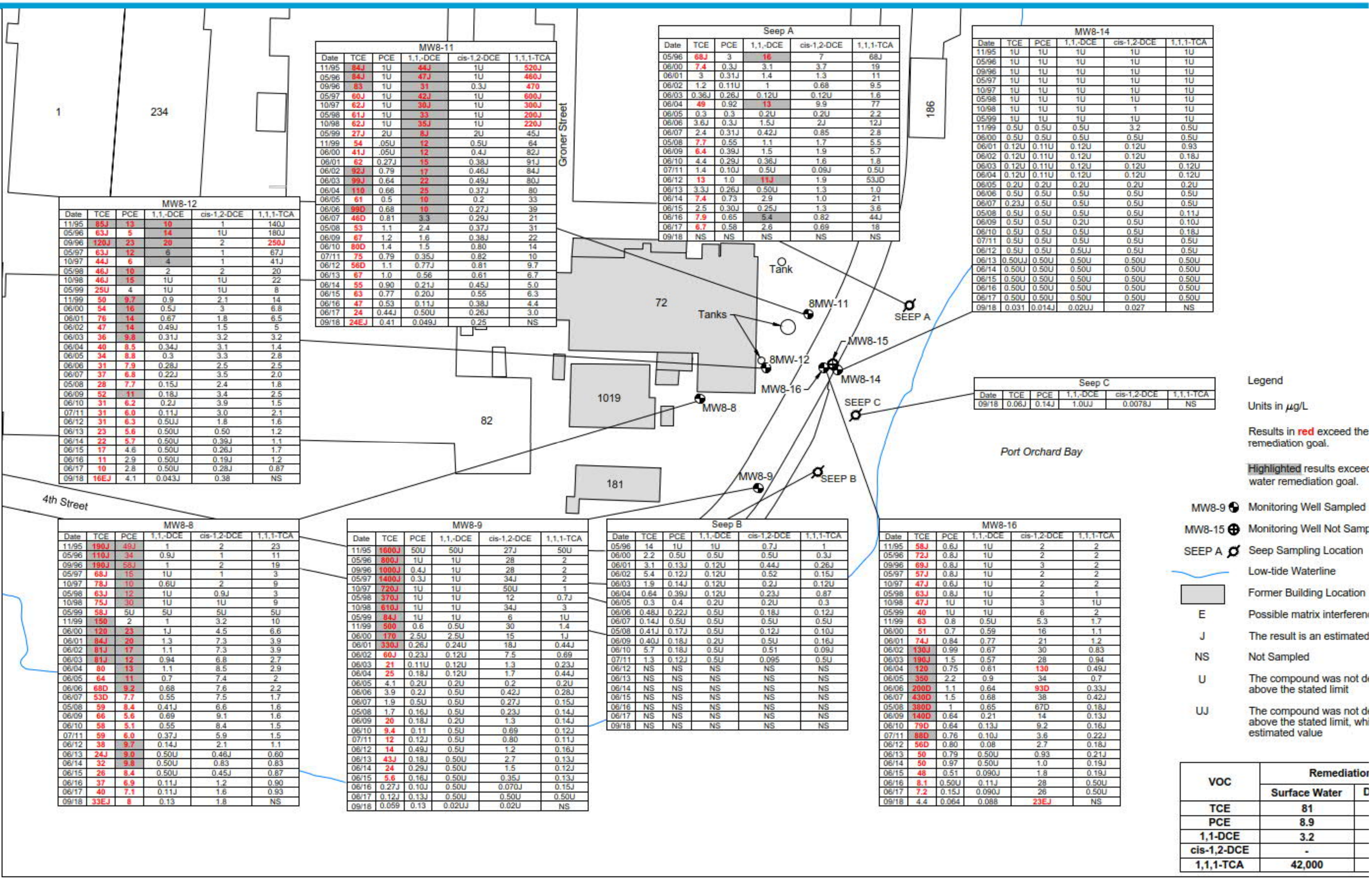
# Area 8 2018 GW Contours



Notes:

1. Low tide on September 14, 2018 was 4.41 feet at 1513 hours. Water levels were collected from 1513-1535 hours.
2. Groundwater elevation data for wells MW8-15 and MW8-16 not used in contouring because MW8-15 is screened in a deeper aquifer and MW8-16 is screened in a deeper part of the shallow aquifer.

# 2018 LTM Results
# VOCs in GW and Seep Water



MW8-11

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 11/95 | 84J | 1U | 44J | 1U | 520J |
| 05/96 | 84J | 1U | 47J | 1U | 460J |
| 09/96 | 83 | 1U | 31 | 0.3J | 470 |
| 05/97 | 60J | 1U | 42J | 1U | 600J |
| 10/97 | 62J | 1U | 30J | 1U | 300J |
| 05/98 | 61J | 1U | 33 | 1U | 200J |
| 10/98 | 62J | 1U | 35J | 1U | 220J |
| 05/99 | 27J | 2U | 8J | 2U | 45J |
| 11/99 | 54 | .05U | 12 | 0.5U | 64 |
| 06/00 | 41J | .05U | 12 | 0.4J | 82J |
| 06/01 | 62 | 0.27J | 15 | 0.38J | 91J |
| 06/02 | 92J | 0.79 | 17 | 0.46J | 84J |
| 06/03 | 99J | 0.64 | 22 | 0.49J | 80J |
| 06/04 | 110 | 0.66 | 25 | 0.37J | 80 |
| 06/05 | 61 | 0.5 | 10 | 0.2 | 33 |
| 06/06 | 99D | 0.68 | 10 | 0.27J | 39 |
| 06/07 | 46D | 0.81 | 3.3 | 0.29J | 21 |
| 05/08 | 53 | 1.1 | 2.4 | 0.37J | 31 |
| 06/09 | 67 | 1.2 | 1.6 | 0.38J | 22 |
| 06/10 | 80D | 1.4 | 1.5 | 0.80 | 14 |
| 07/11 | 75 | 0.79 | 0.35J | 0.82 | 10 |
| 06/12 | 56D | 1.1 | 0.77J | 0.81 | 9.7 |
| 06/13 | 67 | 1.0 | 0.56 | 0.61 | 6.7 |
| 06/14 | 55 | 0.90 | 0.21J | 0.45J | 5.0 |
| 06/15 | 63 | 0.77 | 0.20J | 0.55 | 6.3 |
| 06/16 | 47 | 0.53 | 0.11J | 0.38J | 4.4 |
| 06/17 | 24 | 0.44J | 0.50U | 0.26J | 3.0 |
| 09/18 | 24EJ | 0.41 | 0.049J | 0.25 | NS |

Seep A

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 05/96 | 68J | 3 | 16 | 7 | 68J |
| 06/00 | 7.4 | 0.3J | 3.1 | 3.7 | 19 |
| 06/01 | 3 | 0.31J | 1.4 | 1.3 | 11 |
| 06/02 | 1.2 | 0.11U | 1 | 0.68 | 9.5 |
| 06/03 | 0.36J | 0.26J | 0.12U | 0.12U | 1.6 |
| 06/04 | 49 | 0.92 | 13 | 9.9 | 77 |
| 06/05 | 0.3 | 0.3 | 0.2U | 0.2U | 2.2 |
| 06/06 | 3.6J | 0.3J | 1.5J | 2J | 12J |
| 06/07 | 2.4 | 0.31J | 0.42J | 0.85 | 2.8 |
| 05/08 | 7.7 | 0.55 | 1.1 | 1.7 | 5.5 |
| 06/09 | 6.4 | 0.39J | 1.5 | 1.9 | 5.7 |
| 06/10 | 4.4 | 0.29J | 0.36J | 1.6 | 1.8 |
| 07/11 | 1.4 | 0.10J | 0.5U | 0.09J | 0.5U |
| 06/12 | 13 | 1.0 | 11J | 1.9 | 53JD |
| 06/13 | 3.3J | 0.26J | 0.50U | 1.3 | 1.0 |
| 06/14 | 7.4 | 0.73 | 2.9 | 1.0 | 21 |
| 06/15 | 2.5 | 0.30J | 0.25J | 1.3 | 3.6 |
| 06/16 | 7.9 | 0.65 | 5.4 | 0.82 | 44J |
| 06/17 | 6.7 | 0.58 | 2.6 | 0.69 | 18 |
| 09/18 | NS | NS | NS | NS | NS |

MW8-14

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 11/95 | 1U | 1U | 1U | 1U | 1U |
| 05/96 | 1U | 1U | 1U | 1U | 1U |
| 09/96 | 1U | 1U | 1U | 1U | 1U |
| 05/97 | 1U | 1U | 1U | 1U | 1U |
| 10/97 | 1U | 1U | 1U | 1U | 1U |
| 05/98 | 1U | 1U | 1U | 1U | 1U |
| 10/98 | 1U | 1U | 1U | 1 | 1U |
| 05/99 | 1U | 1U | 1U | 1U | 1U |
| 11/99 | 0.5U | 0.5U | 0.5U | 3.2 | 0.5U |
| 06/00 | 0.5U | 0.5U | 0.5U | 0.5U | 0.5U |
| 06/01 | 0.12U | 0.11U | 0.12U | 0.12U | 0.93 |
| 06/02 | 0.12U | 0.11U | 0.12U | 0.12U | 0.18J |
| 06/03 | 0.12U | 0.11U | 0.12U | 0.12U | 0.12U |
| 06/04 | 0.12U | 0.11U | 0.12U | 0.12U | 0.12U |
| 06/05 | 0.2U | 0.2U | 0.2U | 0.2U | 0.2U |
| 06/06 | 0.5U | 0.5U | 0.5U | 0.5U | 0.5U |
| 06/07 | 0.23J | 0.5U | 0.5U | 0.5U | 0.5U |
| 05/08 | 0.5U | 0.5U | 0.5U | 0.5U | 0.11J |
| 06/09 | 0.5U | 0.5U | 0.2U | 0.5U | 0.10J |
| 06/10 | 0.5U | 0.5U | 0.5U | 0.5U | 0.18J |
| 07/11 | 0.5U | 0.5U | 0.5U | 0.5U | 0.5U |
| 06/12 | 0.5U | 0.5U | 0.5UJ | 0.5U | 0.5U |
| 06/13 | 0.50UJ | 0.50U | 0.50U | 0.50U | 0.50U |
| 06/14 | 0.50U | 0.50U | 0.50U | 0.50U | 0.50U |
| 06/15 | 0.50U | 0.50U | 0.50U | 0.50U | 0.50U |
| 06/16 | 0.50U | 0.50U | 0.50U | 0.50U | 0.50U |
| 06/17 | 0.50U | 0.50U | 0.50U | 0.50U | 0.50U |
| 09/18 | 0.031 | 0.014J | 0.02UJ | 0.027 | NS |

MW8-12

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 11/95 | 85J | 13 | 10 | 1 | 140J |
| 05/96 | 63J | 5 | 14 | 1U | 180J |
| 09/96 | 120J | 23 | 20 | 2 | 250J |
| 05/97 | 63J | 12 | 6 | 1 | 67J |
| 10/97 | 44J | 6 | 4 | 1 | 41J |
| 05/98 | 46J | 10 | 2 | 2 | 20 |
| 10/98 | 46J | 15 | 1U | 1U | 22 |
| 05/99 | 25U | 4 | 1U | 1U | 8 |
| 11/99 | 50 | 9.7 | 0.9 | 2.1 | 14 |
| 06/00 | 54 | 16 | 0.5J | 3 | 6.8 |
| 06/01 | 76 | 14 | 0.67 | 1.8 | 6.5 |
| 06/02 | 47 | 14 | 0.49J | 1.5 | 5 |
| 06/03 | 36 | 9.8 | 0.31J | 3.2 | 3.2 |
| 06/04 | 40 | 8.5 | 0.34J | 3.1 | 1.4 |
| 06/05 | 34 | 8.8 | 0.3 | 3.3 | 2.8 |
| 06/06 | 31 | 7.9 | 0.28J | 2.5 | 2.5 |
| 06/07 | 37 | 6.8 | 0.22J | 3.5 | 2.0 |
| 05/08 | 28 | 7.7 | 0.15J | 2.4 | 1.8 |
| 06/09 | 52 | 11 | 0.18J | 3.4 | 2.5 |
| 06/10 | 31 | 6.2 | 0.2J | 3.9 | 1.5 |
| 07/11 | 31 | 6.0 | 0.11J | 3.0 | 2.1 |
| 06/12 | 31 | 6.3 | 0.5UJ | 1.8 | 1.6 |
| 06/13 | 23 | 5.6 | 0.50U | 0.50 | 1.2 |
| 06/14 | 22 | 5.7 | 0.50U | 0.39J | 1.1 |
| 06/15 | 17 | 4.6 | 0.50U | 0.26J | 1.7 |
| 06/16 | 11 | 2.9 | 0.50U | 0.19J | 1.2 |
| 06/17 | 10 | 2.8 | 0.50U | 0.28J | 0.87 |
| 09/18 | 16EJ | 4.1 | 0.043J | 0.38 | NS |

Seep C

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 09/18 | 0.06J | 0.14J | 1.0UJ | 0.0078J | NS |

Legend

Units in µg/L

Results in red exceed the remediation goal.

Highlighted results excee water remediation goal.

| | |
|---|---|
| MW8-9 ◕ | Monitoring Well Sampled |
| MW8-15 ⊕ | Monitoring Well Not Samp |
| SEEP A ⌀ | Seep Sampling Location |
| 〰 | Low-tide Waterline |
| ▭ | Former Building Location |
| E | Possible matrix interferen |
| J | The result is an estimated |
| NS | Not Sampled |
| U | The compound was not d above the stated limit |
| UJ | The compound was not d above the stated limit, whi estimated value |

MW8-8

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 11/95 | 190J | 49J | 1 | 2 | 23 |
| 05/96 | 110J | 34 | 0.9J | 1 | 11 |
| 09/96 | 190J | 58J | 1 | 2 | 19 |
| 05/97 | 68J | 15 | 1U | 1 | 3 |
| 10/97 | 78J | 10 | 0.6U | 2 | 9 |
| 05/98 | 63J | 12 | 1U | 0.9J | 3 |
| 10/98 | 75J | 30 | 1U | 1U | 9 |
| 05/99 | 58J | 5U | 5U | 5U | 5U |
| 11/99 | 150 | 2 | 1 | 3.2 | 10 |
| 06/00 | 120 | 23 | 1J | 4.5 | 6.6 |
| 06/01 | 84J | 20 | 1.3 | 7.3 | 3.9 |
| 06/02 | 81J | 17 | 1.1 | 7.3 | 3.9 |
| 06/03 | 81J | 12 | 0.94 | 6.8 | 2.7 |
| 06/04 | 80 | 13 | 1.1 | 8.5 | 2.9 |
| 06/05 | 64 | 11 | 0.7 | 7.4 | 2 |
| 06/06 | 68D | 9.2 | 0.68 | 7.6 | 2.2 |
| 06/07 | 53D | 7.7 | 0.55 | 7.5 | 1.7 |
| 05/08 | 59 | 8.4 | 0.41J | 6.6 | 1.6 |
| 06/09 | 66 | 5.6 | 0.69 | 9.1 | 1.6 |
| 06/10 | 58 | 5.1 | 0.55 | 8.4 | 1.5 |
| 07/11 | 59 | 6.0 | 0.37J | 5.9 | 1.5 |
| 06/12 | 38 | 9.7 | 0.14J | 2.1 | 1.1 |
| 06/13 | 24J | 9.0 | 0.50U | 0.46J | 0.60 |
| 06/14 | 32 | 9.8 | 0.50U | 0.83 | 0.83 |
| 06/15 | 26 | 8.4 | 0.50U | 0.45J | 0.87 |
| 06/16 | 37 | 6.9 | 0.11J | 1.2 | 0.90 |
| 06/17 | 40 | 7.1 | 0.11J | 1.6 | 0.93 |
| 09/18 | 33EJ | 8 | 0.13 | 1.8 | NS |

MW8-9

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 11/95 | 1600J | 50U | 50U | 27J | 50U |
| 05/96 | 800J | 1U | 1U | 28 | 2 |
| 09/96 | 1000J | 0.4J | 1U | 28 | 2 |
| 05/97 | 1400J | 0.3J | 1U | 34J | 2 |
| 10/97 | 720J | 1U | 1U | 50U | 1 |
| 05/98 | 370J | 1U | 1U | 12 | 0.7J |
| 10/98 | 610J | 1U | 1U | 34J | 3 |
| 05/99 | 84J | 1U | 1U | 6 | 1U |
| 11/99 | 500 | 0.6 | 0.5U | 30 | 1.4 |
| 06/00 | 170 | 2.5U | 2.5U | 15 | 1J |
| 06/01 | 330J | 0.26J | 0.24U | 18J | 0.44J |
| 06/02 | 60J | 0.23J | 0.12U | 7.5 | 0.69 |
| 06/03 | 21 | 0.11U | 0.12U | 1.3 | 0.23J |
| 06/04 | 25 | 0.18J | 0.12U | 1.7 | 0.44J |
| 06/05 | 4.1 | 0.2U | 0.2U | 0.2 | 0.2U |
| 06/06 | 3.9 | 0.2J | 0.5U | 0.42J | 0.28J |
| 06/07 | 1.9 | 0.5U | 0.5U | 0.27J | 0.15J |
| 05/08 | 1.7 | 0.16J | 0.5U | 0.23J | 0.14J |
| 06/09 | 20 | 0.18J | 0.2U | 1.3 | 0.14J |
| 06/10 | 9.4 | 0.11 | 0.5U | 0.69 | 0.12J |
| 07/11 | 12 | 0.12J | 0.5U | 0.80 | 0.11J |
| 06/12 | 14 | 0.49J | 0.5U | 1.2 | 0.16J |
| 06/13 | 43J | 0.18J | 0.50U | 2.7 | 0.13J |
| 06/14 | 24 | 0.29J | 0.50U | 1.5 | 0.12J |
| 06/15 | 5.6 | 0.16J | 0.50U | 0.35J | 0.13J |
| 06/16 | 0.27J | 0.10J | 0.50U | 0.070J | 0.15J |
| 06/17 | 0.12J | 0.13J | 0.50U | 0.50U | 0.50U |
| 09/18 | 0.059 | 0.13 | 0.02UJ | 0.02U | NS |

Seep B

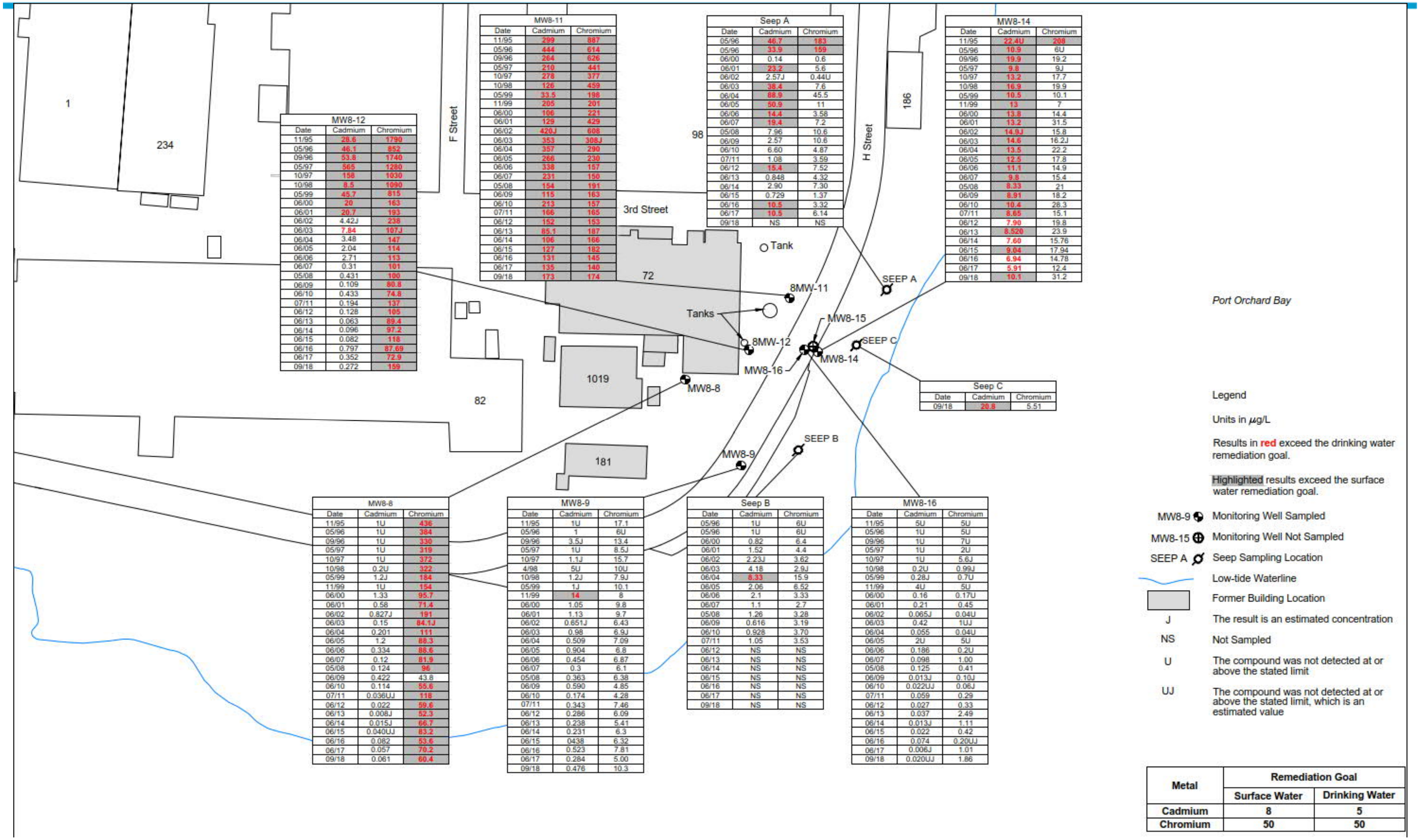
| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 05/96 | 14 | 1U | 1U | 0.7J | 1 |
| 06/00 | 2.2 | 0.5U | 0.5U | 0.5U | 0.3J |
| 06/01 | 3.1 | 0.13J | 0.12U | 0.44J | 0.26J |
| 06/02 | 5.4 | 0.12J | 0.12U | 0.52 | 0.15J |
| 06/03 | 1.9 | 0.14J | 0.12U | 0.2J | 0.12U |
| 06/04 | 0.64 | 0.39J | 0.12U | 0.23J | 0.87 |
| 06/05 | 0.3 | 0.4 | 0.2U | 0.2U | 0.3 |
| 06/06 | 0.48J | 0.22J | 0.5U | 0.18J | 0.12J |
| 06/07 | 0.14J | 0.5U | 0.5U | 0.5U | 0.5U |
| 05/08 | 0.41J | 0.17J | 0.5U | 0.12J | 0.10J |
| 06/09 | 0.40J | 0.18J | 0.2U | 0.5U | 0.16J |
| 06/10 | 5.7 | 0.18J | 0.5U | 0.51 | 0.09J |
| 07/11 | 1.3 | 0.12J | 0.5U | 0.095 | 0.5U |
| 06/12 | NS | NS | NS | NS | NS |
| 06/13 | NS | NS | NS | NS | NS |
| 06/14 | NS | NS | NS | NS | NS |
| 06/15 | NS | NS | NS | NS | NS |
| 06/16 | NS | NS | NS | NS | NS |
| 06/17 | NS | NS | NS | NS | NS |
| 09/18 | NS | NS | NS | NS | NS |

MW8-16

| Date | TCE | PCE | 1,1,-DCE | cis-1,2-DCE | 1,1,1-TCA |
|---|---|---|---|---|---|
| 11/95 | 58J | 0.6J | 1U | 2 | 2 |
| 05/96 | 72J | 0.8J | 1U | 2 | 2 |
| 09/96 | 69J | 0.8J | 1U | 3 | 2 |
| 05/97 | 57J | 0.8J | 1U | 2 | 2 |
| 10/97 | 47J | 0.6J | 1U | 2 | 2 |
| 05/98 | 63J | 0.8J | 1U | 2 | 1 |
| 10/98 | 47J | 1U | 1U | 3 | 1U |
| 05/99 | 40 | 1U | 1U | 6 | 2 |
| 11/99 | 63 | 0.8 | 0.5U | 5.3 | 1.7 |
| 06/00 | 51 | 0.7 | 0.59 | 16 | 1.1 |
| 06/01 | 74J | 0.84 | 0.77 | 21 | 1.2 |
| 06/02 | 130J | 0.99 | 0.67 | 30 | 0.83 |
| 06/03 | 190J | 1.5 | 0.57 | 28 | 0.94 |
| 06/04 | 120 | 0.75 | 0.61 | 130 | 0.49J |
| 06/05 | 350 | 2.2 | 0.9 | 34 | 0.7 |
| 06/06 | 200D | 1.1 | 0.64 | 93D | 0.33J |
| 06/07 | 430D | 1.5 | 0.68 | 38 | 0.42J |
| 05/08 | 380D | 1 | 0.65 | 67D | 0.18J |
| 06/09 | 140D | 0.64 | 0.21 | 14 | 0.13J |
| 06/10 | 79D | 0.64 | 0.13J | 9.2 | 0.16J |
| 07/11 | 88D | 0.76 | 0.10J | 3.6 | 0.22J |
| 06/12 | 56D | 0.80 | 0.08 | 2.7 | 0.18J |
| 06/13 | 50 | 0.79 | 0.50U | 0.93 | 0.21J |
| 06/14 | 50 | 0.97 | 0.50U | 1.0 | 0.19J |
| 06/15 | 48 | 0.51 | 0.090J | 1.8 | 0.19J |
| 06/16 | 8.1 | 0.50U | 0.11J | 28 | 0.50U |
| 06/17 | 7.2 | 0.15J | 0.090J | 26 | 0.50U |
| 09/18 | 4.4 | 0.064 | 0.088 | 23EJ | NS |

| **VOC** | **Remediatio** | |
|---|---|---|
| | **Surface Water** | **D** |
| **TCE** | **81** | |
| **PCE** | **8.9** | |
| **1,1-DCE** | **3.2** | |
| **cis-1,2-DCE** | **-** | |
| **1,1,1-TCA** | **42,000** | |

# 2018 LTM Results
# Metals in GW and Seep Water



| MW8-12 | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 11/95 | 28.6 | 1790 |
| 05/96 | 46.1 | 852 |
| 09/96 | 53.8 | 1740 |
| 05/97 | 565 | 1280 |
| 10/97 | 158 | 1030 |
| 10/98 | 8.5 | 1090 |
| 05/99 | 45.7 | 815 |
| 06/00 | 20 | 163 |
| 06/01 | 20.7 | 193 |
| 06/02 | 4.42J | 238 |
| 06/03 | 7.84 | 107J |
| 06/04 | 3.48 | 147 |
| 06/05 | 2.04 | 114 |
| 06/06 | 2.71 | 113 |
| 06/07 | 0.31 | 101 |
| 05/08 | 0.431 | 100 |
| 06/09 | 0.109 | 80.8 |
| 06/10 | 0.433 | 74.8 |
| 07/11 | 0.194 | 137 |
| 06/12 | 0.128 | 105 |
| 06/13 | 0.063 | 89.4 |
| 06/14 | 0.096 | 97.2 |
| 06/15 | 0.082 | 118 |
| 06/16 | 0.797 | 87.69 |
| 06/17 | 0.352 | 72.9 |
| 09/18 | 0.272 | 159 |

| MW8-11 | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 11/95 | 299 | 887 |
| 05/96 | 444 | 614 |
| 09/96 | 264 | 626 |
| 05/97 | 210 | 441 |
| 10/97 | 278 | 377 |
| 10/98 | 126 | 459 |
| 05/99 | 33.5 | 198 |
| 11/99 | 205 | 201 |
| 06/00 | 106 | 221 |
| 06/01 | 129 | 429 |
| 06/02 | 420J | 608 |
| 06/03 | 353 | 308J |
| 06/04 | 357 | 290 |
| 06/05 | 266 | 230 |
| 06/06 | 338 | 157 |
| 06/07 | 231 | 150 |
| 05/08 | 154 | 191 |
| 06/09 | 115 | 163 |
| 06/10 | 213 | 157 |
| 07/11 | 166 | 165 |
| 06/12 | 152 | 153 |
| 06/13 | 85.1 | 187 |
| 06/14 | 106 | 166 |
| 06/15 | 127 | 182 |
| 06/16 | 131 | 145 |
| 06/17 | 135 | 140 |
| 09/18 | 173 | 174 |

| Seep A | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 05/96 | 46.7 | 183 |
| 05/96 | 33.9 | 159 |
| 06/00 | 0.14 | 0.6 |
| 06/01 | 23.2 | 5.6 |
| 06/02 | 2.57J | 0.44U |
| 06/03 | 38.4 | 7.6 |
| 06/04 | 88.9 | 45.5 |
| 06/05 | 50.9 | 11 |
| 06/06 | 14.4 | 3.58 |
| 06/07 | 19.4 | 7.2 |
| 05/08 | 7.96 | 10.6 |
| 06/09 | 2.57 | 10.6 |
| 06/10 | 6.60 | 4.87 |
| 07/11 | 1.08 | 3.59 |
| 06/12 | 15.4 | 7.52 |
| 06/13 | 0.848 | 4.32 |
| 06/14 | 2.90 | 7.30 |
| 06/15 | 0.729 | 1.37 |
| 06/16 | 10.5 | 3.32 |
| 06/17 | 10.5 | 6.14 |
| 09/18 | NS | NS |

| MW8-14 | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 11/95 | 22.4U | 208 |
| 05/96 | 10.9 | 6U |
| 09/96 | 19.9 | 19.2 |
| 05/97 | 9.8 | 9J |
| 10/97 | 13.2 | 17.7 |
| 10/98 | 16.9 | 19.9 |
| 05/99 | 10.5 | 10.1 |
| 11/99 | 13 | 7 |
| 06/00 | 13.8 | 14.4 |
| 06/01 | 13.2 | 31.5 |
| 06/02 | 14.9J | 15.8 |
| 06/03 | 14.6 | 16.2J |
| 06/04 | 13.5 | 22.2 |
| 06/05 | 12.5 | 17.8 |
| 06/06 | 11.1 | 14.9 |
| 06/07 | 9.8 | 15.4 |
| 05/08 | 8.33 | 21 |
| 06/09 | 8.91 | 18.2 |
| 06/10 | 10.4 | 28.3 |
| 07/11 | 8.65 | 15.1 |
| 06/12 | 7.90 | 19.8 |
| 06/13 | 8.520 | 23.9 |
| 06/14 | 7.60 | 15.76 |
| 06/15 | 9.04 | 17.94 |
| 06/16 | 6.94 | 14.78 |
| 06/17 | 5.91 | 12.4 |
| 09/18 | 10.1 | 31.2 |

| Seep C | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 09/18 | 20.8 | 5.51 |

| MW8-8 | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 11/95 | 1U | 436 |
| 05/96 | 1U | 384 |
| 09/96 | 1U | 330 |
| 05/97 | 1U | 319 |
| 10/97 | 1U | 372 |
| 10/98 | 0.2U | 322 |
| 05/99 | 1.2J | 184 |
| 11/99 | 1U | 154 |
| 06/00 | 1.33 | 95.7 |
| 06/01 | 0.58 | 71.4 |
| 06/02 | 0.827J | 191 |
| 06/03 | 0.15 | 84.1J |
| 06/04 | 0.201 | 111 |
| 06/05 | 1.2 | 88.3 |
| 06/06 | 0.334 | 88.6 |
| 06/07 | 0.12 | 81.9 |
| 05/08 | 0.124 | 96 |
| 06/09 | 0.422 | 43.8 |
| 06/10 | 0.114 | 55.6 |
| 07/11 | 0.036UJ | 118 |
| 06/12 | 0.022 | 59.6 |
| 06/13 | 0.008J | 52.3 |
| 06/14 | 0.015J | 66.7 |
| 06/15 | 0.040UJ | 83.2 |
| 06/16 | 0.082 | 53.6 |
| 06/17 | 0.057 | 70.2 |
| 09/18 | 0.061 | 60.4 |

| MW8-9 | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 11/95 | 1U | 17.1 |
| 05/96 | 1 | 6U |
| 09/96 | 3.5J | 13.4 |
| 05/97 | 1U | 8.5J |
| 10/97 | 1.1J | 15.7 |
| 4/98 | 5U | 10U |
| 10/98 | 1.2J | 7.9J |
| 05/99 | 1J | 10.1 |
| 11/99 | 14 | 8 |
| 06/00 | 1.05 | 9.8 |
| 06/01 | 1.13 | 9.7 |
| 06/02 | 0.651J | 6.43 |
| 06/03 | 0.98 | 6.9J |
| 06/04 | 0.509 | 7.09 |
| 06/05 | 0.904 | 6.8 |
| 06/06 | 0.454 | 6.87 |
| 06/07 | 0.3 | 6.1 |
| 05/08 | 0.363 | 6.38 |
| 06/09 | 0.590 | 4.85 |
| 06/10 | 0.174 | 4.28 |
| 07/11 | 0.343 | 7.46 |
| 06/12 | 0.286 | 6.09 |
| 06/13 | 0.238 | 5.41 |
| 06/14 | 0.231 | 6.3 |
| 06/15 | 0438 | 6.32 |
| 06/16 | 0.523 | 7.81 |
| 06/17 | 0.284 | 5.00 |
| 09/18 | 0.476 | 10.3 |

| Seep B | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 05/96 | 1U | 6U |
| 05/96 | 1U | 6U |
| 06/00 | 0.82 | 6.4 |
| 06/01 | 1.52 | 4.4 |
| 06/02 | 2.23J | 3.62 |
| 06/03 | 4.18 | 2.9J |
| 06/04 | 8.33 | 15.9 |
| 06/05 | 2.06 | 6.52 |
| 06/06 | 2.1 | 3.33 |
| 06/07 | 1.1 | 2.7 |
| 05/08 | 1.26 | 3.28 |
| 06/09 | 0.616 | 3.19 |
| 06/10 | 0.928 | 3.70 |
| 07/11 | 1.05 | 3.53 |
| 06/12 | NS | NS |
| 06/13 | NS | NS |
| 06/14 | NS | NS |
| 06/15 | NS | NS |
| 06/16 | NS | NS |
| 06/17 | NS | NS |
| 09/18 | NS | NS |

| MW8-16 | | |
|---|---|---|
| Date | Cadmium | Chromium |
| 11/95 | 5U | 5U |
| 05/96 | 1U | 5U |
| 09/96 | 1U | 7U |
| 05/97 | 1U | 2U |
| 10/97 | 1U | 5.6J |
| 10/98 | 0.2U | 0.99J |
| 05/99 | 0.28J | 0.7U |
| 11/99 | 4U | 5U |
| 06/00 | 0.16 | 0.17U |
| 06/01 | 0.21 | 0.45 |
| 06/02 | 0.065J | 0.04U |
| 06/03 | 0.42 | 1UJ |
| 06/04 | 0.055 | 0.04U |
| 06/05 | 2U | 5U |
| 06/06 | 0.186 | 0.2U |
| 06/07 | 0.098 | 1.00 |
| 05/08 | 0.125 | 0.41 |
| 06/09 | 0.013J | 0.10J |
| 06/10 | 0.022UJ | 0.06J |
| 07/11 | 0.059 | 0.29 |
| 06/12 | 0.027 | 0.33 |
| 06/13 | 0.037 | 2.49 |
| 06/14 | 0.013J | 1.11 |
| 06/15 | 0.022 | 0.42 |
| 06/16 | 0.074 | 0.20UJ |
| 06/17 | 0.006J | 1.01 |
| 09/18 | 0.020UJ | 1.86 |

Legend

Units in µg/L

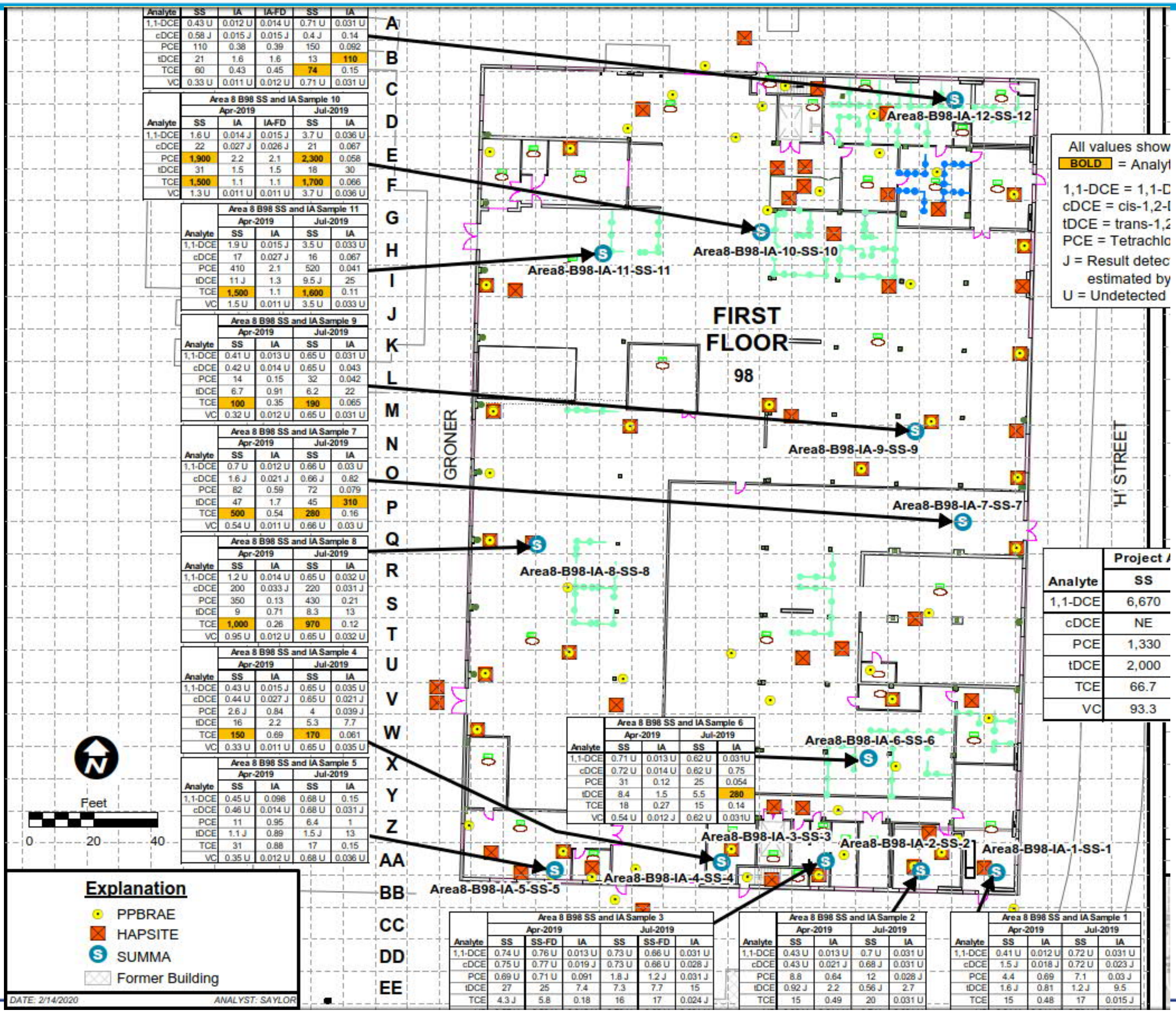
Results in red exceed the drinking water remediation goal.

Highlighted results exceed the surface water remediation goal.

| | |
|---|---|
| MW8-9 ◒ | Monitoring Well Sampled |
| MW8-15 ⊕ | Monitoring Well Not Sampled |
| SEEP A ⌀ | Seep Sampling Location |
| ～ | Low-tide Waterline |
| ▨ | Former Building Location |
| J | The result is an estimated concentration |
| NS | Not Sampled |
| U | The compound was not detected at or above the stated limit |
| UJ | The compound was not detected at or above the stated limit, which is an estimated value |

| Metal | Remediation Goal | |
|---|---|---|
| | Surface Water | Drinking Water |
| Cadmium | 8 | 5 |
| Chromium | 50 | 50 |

# 2019 Indoor Air/SS Vapor Results – BLDG 98



**Explanation**

- ● PPBRAE
- ☒ HAPSITE
- Ⓢ SUMMA
- ▨ Former Building

All values show

BOLD = Analyt

1,1-DCE = 1,1-D
cDCE = cis-1,2-
tDCE = trans-1,2
PCE = Tetrachlo
J = Result detec
estimated by
U = Undetected

| Analyte | SS | IA | IA-FD | SS | IA |
|---|---|---|---|---|---|
| 1,1-DCE | 0.43 U | 0.012 U | 0.014 U | 0.71 U | 0.031 U |
| cDCE | 0.58 J | 0.015 J | 0.015 J | 0.4 J | 0.14 |
| PCE | 110 | 0.38 | 0.39 | 150 | 0.092 |
| tDCE | 21 | 1.6 | 1.6 | 13 | **110** |
| TCE | 60 | 0.43 | 0.45 | **74** | 0.15 |
| VC | 0.33 U | 0.011 U | 0.012 U | 0.71 U | 0.031 U |

| | Area 8 B98 SS and IA Sample 10 | | | | |
|---|---|---|---|---|---|
| | Apr-2019 | | | Jul-2019 | |
| Analyte | SS | IA | IA-FD | SS | IA |
| 1,1-DCE | 1.6 U | 0.014 J | 0.015 J | 3.7 U | 0.036 U |
| cDCE | 22 | 0.027 J | 0.026 J | 21 | 0.067 |
| PCE | **1,900** | 2.2 | 2.1 | **2,300** | 0.058 |
| tDCE | 31 | 1.5 | 1.5 | 18 | 30 |
| TCE | **1,500** | 1.1 | 1.1 | **1,700** | 0.066 |
| VC | 1.3 U | 0.011 U | 0.011 U | 3.7 U | 0.036 U |

| | Area 8 B98 SS and IA Sample 11 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 1.9 U | 0.015 J | 3.5 U | 0.033 U |
| cDCE | 17 | 0.027 J | 16 | 0.067 |
| PCE | 410 | 2.1 | 520 | 0.041 |
| tDCE | 11 J | 1.3 | 9.5 J | 25 |
| TCE | **1,500** | 1.1 | **1,600** | 0.11 |
| VC | 1.5 U | 0.011 U | 3.5 U | 0.033 U |

| | Area 8 B98 SS and IA Sample 9 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.41 U | 0.013 U | 0.65 U | 0.031 U |
| cDCE | 0.42 U | 0.014 U | 0.65 U | 0.043 |
| PCE | 14 | 0.15 | 32 | 0.042 |
| tDCE | 6.7 | 0.91 | 6.2 | 22 |
| TCE | **100** | 0.35 | **190** | 0.065 |
| VC | 0.32 U | 0.012 U | 0.65 U | 0.031 U |

| | Area 8 B98 SS and IA Sample 7 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.7 U | 0.012 U | 0.66 U | 0.03 U |
| cDCE | 1.6 J | 0.021 J | 0.66 J | 0.82 |
| PCE | 82 | 0.59 | 72 | 0.079 |
| tDCE | 47 | 1.7 | 45 | **310** |
| TCE | **500** | 0.54 | **280** | 0.16 |
| VC | 0.54 U | 0.011 U | 0.66 U | 0.03 U |

| | Area 8 B98 SS and IA Sample 8 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 1.2 U | 0.014 U | 0.65 U | 0.032 U |
| cDCE | 200 | 0.033 J | 220 | 0.031 J |
| PCE | 350 | 0.13 | 430 | 0.21 |
| tDCE | 9 | 0.71 | 8.3 | 13 |
| TCE | **1,000** | 0.26 | **970** | 0.12 |
| VC | 0.95 U | 0.012 U | 0.65 U | 0.032 U |

| | Area 8 B98 SS and IA Sample 4 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.43 U | 0.015 J | 0.65 U | 0.035 U |
| cDCE | 0.44 U | 0.027 J | 0.65 U | 0.021 J |
| PCE | 2.6 J | 0.84 | 4 | 0.039 J |
| tDCE | 16 | 2.2 | 5.3 | 7.7 |
| TCE | **150** | 0.69 | **170** | 0.061 |
| VC | 0.33 U | 0.011 U | 0.65 U | 0.035 U |

| | Area 8 B98 SS and IA Sample 5 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.45 U | 0.098 | 0.68 U | 0.15 |
| cDCE | 0.46 U | 0.014 U | 0.68 U | 0.031 J |
| PCE | 11 | 0.95 | 6.4 | 1 |
| tDCE | 1.1 J | 0.89 | 1.5 J | 13 |
| TCE | 31 | 0.88 | 17 | 0.15 |
| VC | 0.35 U | 0.012 U | 0.68 U | 0.036 U |

| | Area 8 B98 SS and IA Sample 6 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.71 U | 0.013 U | 0.62 U | 0.031U |
| cDCE | 0.72 U | 0.014 U | 0.62 U | 0.75 |
| PCE | 31 | 0.12 | 25 | 0.054 |
| tDCE | 8.4 | 1.5 | 5.5 | **280** |
| TCE | 18 | 0.27 | 15 | 0.14 |
| VC | 0.54 U | 0.012 J | 0.62 U | 0.031U |

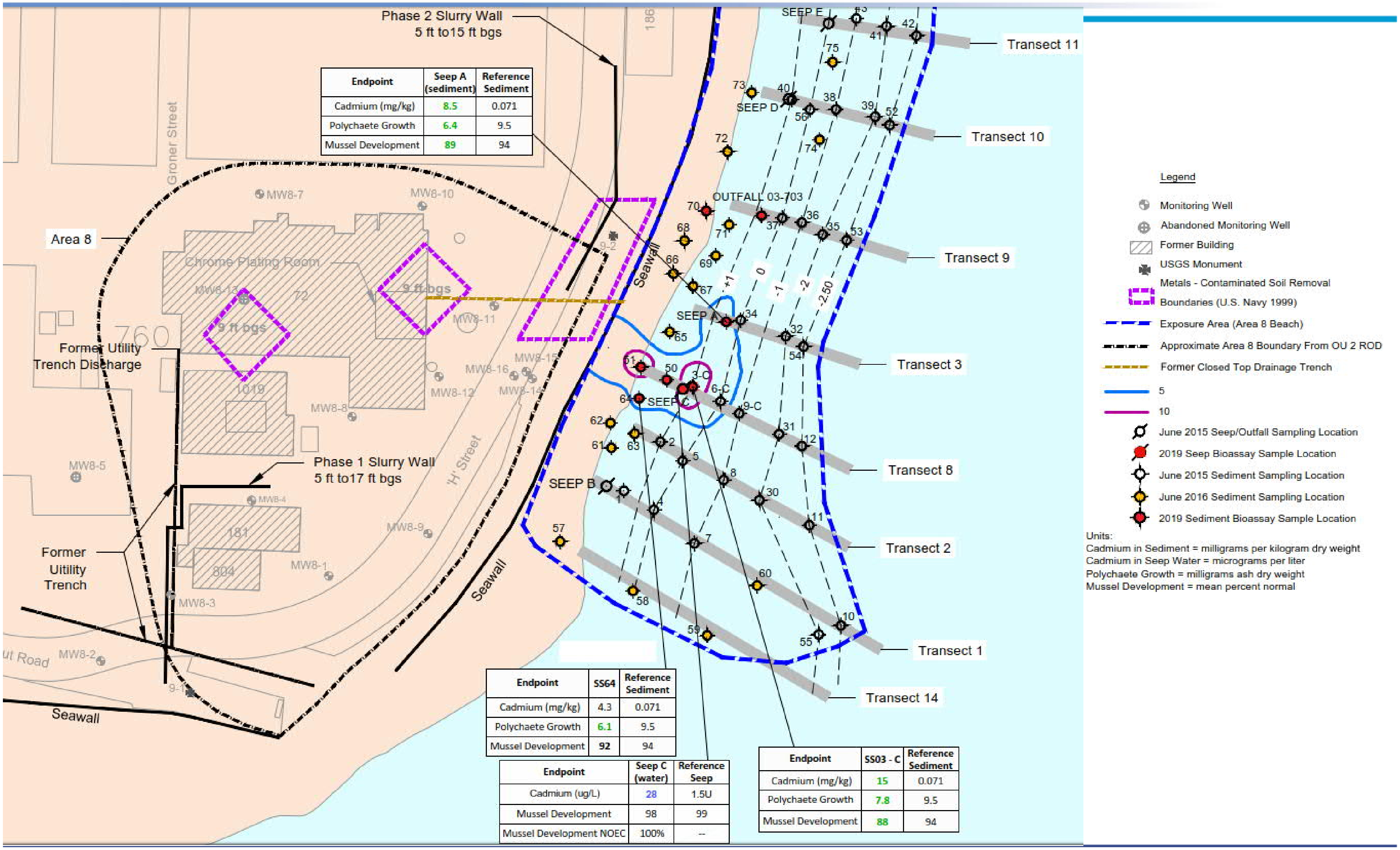
| | Area 8 B98 SS and IA Sample 3 | | | | | |
|---|---|---|---|---|---|---|
| | Apr-2019 | | | Jul-2019 | | |
| Analyte | SS | SS-FD | IA | SS | SS-FD | IA |
| 1,1-DCE | 0.74 U | 0.76 U | 0.013 U | 0.73 U | 0.66 U | 0.031 U |
| cDCE | 0.75 U | 0.77 U | 0.019 J | 0.73 U | 0.66 U | 0.028 J |
| PCE | 0.69 U | 0.71 U | 0.091 | 1.8 J | 1.2 J | 0.031 J |
| tDCE | 27 | 25 | 7.4 | 7.3 | 7.7 | 15 |
| TCE | 4.3 J | 5.8 | 0.18 | 16 | 17 | 0.024 J |

| | Area 8 B98 SS and IA Sample 2 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.43 U | 0.013 U | 0.7 U | 0.031 U |
| cDCE | 0.43 U | 0.021 J | 0.68 J | 0.031 U |
| PCE | 8.8 | 0.64 | 12 | 0.028 J |
| tDCE | 0.92 J | 2.2 | 0.56 J | 2.7 |
| TCE | 15 | 0.49 | 20 | 0.031 U |

| | Area 8 B98 SS and IA Sample 1 | | | |
|---|---|---|---|---|
| | Apr-2019 | | Jul-2019 | |
| Analyte | SS | IA | SS | IA |
| 1,1-DCE | 0.41 U | 0.012 U | 0.72 U | 0.031 U |
| cDCE | 1.5 J | 0.018 J | 0.72 U | 0.023 J |
| PCE | 4.4 | 0.69 | 7.1 | 0.03 J |
| tDCE | 1.6 J | 0.81 | 1.2 J | 9.5 |
| TCE | 15 | 0.48 | 17 | 0.015 J |

| | Project |
|---|---|
| Analyte | SS |
| 1,1-DCE | 6,670 |
| cDCE | NE |
| PCE | 1,330 |
| tDCE | 2,000 |
| TCE | 66.7 |
| VC | 93.3 |

# 2019 Seep and Sediment Sample Results



| Endpoint | Seep A (sediment) | Reference Sediment |
|---|---|---|
| Cadmium (mg/kg) | 8.5 | 0.071 |
| Polychaete Growth | 6.4 | 9.5 |
| Mussel Development | 89 | 94 |

| Endpoint | SS64 | Reference Sediment |
|---|---|---|
| Cadmium (mg/kg) | 4.3 | 0.071 |
| Polychaete Growth | 6.1 | 9.5 |
| Mussel Development | **92** | 94 |

| Endpoint | Seep C (water) | Reference Seep |
|---|---|---|
| Cadmium (ug/L) | 28 | 1.5U |
| Mussel Development | 98 | 99 |
| Mussel Development NOEC | 100% | -- |

| Endpoint | SS03 - C | Reference Sediment |
|---|---|---|
| Cadmium (mg/kg) | 15 | 0.071 |
| Polychaete Growth | 7.8 | 9.5 |
| Mussel Development | 88 | 94 |

Units:
Cadmium in Sediment = milligrams per kilogram dry weight
Cadmium in Seep Water = micrograms per liter
Polychaete Growth = milligrams ash dry weight
Mussel Development = mean percent normal

# Data Gaps

## Metals

- One soil sample collected during 1998/99 Building 72 remedial excavation had a Cd concentration of 4,380 mg/kg at 9 ft bgs. Just south of MW8-11 and is upgradient of Seep A. Possible that elevated Cd remain in saturated and unsaturated soil at this location, resulting in concentrations observed at Seep A.

## CVOCs

- The fourth five-year review concluded that a vapor intrusion study was warranted
  - Prior investigations did not explore the possibility of vapor sources directly beneath the buildings

## PFAS

- PFAS have been found to be used in some metal plating applications, most notably in chrome plating

# Proposed Scope

- **Field investigation will be accomplished in three mobilizations**

## Mobilization 1

- **Map salt-water wedge geometry and depth below the terrestrial portion of the site**
  - Conduct a geophysical survey, over a 24-hour tide cycle, in June during the highest and lowest tides of the year using electromagnetic, ground penetrating radar, and electrical resistivity methods
  - Deploy data logger in existing site monitoring wells to record groundwater geochemical parameters during the geophysical survey/24-hour tide cycle.

## Mobilization 2

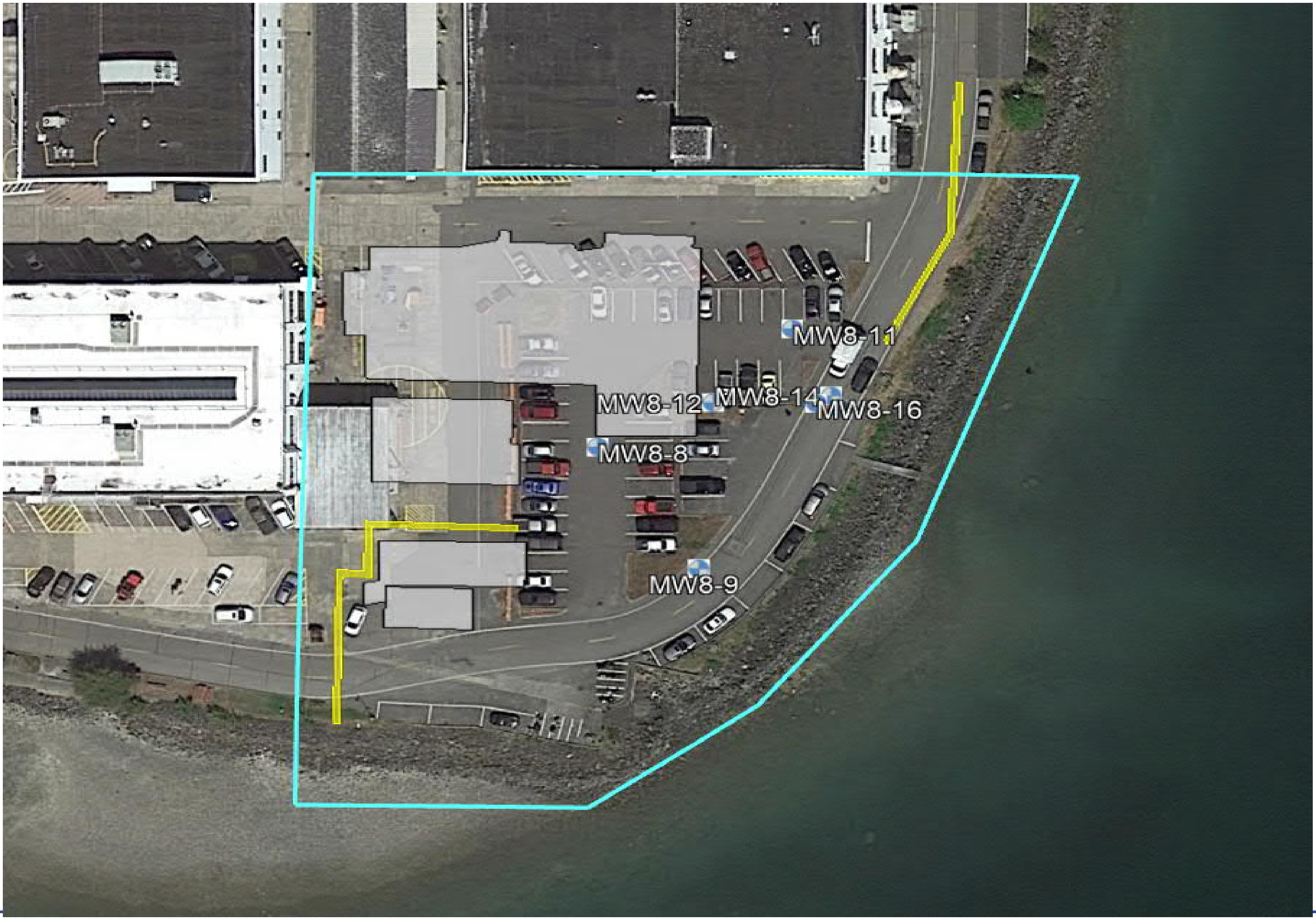
- **Further delineate the lateral and vertical extent of VOCs, metals, 1,4-dioxane, and PFAS in soil**
  - Advance up to 20 direct-push borings to a depth of up to 50 feet bgs
    - Collect up to three grab soil samples and one grab groundwater sample per boring

# Proposed Scope

## Mobilization 3

- **Based on the results of Mobe 2, assess soil physical properties including TOC, permeability, porosity, density, and grain size to refine site geology/hydrogeology**
  - Install three borings to 150 feet bgs using sonic drilling methods
    - No well completion, and up to three grab soil samples and one grab groundwater sample per boring
  - Install up to 10 borings to 50 feet bgs
    - completed as 2-inch ID PVC wells, up to three grab soil samples will be collected during drilling
  - Install up to three borings to 150 feet bgs
    - completed as 2-inch ID PVC wells, up to three grab soil samples will be collected during drilling

# Proposed Scope – Field Mobe #1 Geophysical Survey Area



# Proposed Scope – Field Mobe #2
# Direct Push Boring Investigation

# Schedule

- **Draft QAPP delivered in mid-February 2021**
- **Stakeholder review mid-February to mid-March 2021**
- **Prepare response to comments mid-March to early April 2021**
- **Comment Resolution Meeting mid-April 2021**
- **QAPP finalized mid-April to mid-May 2021**
- **Field Mobilization #1 late May through June 2021**
- **Field Mobilization #2 late June through mid-September 2021 (includes lab analysis and data validation)**
- **Field Mobilization #3 September 2021 through October 2021**

# Appendix B: Figures

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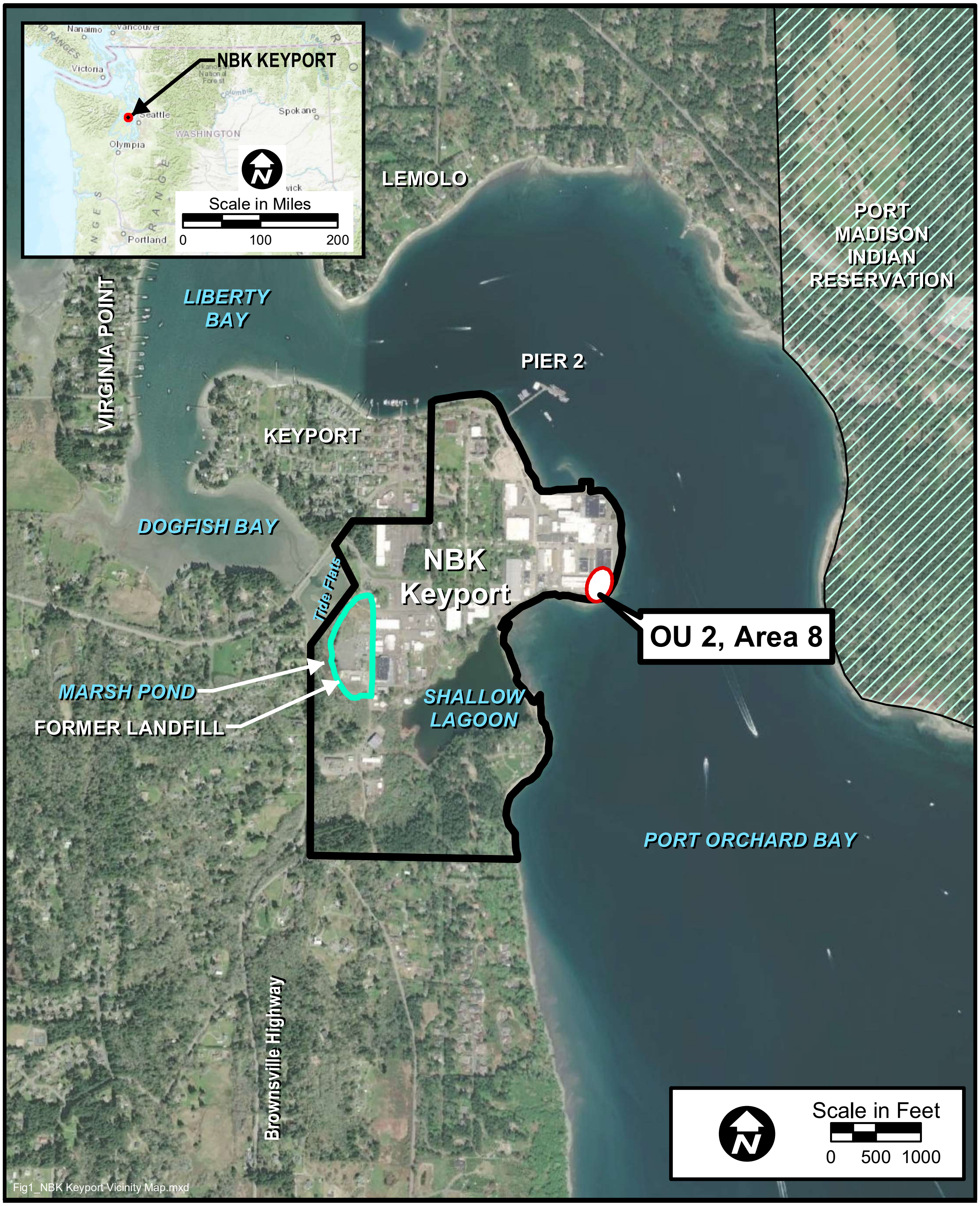

| U.S. NAVY | Figure 1<br>NBK Keyport Vicinity Map | CTO N4425520F4176<br>NBK Keyport, Area 8 QAPP<br>Supplemental Remedial Investigation |
|---|---|---|

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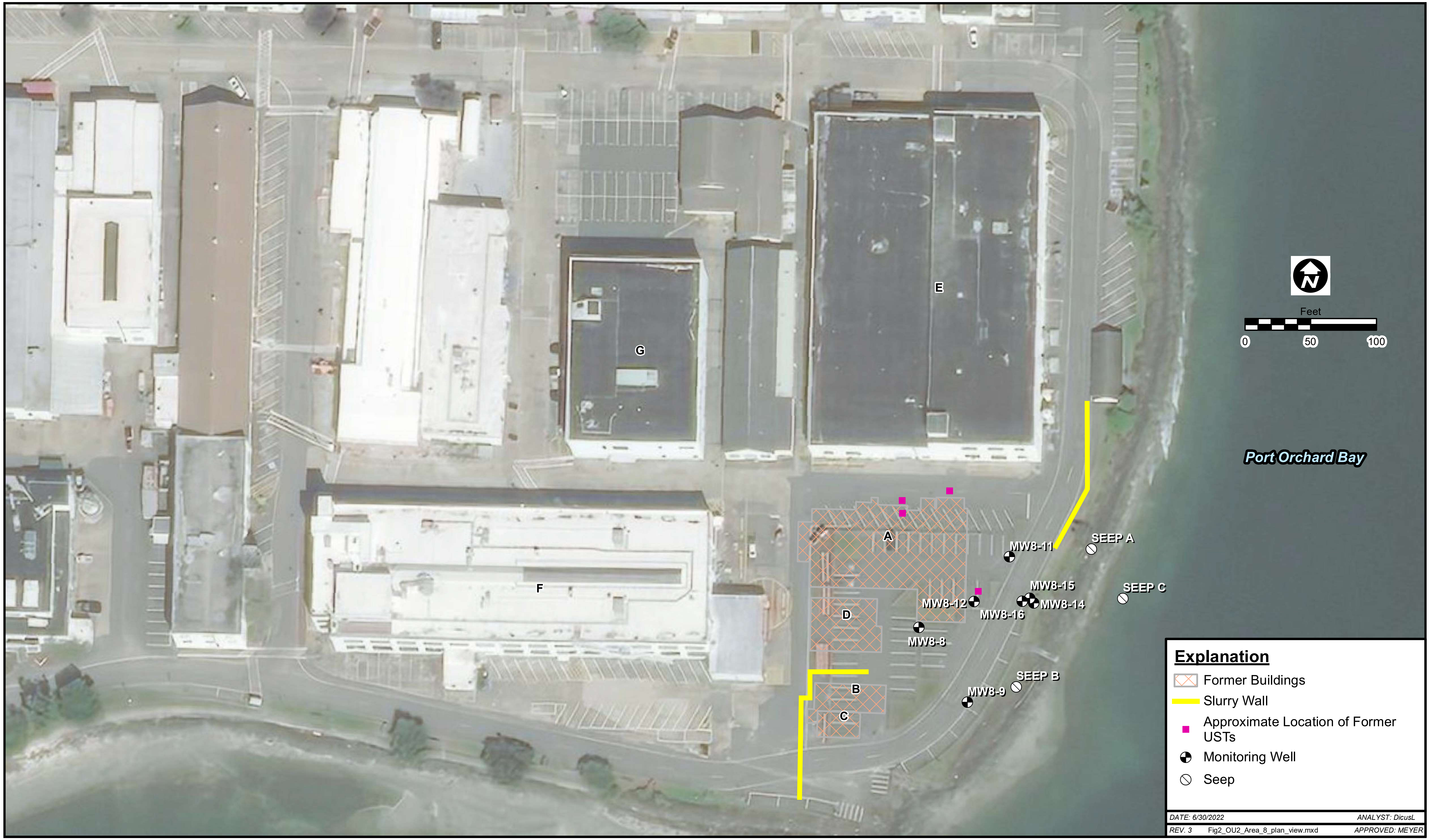

**U.S. NAVY**

**Figure 2**
**Area 8 Plan View**

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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**U.S. NAVY**

## Figure 3
## Historic Boring Locations

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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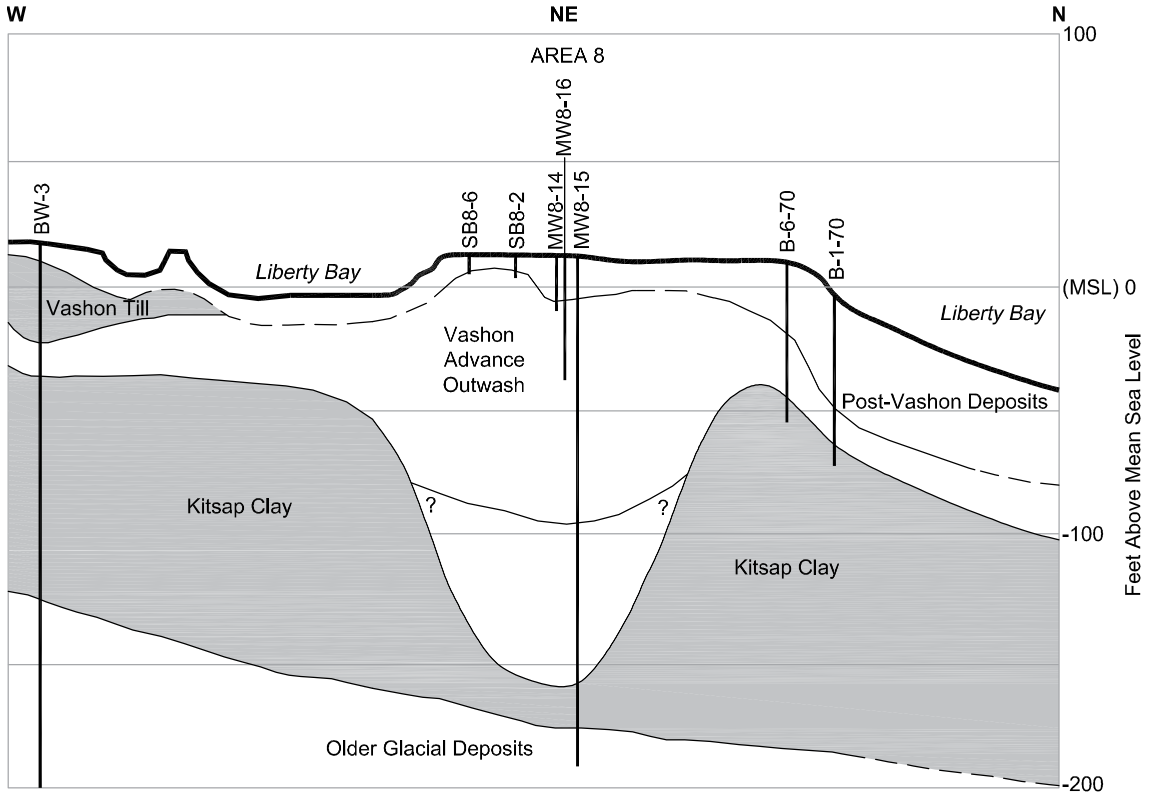
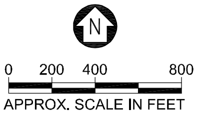


## Explanation

▨ Fine-Grained Units

7X Vertical Exaggeration



Source: U.S. Navy 1993

**U.S. NAVY**

**Figure 4**
**1993 Area 8 RI Cross Section**

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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**U.S. NAVY**

## Figure 5
## Updated Area 8 Cross Section Locations

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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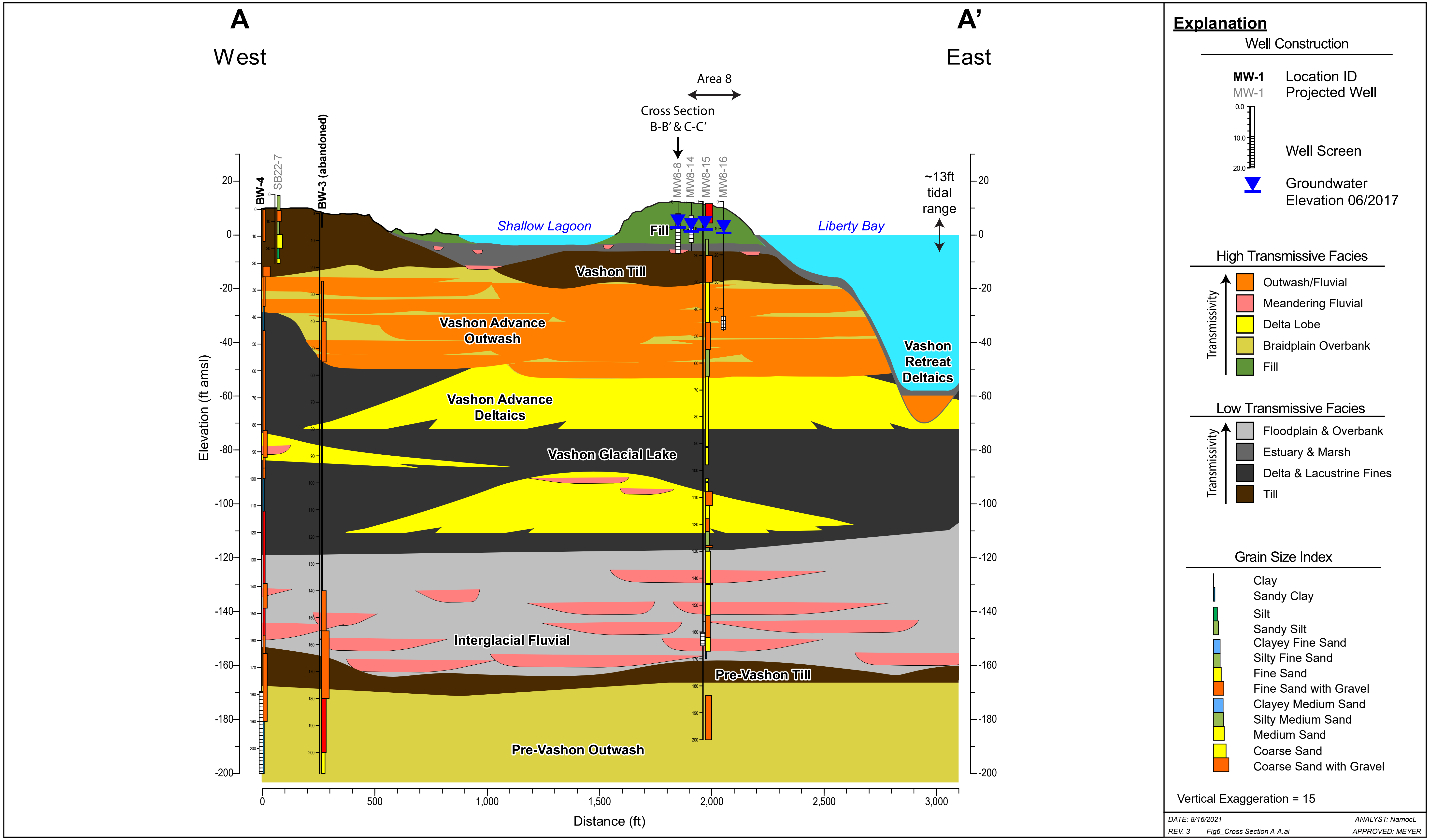

**U.S. NAVY**

**Figure 6**
**Cross Section A-A'**

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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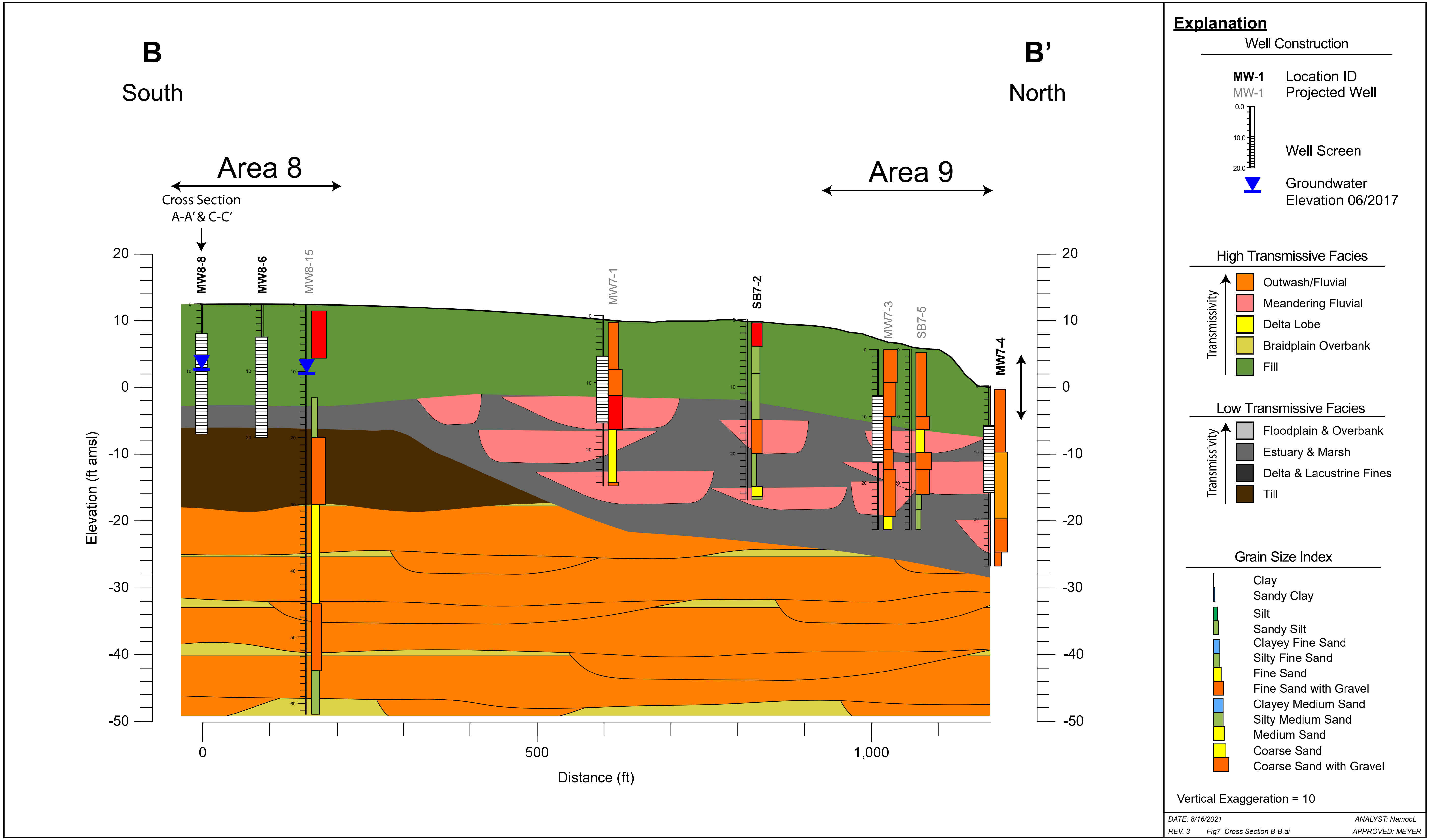

**U.S. NAVY**

**Figure 7**
**Cross Section B-B'**

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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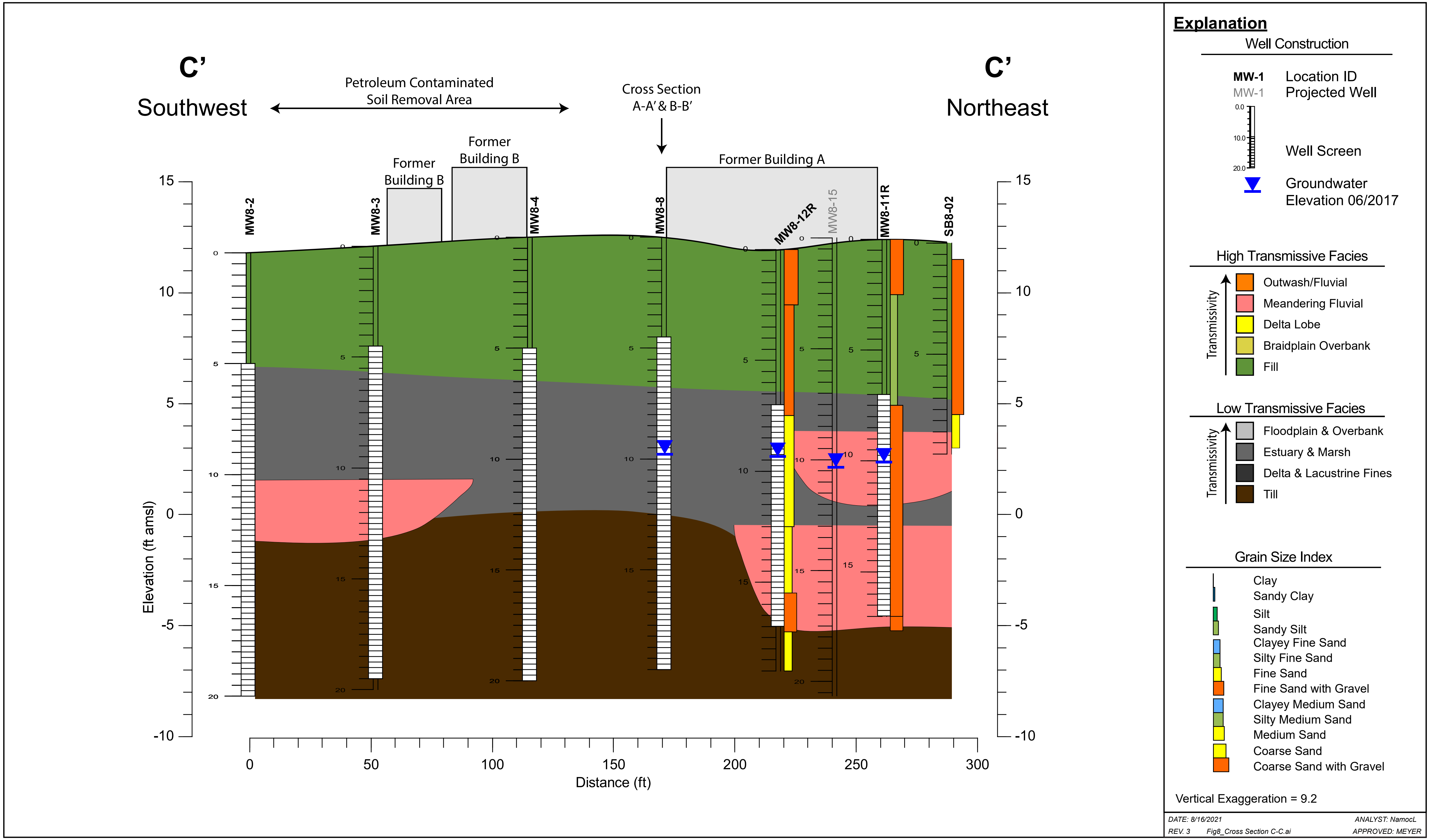

**U.S. NAVY**

**Figure 8**
**Cross Section C-C'**

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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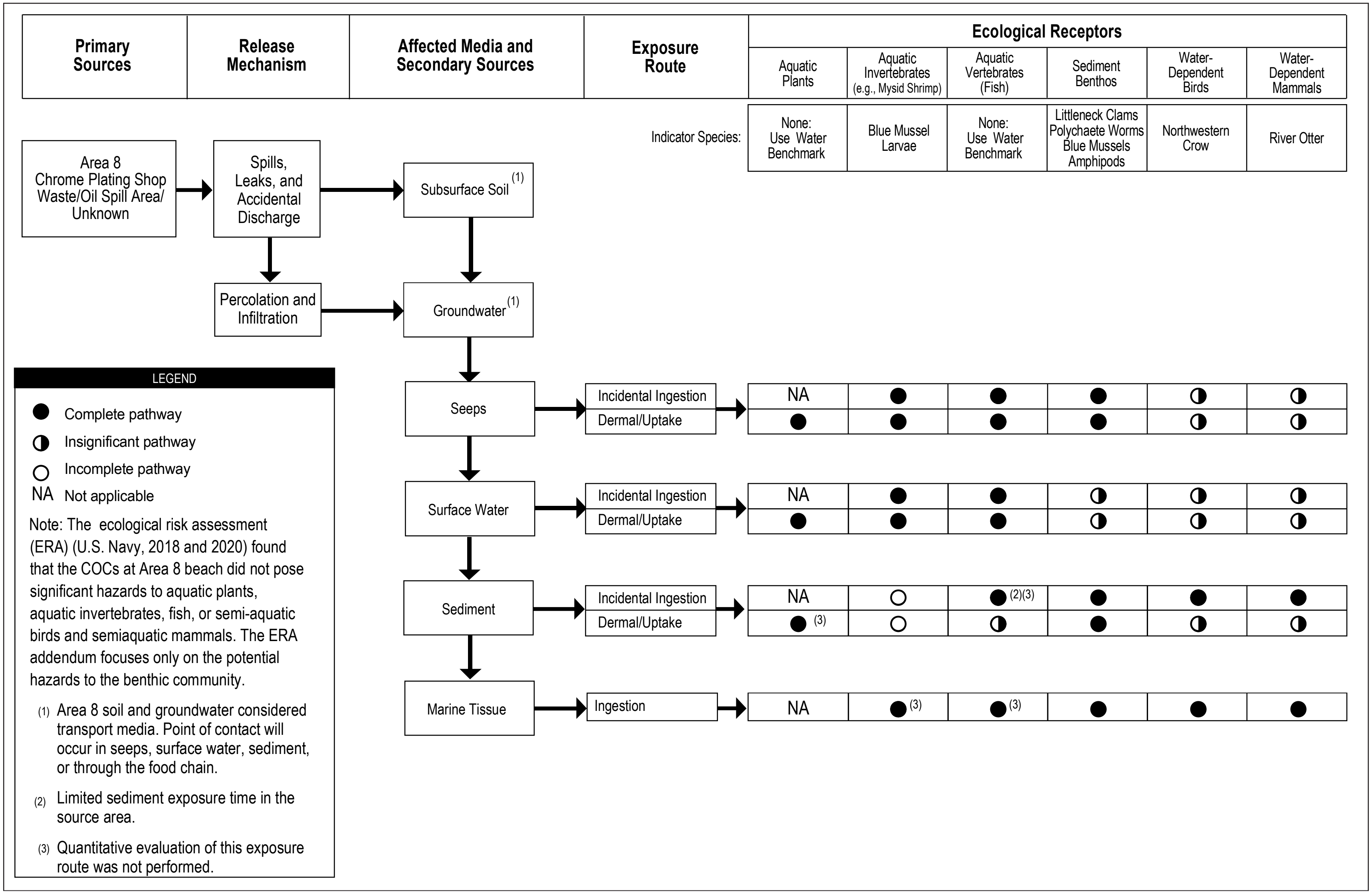


| Affected Media | Exposure Route | Aquatic Plants | Aquatic Invertebrates (e.g., Mysid Shrimp) | Aquatic Vertebrates (Fish) | Sediment Benthos | Water-Dependent Birds | Water-Dependent Mammals |
|---|---|---|---|---|---|---|---|
| Indicator Species: | | None: Use Water Benchmark | Blue Mussel Larvae | None: Use Water Benchmark | Littleneck Clams<br>Polychaete Worms<br>Blue Mussels<br>Amphipods | Northwestern Crow | River Otter |
| Seeps | Incidental Ingestion | NA | ● | ● | ● | ◑ | ◑ |
| | Dermal/Uptake | ● | ● | ● | ● | ◑ | ◑ |
| Surface Water | Incidental Ingestion | NA | ● | ● | ◑ | ◑ | ◑ |
| | Dermal/Uptake | ● | ● | ● | ◑ | ◑ | ◑ |
| Sediment | Incidental Ingestion | NA | ○ | ● (2)(3) | ● | ● | ● |
| | Dermal/Uptake | ● (3) | ○ | ◑ | ● | ◑ | ◑ |
| Marine Tissue | Ingestion | NA | ● (3) | ● (3) | ● | ● | ● |

LEGEND

● Complete pathway
◑ Insignificant pathway
○ Incomplete pathway
NA Not applicable

Note: The ecological risk assessment (ERA) (U.S. Navy, 2018 and 2020) found that the COCs at Area 8 beach did not pose significant hazards to aquatic plants, aquatic invertebrates, fish, or semi-aquatic birds and semiaquatic mammals. The ERA addendum focuses only on the potential hazards to the benthic community.

(1) Area 8 soil and groundwater considered transport media. Point of contact will occur in seeps, surface water, sediment, or through the food chain.

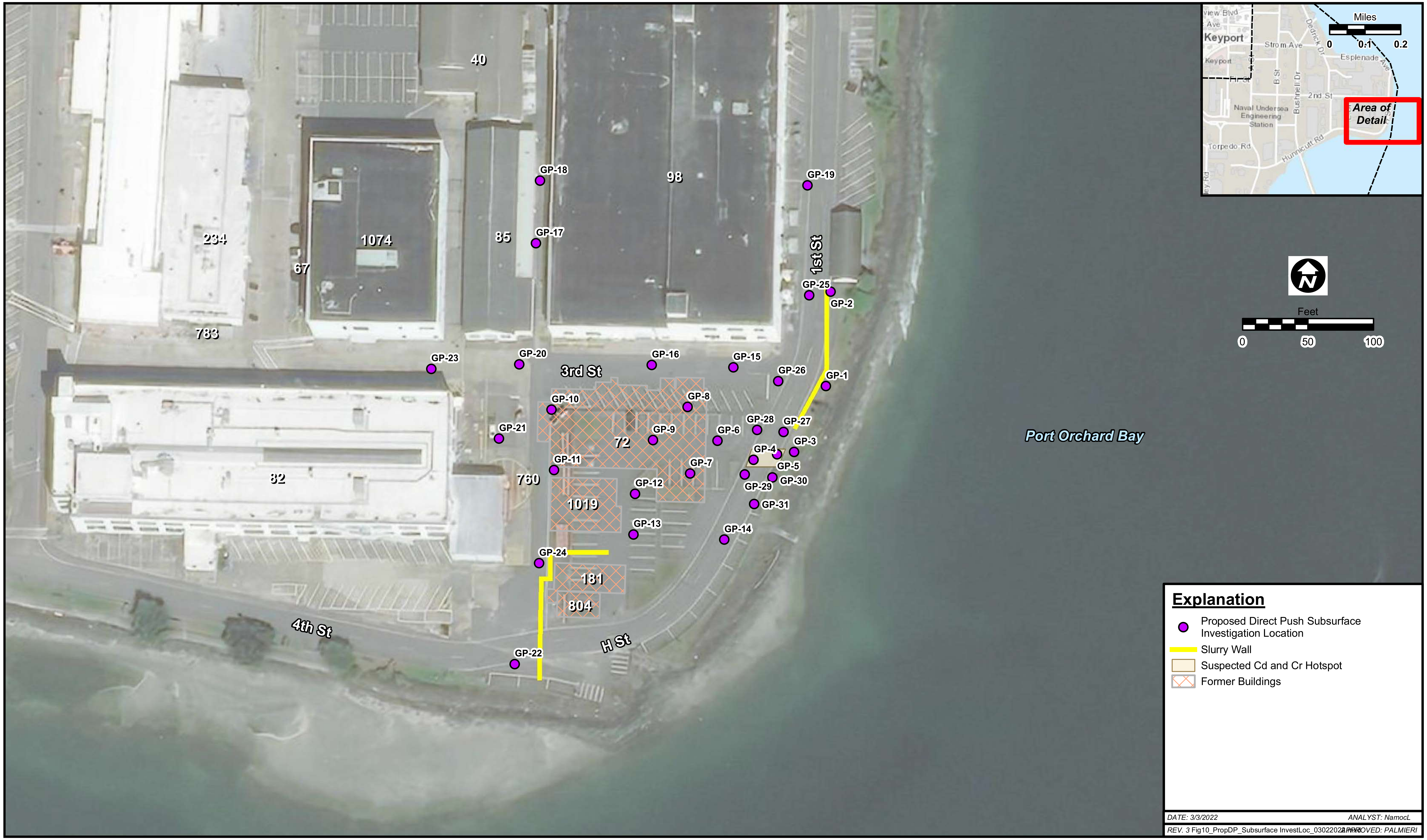
(2) Limited sediment exposure time in the source area.

(3) Quantitative evaluation of this exposure route was not performed.

**U.S. NAVY**

Figure 9
Ecological Conceptual Site Model

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial Investigation



**U.S. NAVY**

## Figure 10
## Proposed Direct Push Subsurface Investigation Locations

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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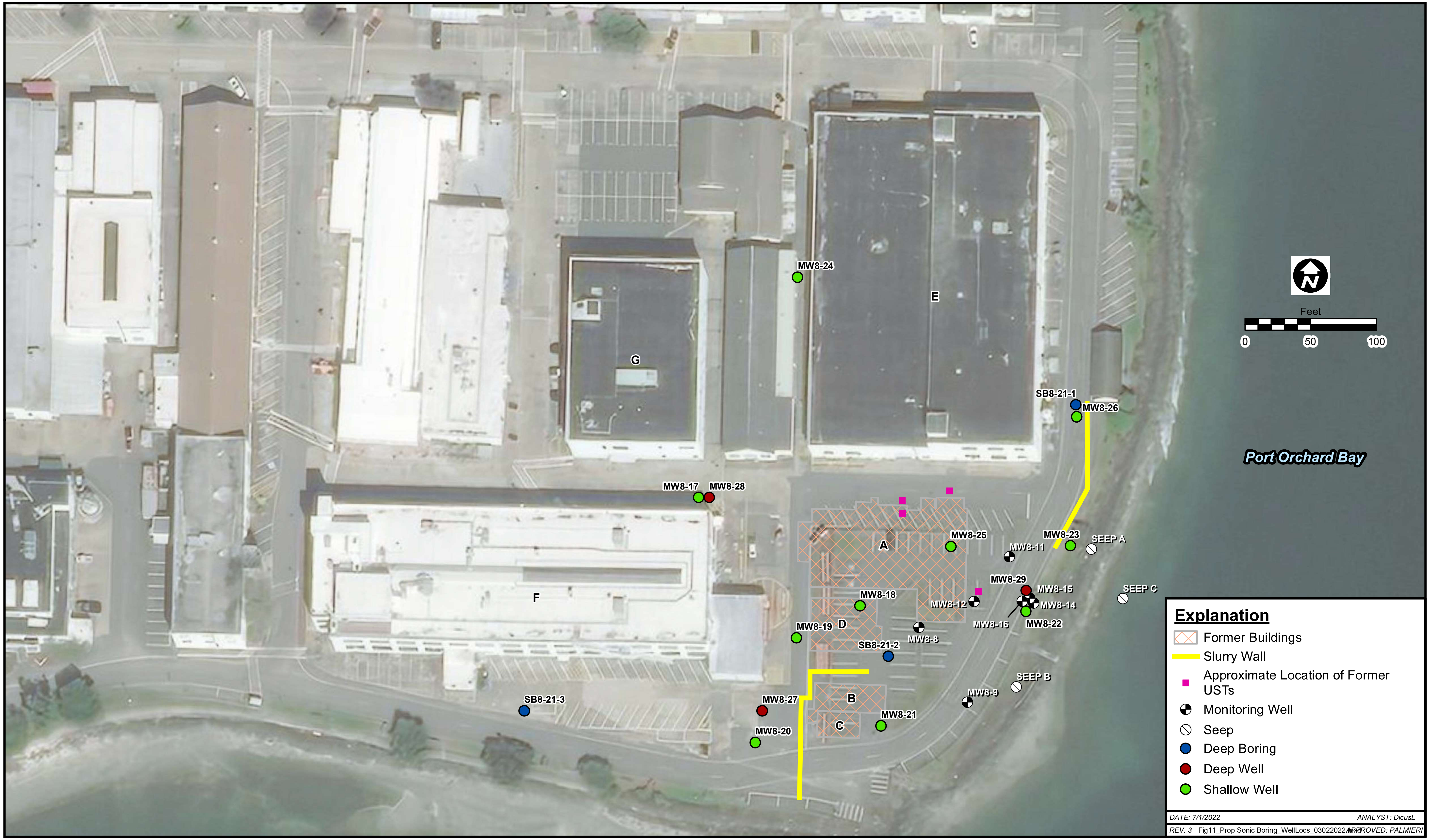

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## Figure 11
## Proposed Sonic Boring / Well Locations

CTO N4425520F4176
NBK Keyport, Area 8 QAPP
Supplemental Remedial
Investigation

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# Appendix C:
# Project Screening Levels and Historic Data Summary

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**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Near-surface soil | MET | 7429-90-5 | ALUMINUM | | 3 | 3 | 11100 | 17600 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7440-36-0 | ANTIMONY | | 3 | | | | MG_KG | | | 3 | 1.7 | 2 | MG_KG | 1998/05/12 | 1998/05/12 | 0 |
| S | Near-surface soil | MET | 7440-38-2 | ARSENIC | HH | 3 | 3 | 1.8 | 11.3 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0.992 |
| S | Near-surface soil | MET | 7440-39-3 | BARIUM | | 3 | 3 | 38.7 | 83 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0.316 |
| S | Near-surface soil | MET | 7440-41-7 | BERYLLIUM | | 3 | 3 | 0.15 | 0.29 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7440-43-9 | CADMIUM | HH | 3 | 2 | 2.6 | 5 | MG_KG | 1998/05/12 | 1998/05/12 | 1 | 0.25 | 0.25 | MG_KG | 1998/05/12 | 1998/05/12 | 0.196 |
| S | Near-surface soil | MET | 7440-70-2 | CALCIUM | | 3 | 3 | 2480 | 20900 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 16065-83-1 | CHROMIUM, TOTAL (7440-47-3) | HH | 3 | 3 | 18.7 | 31.6 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0.372 |
| S | Near-surface soil | MET | 7440-48-4 | COBALT | | 3 | 3 | 8 | 13.9 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7440-50-8 | COPPER | | 3 | 3 | 17.4 | 53.8 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 1.5 |
| S | Near-surface soil | MET | 7439-89-6 | IRON | | 3 | 3 | 11800 | 19200 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7439-92-1 | LEAD | HH | 3 | 3 | 5.7 | 68.8 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0.880 |
| S | Near-surface soil | MET | 7439-95-4 | MAGNESIUM | | 3 | 3 | 4750 | 5870 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7439-96-5 | MANGANESE | | 3 | 3 | 214 | 297 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7439-97-6 | MERCURY | HH | 3 | | | | MG_KG | | | 3 | 0.11 | 0.11 | MG_KG | 1998/05/12 | 1998/05/12 | 0.0170 |
| S | Near-surface soil | MET | 7440-02-0 | NICKEL | | 3 | 3 | 30.8 | 42.3 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0.5 |
| S | Near-surface soil | MET | 7440-09-7 | POTASSIUM | | 3 | 3 | 272 | 983 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7782-49-2 | SELENIUM | | 3 | | | | MG_KG | | | 3 | 0.25 | 0.27 | MG_KG | 1998/05/12 | 1998/05/12 | 1.58 |
| S | Near-surface soil | MET | 7440-22-4 | SILVER | | 3 | | | | MG_KG | | | 3 | 0.4 | 0.46 | MG_KG | 1998/05/12 | 1998/05/12 | 2.24 |
| S | Near-surface soil | MET | 7440-23-5 | SODIUM | | 3 | 3 | 188 | 417 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7440-28-0 | THALLIUM | | 3 | | | | MG_KG | | | 3 | 0.29 | 0.31 | MG_KG | 1998/05/12 | 1998/05/12 | 0 |
| S | Near-surface soil | MET | 7440-62-2 | VANADIUM | | 3 | 3 | 24.4 | 41.6 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 0 |
| S | Near-surface soil | MET | 7440-66-6 | ZINC | | 3 | 3 | 26.5 | 137 | MG_KG | 1998/05/12 | 1998/05/12 | | | | | | | 1.5 |
| S | Near-surface soil | TPH | unavailable09 | TPH-DIESEL RANGE | | 3 | 1 | 14 | 14 | MG_KG | 1998/05/12 | 1998/05/12 | 2 | 11 | 12 | MG_KG | 1998/05/12 | 1998/05/12 | 30.0 |
| S | Near-surface soil | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL | | 3 | 1 | 52 | 52 | MG_KG | 1998/05/12 | 1998/05/12 | 2 | 44 | 47 | MG_KG | 1998/05/12 | 1998/05/12 | 30.0 |
| S | Soil | INO | 57-12-5 | CYANIDE | | 3 | 3 | 0.31 | 0.72 | MG_KG | 1995/05/17 | 1998/07/14 | | | | | | | 50 |
| S | Soil | MET | 7429-90-5 | ALUMINUM | | 2 | 2 | 13300 | 17700 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7440-36-0 | ANTIMONY | | 2 | 1 | 8.1 | 8.1 | MG_KG | 1995/05/17 | 1995/05/17 | 1 | 2.7 | 2.7 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | MET | 7440-38-2 | ARSENIC | HH | 2 | 2 | 0.95 | 1.2 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.992 |
| S | Soil | MET | 7440-39-3 | BARIUM | | 2 | 2 | 46.8 | 70.3 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.316 |
| S | Soil | MET | 7440-41-7 | BERYLLIUM | | 2 | 2 | 0.26 | 0.31 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7440-43-9 | CADMIUM | HH | 2 | 2 | 2.7 | 12 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.196 |
| S | Soil | MET | 7440-70-2 | CALCIUM | | 2 | 2 | 5980 | 6680 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 18540-29-9 | CHROMIUM VI | | 2 | 2 | 0.26 | 7 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 16065-83-1 | CHROMIUM, TOTAL (7440-47-3) | HH | 2 | 2 | 197 | 1760 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.372 |
| S | Soil | MET | 7440-48-4 | COBALT | | 2 | 2 | 13.8 | 16.1 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7440-50-8 | COPPER | | 2 | 2 | 29.6 | 146 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 1.5 |
| S | Soil | MET | 7439-89-6 | IRON | | 2 | 2 | 21200 | 23900 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7439-92-1 | LEAD | HH | 2 | 2 | 2.6 | 1090 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.880 |
| S | Soil | MET | 7439-95-4 | MAGNESIUM | | 2 | 2 | 4720 | 6690 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7439-96-5 | MANGANESE | | 2 | 2 | 302 | 439 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7439-97-6 | MERCURY | HH | 2 | 1 | 0.04 | 0.04 | MG_KG | 1995/05/17 | 1995/05/17 | 1 | 0.02 | 0.02 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0170 |
| S | Soil | MET | 7440-02-0 | NICKEL | | 2 | 2 | 41.1 | 52.7 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.5 |
| S | Soil | MET | 7440-09-7 | POTASSIUM | | 2 | 2 | 757 | 761 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7782-49-2 | SELENIUM | | 2 | | | | MG_KG | | | 2 | 0.1 | 0.5 | MG_KG | 1995/05/17 | 1995/05/17 | 1.58 |
| S | Soil | MET | 7440-22-4 | SILVER | | 2 | 1 | 1.1 | 1.1 | MG_KG | 1995/05/17 | 1995/05/17 | 1 | 0.54 | 0.54 | MG_KG | 1995/05/17 | 1995/05/17 | 2.24 |
| S | Soil | MET | 7440-23-5 | SODIUM | | 2 | 2 | 251 | 546 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7440-28-0 | THALLIUM | | 2 | 1 | 0.14 | 0.14 | MG_KG | 1995/05/17 | 1995/05/17 | 1 | 0.1 | 0.1 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | MET | 7440-62-2 | VANADIUM | | 2 | 2 | 48 | 61.6 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0 |
| S | Soil | MET | 7440-66-6 | ZINC | | 2 | 2 | 44.7 | 130 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 1.5 |
| S | Soil | P_A | 72-54-8 | 4,4-DDD | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 72-55-9 | 4,4-DDE | | 1 | 1 | 0.57 | 0.57 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.000750 |
| S | Soil | P_A | 50-29-3 | 4,4-DDT | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Near-surface soil | MET | 7429-90-5 | ALUMINUM | No | 0 | 0 | 24000 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | 0 |
| S | Near-surface soil | MET | 7440-36-0 | ANTIMONY | No | 0 | 0 | 0.27 | MTCA PRO GW SAT | | No | SAMPLE GW | 0 | YES | 0 |
| S | Near-surface soil | MET | 7440-38-2 | ARSENIC | Yes | 0.005 | MTCA B PRO DW | 0.15 | MTCA PRO GW TO MW SAT | | Yes | | YES | 0 | YES |
| S | Near-surface soil | MET | 7440-39-3 | BARIUM | Yes | 100 | MTCA B PRO DW | 83 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | YES |
| S | Near-surface soil | MET | 7440-41-7 | BERYLLIUM | No | 0 | 0 | 3.2 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | 0 |
| S | Near-surface soil | MET | 7440-43-9 | CADMIUM | Yes | 0.5 | MTCA B PRO DW | 0.035 | MTCA PRO GW SAT | | Yes | SAMPLE GW | YES | YES | YES |
| S | Near-surface soil | MET | 7440-70-2 | CALCIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Near-surface soil | MET | 16065-83-1 | CHROMIUM, TOTAL (7440-47-3) | Yes | 1600 | MTCA B PRO DW | 2000 | MTCA A | | Yes | MAX<ARAR | n | 0 | YES |
| S | Near-surface soil | MET | 7440-48-4 | COBALT | No | 0 | 0 | 0.22 | MTCA PRO GW SAT | | Yes | | YES | 0 | 0 |
| S | Near-surface soil | MET | 7440-50-8 | COPPER | Yes | 0.25 | MTCA B PRO SW | 0.069 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | YES |
| S | Near-surface soil | MET | 7439-89-6 | IRON | No | 0 | 0 | 280 | MTCA PRO GW SAT | | No | Naturally occurring | YES | 0 | 0 |
| S | Near-surface soil | MET | 7439-92-1 | LEAD | Yes | 0.58 | MTCA B PRO SW | 56 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | YES |
| S | Near-surface soil | MET | 7439-95-4 | MAGNESIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Near-surface soil | MET | 7439-96-5 | MANGANESE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Near-surface soil | MET | 7439-97-6 | MERCURY | Yes | 0.0025 | MTCA B PRO SW | 0.0013 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Near-surface soil | MET | 7440-02-0 | NICKEL | Yes | 0.79 | MTCA B PRO SW | 0.54 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | n |
| S | Near-surface soil | MET | 7440-09-7 | POTASSIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Near-surface soil | MET | 7782-49-2 | SELENIUM | No | 0 | 0 | 0.26 | MTCA PRO GW SAT | | No | PAST RL approx =ARAR | 0 | YES | YES |
| S | Near-surface soil | MET | 7440-22-4 | SILVER | Yes | 0.12 | MTCA B PRO SW | 0.016 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Near-surface soil | MET | 7440-23-5 | SODIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Near-surface soil | MET | 7440-28-0 | THALLIUM | Yes | 0.11 | MTCA B PRO DW | 0.011 | MTCA PRO GW SAT | | No | SAMPLE GW | 0 | YES | 0 |
| S | Near-surface soil | MET | 7440-62-2 | VANADIUM | No | 0 | 0 | 80 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | 0 |
| S | Near-surface soil | MET | 7440-66-6 | ZINC | Yes | 7.7 | MTCA B PRO SW | 5 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | n |
| S | Near-surface soil | TPH | unavailable09 | TPH-DIESEL RANGE | | | | 2000 | MTCA A | | No | MAX<ARAR | n | n | YES |
| S | Near-surface soil | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL | | | | 2000 | MTCA A | | No | MAX<ARAR | n | n | YES |
| S | Soil | INO | 57-12-5 | CYANIDE | Yes | 0.1 | MTCA B PRO SW | 0.01 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | YES | 0 | YES |
| S | Soil | MET | 7429-90-5 | ALUMINUM | No | 0 | 0 | 24000 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | 0 |
| S | Soil | MET | 7440-36-0 | ANTIMONY | No | 0 | 0 | 0.27 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | 0 |
| S | Soil | MET | 7440-38-2 | ARSENIC | Yes | 0.005 | MTCA B PRO DW | 0.15 | MTCA PRO GW TO MW SAT | | Yes | | YES | 0 | YES |
| S | Soil | MET | 7440-39-3 | BARIUM | Yes | 100 | MTCA B PRO DW | 83 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | YES |
| S | Soil | MET | 7440-41-7 | BERYLLIUM | No | 0 | 0 | 3.2 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | 0 |
| S | Soil | MET | 7440-43-9 | CADMIUM | Yes | 0.5 | MTCA B PRO DW | 0.035 | MTCA PRO GW SAT | | Yes | SAMPLE GW | YES | 0 | YES |
| S | Soil | MET | 7440-70-2 | CALCIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | MET | 18540-29-9 | CHROMIUM VI | Yes | 5 | MTCA B PRO SW | 0.00089 | MTCA PRO GW SAT | after 2000 | Yes | SAMPLE GW | YES | 0 | 0 |
| S | Soil | MET | 16065-83-1 | CHROMIUM, TOTAL (7440-47-3) | Yes | 1600 | MTCA B PRO DW | 2000 | MTCA A | | Yes | MAX<ARAR | n | 0 | YES |
| S | Soil | MET | 7440-48-4 | COBALT | No | 0 | 0 | 0.22 | MTCA PRO GW SAT | | Yes | | YES | 0 | 0 |
| S | Soil | MET | 7440-50-8 | COPPER | Yes | 0.25 | MTCA B PRO SW | 0.069 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | YES |
| S | Soil | MET | 7439-89-6 | IRON | No | 0 | 0 | 280 | MTCA PRO GW SAT | | No | Naturally occurring | YES | 0 | 0 |
| S | Soil | MET | 7439-92-1 | LEAD | Yes | 0.58 | MTCA B PRO SW | 56 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | YES |
| S | Soil | MET | 7439-95-4 | MAGNESIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | MET | 7439-96-5 | MANGANESE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | MET | 7439-97-6 | MERCURY | Yes | 0.0025 | MTCA B PRO SW | 0.0013 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | YES | YES |
| S | Soil | MET | 7440-02-0 | NICKEL | Yes | 0.79 | MTCA B PRO SW | 0.54 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | n |
| S | Soil | MET | 7440-09-7 | POTASSIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | MET | 7782-49-2 | SELENIUM | No | 0 | 0 | 0.26 | MTCA PRO GW SAT | | No | PAST RL approx =ARAR | 0 | YES | YES |
| S | Soil | MET | 7440-22-4 | SILVER | Yes | 0.12 | MTCA B PRO SW | 0.016 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | YES | YES |
| S | Soil | MET | 7440-23-5 | SODIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | MET | 7440-28-0 | THALLIUM | Yes | 0.11 | MTCA B PRO DW | 0.011 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | 0 |
| S | Soil | MET | 7440-62-2 | VANADIUM | No | 0 | 0 | 80 | MTCA PRO GW SAT | | No | MAX<ARAR | n | 0 | 0 |
| S | Soil | MET | 7440-66-6 | ZINC | Yes | 7.7 | MTCA B PRO SW | 5 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | 0 | n |
| S | Soil | P_A | 72-54-8 | 4,4-DDD | No | 0 | 0 | 0.00000036 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 72-55-9 | 4,4-DDE | No | 0 | 0 | 0.000000076 | MTCA PRO GW TO MW SAT | | No | | YES | 0 | YES |
| S | Soil | P_A | 50-29-3 | 4,4-DDT | No | 0 | 0 | 0.00000081 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Soil | P_A | 309-00-2 | ALDRIN | | 2 | | | | MG_KG | | | 2 | 0.0018 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 319-84-6 | ALPHA-BHC | | 2 | | | | MG_KG | | | 2 | 0.0018 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000400 |
| S | Soil | P_A | 12674-11-2 | AROCLOR-1016 | | 2 | | | | MG_KG | | | 2 | 0.035 | 0.71 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0150 |
| S | Soil | P_A | 11104-28-2 | AROCLOR-1221 | | 2 | | | | MG_KG | | | 2 | 0.071 | 1.4 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0100 |
| S | Soil | P_A | 11141-16-5 | AROCLOR-1232 | | 2 | | | | MG_KG | | | 2 | 0.035 | 0.71 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0100 |
| S | Soil | P_A | 53469-21-9 | AROCLOR-1242 | | 2 | | | | MG_KG | | | 2 | 0.035 | 0.71 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0100 |
| S | Soil | P_A | 12672-29-6 | AROCLOR-1248 | | 2 | | | | MG_KG | | | 2 | 0.035 | 0.71 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00600 |
| S | Soil | P_A | 11097-69-1 | AROCLOR-1254 | | 2 | | | | MG_KG | | | 2 | 0.035 | 0.71 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0100 |
| S | Soil | P_A | 11096-82-5 | AROCLOR-1260 | | 2 | | | | MG_KG | | | 2 | 0.035 | 0.71 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0150 |
| S | Soil | P_A | 319-85-7 | BETA-BHC | | 2 | | | | MG_KG | | | 2 | 0.0018 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 12789-03-6 | CHLORDANE | | 2 | | | | MG_KG | | | 2 | 0.018 | 0.37 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | P_A | 12789-03-6 | CHLORDANE, TECHNICAL | | 1 | | | | MG_KG | | | 1 | 0.018 | 0.018 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | P_A | 50-29-3 | DDT, TOTAL | | 1 | 1 | 0.57 | 0.57 | MG_KG | 1995/05/17 | 1995/05/17 | | | | | | | 0.000750 |
| S | Soil | P_A | 319-86-8 | DELTA-BHC | | 2 | | | | MG_KG | | | 2 | 0.0018 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 60-57-1 | DIELDRIN | | 2 | | | | MG_KG | | | 2 | 0.6 | 0.6 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 115-29-7 | ENDOSULFAN | | 1 | | | | MG_KG | | | 1 | 0.38 | 0.38 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | P_A | 959-98-8 | ENDOSULFAN I | | 2 | | | | MG_KG | | | 2 | 0.38 | 0.38 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 33213-65-9 | ENDOSULFAN II | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 1031-07-8 | ENDOSULFAN SULFATE | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 72-20-8 | ENDRIN | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00150 |
| S | Soil | P_A | 7421-93-4 | ENDRIN ALDEHYDE | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0150 |
| S | Soil | P_A | 53494-70-5 | ENDRIN KETONE | | 2 | | | | MG_KG | | | 2 | 0.0035 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00150 |
| S | Soil | P_A | 76-44-8 | HEPTACHLOR | | 2 | | | | MG_KG | | | 2 | 0.0018 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000400 |
| S | Soil | P_A | 1024-57-3 | HEPTACHLOR EPOXIDE | | 2 | 1 | 0.0033 | 0.0033 | MG_KG | 1995/05/17 | 1995/05/17 | 1 | 0.037 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 58-89-9 | LINDANE | | 2 | | | | MG_KG | | | 2 | 0.0018 | 0.037 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00150 |
| S | Soil | P_A | 72-43-5 | METHOXYCHLOR | | 2 | | | | MG_KG | | | 2 | 0.018 | 0.37 | MG_KG | 1995/05/17 | 1995/05/17 | 0.000750 |
| S | Soil | P_A | 1336-36-3 | PCB, TOTAL | | 1 | | | | MG_KG | | | 1 | 0.071 | 0.071 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | P_A | 8001-35-2 | TOXAPHENE | | 2 | | | | MG_KG | | | 2 | 0.18 | 3.7 | MG_KG | 1995/05/17 | 1995/05/17 | 0.0800 |
| S | Soil | SVOA | 106-46-7 | 1,4-DICHLOROBENZENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Sub-surface soil ( > 6") | SVOA | 106-46-7 | 1,4-DICHLOROBENZENE | | 29 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | SVOA | 122-66-7 | 1,2-DIPHENYLHYDRAZINE | | 2 | | | | MG_KG | | | 2 | 0.33 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0 |
| S | Soil | SVOA | 108-60-1 | 2,2'-OXYBIS(1-CHLOROPROPANE) | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 95-95-4 | 2,4,5-TRICHLOROPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 88-06-2 | 2,4,6-TRICHLOROPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 120-83-2 | 2,4-DICHLOROPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 105-67-9 | 2,4-DIMETHYLPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 51-28-5 | 2,4-DINITROPHENOL | | 3 | | | | MG_KG | | | 3 | 0.67 | 6.7 | MG_KG | 1995/05/17 | 1998/07/14 | 1.20 |
| S | Soil | SVOA | 121-14-2 | 2,4-DINITROTOLUENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 606-20-2 | 2,6-DINITROTOLUENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 91-58-7 | 2-CHLORONAPHTHALENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 95-57-8 | 2-CHLOROPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 91-57-6 | 2-METHYLNAPHTHALENE | | 3 | 1 | 0.055 | 0.055 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.36 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00300 |
| S | Soil | SVOA | 95-48-7 | 2-METHYLPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 88-74-4 | 2-NITROANILINE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 88-75-5 | 2-NITROPHENOL | | 3 | 1 | 0.6 | 0.6 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.33 | 0.36 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 91-94-1 | 3,3-DICHLOROBENZIDINE | | 3 | | | | MG_KG | | | 3 | 0.36 | 6.7 | MG_KG | 1995/05/17 | 1998/07/14 | 0.200 |
| S | Soil | SVOA | 99-09-2 | 3-NITROANILINE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.200 |
| S | Soil | SVOA | 534-52-1 | 4,6-DINITRO-2-METHYLPHENOL | | 3 | | | | MG_KG | | | 3 | 0.67 | 6.7 | MG_KG | 1995/05/17 | 1998/07/14 | 0.400 |
| S | Soil | SVOA | 101-55-3 | 4-BROMOPHENYL-PHENYLETHER | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 59-50-7 | 4-CHLORO-3-METHYLPHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 106-47-8 | 4-CHLOROANILINE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.200 |
| S | Soil | SVOA | 7005-72-3 | 4-CHLOROPHENYL-PHENYLETHER | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 106-44-5 | 4-METHYLPHENOL | | 3 | 2 | 0.57 | 2.3 | MG_KG | 1998/07/14 | 1998/07/14 | 1 | 0.36 | 0.36 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Soil | P_A | 309-00-2 | ALDRIN | No | 0 | 0 | 0.000000002 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 319-84-6 | ALPHA-BHC | No | 0 | 0 | 0.000000098 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 12674-11-2 | AROCLOR-1016 | No | 0 | 0 | 0.00032 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 11104-28-2 | AROCLOR-1221 | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | P_A | 11141-16-5 | AROCLOR-1232 | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | P_A | 53469-21-9 | AROCLOR-1242 | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | P_A | 12672-29-6 | AROCLOR-1248 | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | P_A | 11097-69-1 | AROCLOR-1254 | No | 0 | 0 | 0.000014 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 11096-82-5 | AROCLOR-1260 | No | 0 | 0 | 0.018 | MTCA PRO GW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 319-85-7 | BETA-BHC | No | 0 | 0 | 0.0000034 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 12789-03-6 | CHLORDANE | No | 0 | 0 | 0.0000011 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | 0 |
| S | Soil | P_A | 12789-03-6 | CHLORDANE, TECHNICAL | No | 0 | 0 | 0.0000011 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | 0 |
| S | Soil | P_A | 50-29-3 | DDT, TOTAL | No | 0 | 0 | 0.00000081 | MTCA PRO GW TO MW SAT | | No | | YES | 0 | YES |
| S | Soil | P_A | 319-86-8 | DELTA-BHC | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | P_A | 60-57-1 | DIELDRIN | No | 0 | 0 | 1.8E-09 | MTCA PRO GW TO MW SAT | | No | SD NOT IMPACTED | 0 | YES | YES |
| S | Soil | P_A | 115-29-7 | ENDOSULFAN | No | 0 | 0 | 0.00002 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | 0 |
| S | Soil | P_A | 959-98-8 | ENDOSULFAN I | No | 0 | 0 | 0.000061 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 33213-65-9 | ENDOSULFAN II | No | 0 | 0 | 0.000061 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 1031-07-8 | ENDOSULFAN SULFATE | No | 0 | 0 | 0.1 | MTCA PRO GW TO MW SAT | | No | PAST RL<ARAR | 0 | n | YES |
| S | Soil | P_A | 72-20-8 | ENDRIN | No | 0 | 0 | 0.000022 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 7421-93-4 | ENDRIN ALDEHYDE | No | 0 | 0 | 0.00012 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 53494-70-5 | ENDRIN KETONE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | P_A | 76-44-8 | HEPTACHLOR | No | 0 | 0 | 3.3E-09 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 1024-57-3 | HEPTACHLOR EPOXIDE | No | 0 | 0 | 0.000000025 | MTCA PRO GW TO MW SAT | | No | | YES | YES | YES |
| S | Soil | P_A | 58-89-9 | LINDANE | No | 0 | 0 | 0.00026 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 72-43-5 | METHOXYCHLOR | No | 0 | 0 | 0.0016 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | P_A | 1336-36-3 | PCB, TOTAL | No | 0 | 0 | 0.00000055 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | 0 |
| S | Soil | P_A | 8001-35-2 | TOXAPHENE | No | 0 | 0 | 0.0000031 | MTCA PRO GW TO MW SAT | | No | | 0 | YES | YES |
| S | Soil | SVOA | 106-46-7 | 1,4-DICHLOROBENZENE | No | 0 | 0 | 0.000072 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 106-46-7 | 1,4-DICHLOROBENZENE | No | 0 | 0 | 0.4 | MTCA PRO GW SAT | | Yes | Not detected in GW | 0 | YES | YES |
| S | Soil | SVOA | 122-66-7 | 1,2-DIPHENYLHYDRAZINE | No | 0 | 0 | 0.000036 | MTCA PRO GW TO MW | | No | | 0 | YES | 0 |
| S | Soil | SVOA | 108-60-1 | 2,2'-OXYBIS(1-CHLOROPROPANE) | No | 0 | 0 | 0.00023 | MTCA PRO GW SAT | | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 95-95-4 | 2,4,5-TRICHLOROPHENOL | No | 0 | 0 | 1.1 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 88-06-2 | 2,4,6-TRICHLOROPHENOL | No | 0 | 0 | 0.00019 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Soil | SVOA | 120-83-2 | 2,4-DICHLOROPHENOL | No | 0 | 0 | 0.0043 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 105-67-9 | 2,4-DIMETHYLPHENOL | No | 0 | 0 | 0.076 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 51-28-5 | 2,4-DINITROPHENOL | No | 0 | 0 | 0.0092 | MTCA PRO GW SAT | | No | PAST GW RL APPROX ARAR | 0 | YES | YES |
| S | Soil | SVOA | 121-14-2 | 2,4-DINITROTOLUENE | No | 0 | 0 | 0.00016 | MTCA PRO GW TO MW SAT | | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 606-20-2 | 2,6-DINITROTOLUENE | No | 0 | 0 | 0.000051 | MTCA PRO GW SAT | | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 91-58-7 | 2-CHLORONAPHTHALENE | No | 0 | 0 | 0.28 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 95-57-8 | 2-CHLOROPHENOL | No | 0 | 0 | 0.011 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 91-57-6 | 2-METHYLNAPHTHALENE | No | 0 | 0 | 0.088 | MTCA PRO GW SAT | | Yes | MAX>ARAR | n | YES | YES |
| S | Soil | SVOA | 95-48-7 | 2-METHYLPHENOL | No | 0 | 0 | 0.47 | MTCA PRO GW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 88-74-4 | 2-NITROANILINE | No | 0 | 0 | 0.064 | MTCA PRO GW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 88-75-5 | 2-NITROPHENOL | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 91-94-1 | 3,3-DICHLOROBENZIDINE | No | 0 | 0 | 0.000011 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Soil | SVOA | 99-09-2 | 3-NITROANILINE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 534-52-1 | 4,6-DINITRO-2-METHYLPHENOL | No | 0 | 0 | 0.0013 | MTCA PRO GW SAT | | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 101-55-3 | 4-BROMOPHENYL-PHENYLETHER | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 59-50-7 | 4-CHLORO-3-METHYLPHENOL | No | 0 | 0 | 0.028 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 106-47-8 | 4-CHLOROANILINE | No | 0 | 0 | 0.00017 | MTCA PRO GW SAT | | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 7005-72-3 | 4-CHLOROPHENYL-PHENYLETHER | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 106-44-5 | 4-METHYLPHENOL | No | 0 | 0 | 0.94 | MTCA PRO GW SAT | | No | GW Not impacted | YES | n | 0 |

**Appendix C: Screening Level Data Summary**

**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Soil | SVOA | 100-01-6 | 4-NITROANILINE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 100-02-7 | 4-NITROPHENOL | | 3 | | | | MG_KG | | | 3 | 0.67 | 6.7 | MG_KG | 1995/05/17 | 1998/07/14 | 0.400 |
| S | Soil | SVOA | 83-32-9 | ACENAPHTHENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 208-96-8 | ACENAPHTHYLENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 62-53-3 | ANILINE | | 2 | | | | MG_KG | | | 2 | 0.33 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0 |
| S | Soil | SVOA | 120-12-7 | ANTHRACENE | | 3 | 1 | 0.055 | 0.055 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.36 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 56-55-3 | BENZO[A]ANTHRACENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00400 |
| S | Soil | SVOA | 50-32-8 | BENZO[A]PYRENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00300 |
| S | Soil | SVOA | 205-99-2 | BENZO[B]FLUORANTHENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00300 |
| S | Soil | SVOA | 191-24-2 | BENZO[G,H,I]PERYLENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 207-08-9 | BENZO[K]FLUORANTHENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 56832-73-6 | BENZOFLUORANTHENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0 |
| S | Soil | SVOA | 65-85-0 | BENZOIC ACID | | 2 | | | | MG_KG | | | 2 | 1.7 | 17 | MG_KG | 1998/07/14 | 1998/07/14 | 2.00 |
| S | Soil | SVOA | 100-51-6 | BENZYL ALCOHOL | | 2 | | | | MG_KG | | | 2 | 0.33 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 111-91-1 | BIS(2-CHLOROETHOXY)METHANE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0500 |
| S | Soil | SVOA | 111-44-4 | BIS(2-CHLOROETHYL)ETHER | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 117-81-7 | BIS(2-ETHYLHEXYL)PHTHALATE | | 3 | 1 | 0.89 | 0.89 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 1.8 | 2.1 | MG_KG | 1995/05/17 | 1998/07/14 | 0.200 |
| S | Soil | SVOA | 85-68-7 | BUTYLBENZYLPHTHALATE | | 3 | 2 | 0.033 | 2 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 3.3 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0.100 |
| S | Soil | SVOA | 86-74-8 | CARBAZOLE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 218-01-9 | CHRYSENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00300 |
| S | Soil | SVOA | -61 | CPAH, TOTAL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0 |
| S | Soil | SVOA | 53-70-3 | DIBENZ[A,H]ANTHRACENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 132-64-9 | DIBENZOFURAN | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 84-66-2 | DIETHYLPHTHALATE | | 3 | 1 | 0.014 | 0.014 | MG_KG | 1995/05/17 | 1995/05/17 | 2 | 0.33 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0.0500 |
| S | Soil | SVOA | 131-11-3 | DIMETHYL PHTHALATE | | 3 | 1 | 0.033 | 0.033 | MG_KG | 1995/05/17 | 1995/05/17 | 2 | 0.33 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | 84-74-2 | DI-N-BUTYLPHTHALATE | | 3 | 3 | 0.027 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | | | | | | | 0.100 |
| S | Soil | SVOA | 117-84-0 | DI-N-OCTYLPHTHALATE | | 3 | 1 | 1.4 | 1.4 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.36 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 206-44-0 | FLUORANTHENE | | 3 | 2 | 0.009 | 0.057 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 3.3 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0.00300 |
| S | Soil | SVOA | 86-73-7 | FLUORENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 118-74-1 | HEXACHLOROBENZENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 87-68-3 | HEXACHLOROBUTADIENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | SVOA | 77-47-4 | HEXACHLOROCYCLOPENTADIENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 67-72-1 | HEXACHLOROETHANE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0150 |
| S | Soil | SVOA | -63 | HPAH, TOTAL | | 3 | 2 | 0.009 | 0.111 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 3.3 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0 |
| S | Soil | SVOA | 193-39-5 | INDENO[1,2,3-CD]PYRENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00150 |
| S | Soil | SVOA | 78-59-1 | ISOPHORONE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | -64 | LPAH, TOTAL | | 3 | 2 | 0.009 | 1.197 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 3.3 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0 |
| S | Soil | SVOA | 91-20-3 | NAPHTHALENE | | 3 | 1 | 1.1 | 1.1 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.36 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00400 |
| S | Soil | SVOA | -150 | NCPAH, TOTAL | | 3 | 2 | 0.018 | 1.363 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 3.3 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0 |
| S | Soil | SVOA | 98-95-3 | NITROBENZENE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0500 |
| S | Soil | SVOA | 621-64-7 | N-NITROSODINPROPYLAMINE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0500 |
| S | Soil | SVOA | 86-30-6 | N-NITROSODIPHENYLAMINE | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0300 |
| S | Soil | SVOA | 87-86-5 | PENTACHLOROPHENOL | | 3 | 1 | 0.15 | 0.15 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.86 | 6.7 | MG_KG | 1995/05/17 | 1998/07/14 | 0.200 |
| S | Soil | SVOA | 85-01-8 | PHENANTHRENE | | 3 | 2 | 0.009 | 0.042 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 3.3 | 3.3 | MG_KG | 1998/07/14 | 1998/07/14 | 0.00400 |
| S | Soil | SVOA | 108-95-2 | PHENOL | | 3 | | | | MG_KG | | | 3 | 0.33 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.0500 |
| S | Soil | SVOA | 129-00-0 | PYRENE | | 3 | 1 | 0.054 | 0.054 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.36 | 3.3 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00300 |
| S | Soil | TPH | unavailable09 | TPH-DIESEL RANGE | | 3 | 3 | 120 | 1500 | MG_KG | 1998/04/24 | 1998/04/24 | | | | | | | 30.0 |
| S | Soil | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL | | 3 | 3 | 610 | 2500 | MG_KG | 1998/04/24 | 1998/04/24 | | | | | | | 30.0 |
| S | Soil | VOA | 71-55-6 | 1,1,1-TRICHLOROETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 79-34-5 | 1,1,2,2-TETRACHLOROETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 79-00-5 | 1,1,2-TRICHLOROETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |
| S | Soil | VOA | 75-34-3 | 1,1-DICHLOROETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |
| S | Soil | VOA | 75-35-4 | 1,1-DICHLOROETHENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00300 |
| S | Soil | VOA | 107-06-2 | 1,2-DICHLOROETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Soil | SVOA | 100-01-6 | 4-NITROANILINE | No | 0 | 0 | 0.0017 | MTCA PRO GW SAT |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 100-02-7 | 4-NITROPHENOL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 83-32-9 | ACENAPHTHENE | No | 0 | 0 | 0.16 | MTCA PRO GW TO MW SAT |  | Yes | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 208-96-8 | ACENAPHTHYLENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 62-53-3 | ANILINE | No | 0 | 0 | 0.0055 | MTCA PRO GW SAT |  | No |  | 0 | YES | 0 |
| S | Soil | SVOA | 120-12-7 | ANTHRACENE | No | 0 | 0 | 2.4 | MTCA PRO GW TO MW SAT |  | Yes |  | n | YES | YES |
| S | Soil | SVOA | 56-55-3 | BENZO[A]ANTHRACENE | No | 0 | 0 | 0.000057 | MTCA PRO GW TO MW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | SVOA | 50-32-8 | BENZO[A]PYRENE | No | 0 | 0 | 0.000016 | MTCA PRO GW TO MW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | SVOA | 205-99-2 | BENZO[B]FLUORANTHENE | No | 0 | 0 | 0.000096 | MTCA PRO GW TO MW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | SVOA | 191-24-2 | BENZO[G,H,I]PERYLENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 207-08-9 | BENZO[K]FLUORANTHENE | No | 0 | 0 | 0.00094 | MTCA PRO GW TO MW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | SVOA | 56832-73-6 | BENZOFLUORANTHENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 65-85-0 | BENZOIC ACID | No | 0 | 0 | 18 | MTCA PRO GW SAT |  | No | PAST RL<ARAR | 0 | n | YES |
| S | Soil | SVOA | 100-51-6 | BENZYL ALCOHOL | No | 0 | 0 | 0.49 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 111-91-1 | BIS(2-CHLOROETHOXY)METHANE | No | 0 | 0 | 0.014 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 111-44-4 | BIS(2-CHLOROETHYL)ETHER | No | 0 | 0 | 0.000014 | MTCA PRO GW SAT |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 117-81-7 | BIS(2-ETHYLHEXYL)PHTHALATE | Yes | 0.59 | MTCA B PRO SW | 0.0051 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Soil | SVOA | 85-68-7 | BUTYLBENZYLPHTHALATE | Yes | 130 | MTCA B PRO SW | 0.00018 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Soil | SVOA | 86-74-8 | CARBAZOLE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 218-01-9 | CHRYSENE | No | 0 | 0 | 0.0029 | MTCA PRO GW TO MW SAT |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| S | Soil | SVOA | -61 | CPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 53-70-3 | DIBENZ[A,H]ANTHRACENE | No | 0 | 0 | 0.000029 | MTCA PRO GW TO MW SAT |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| S | Soil | SVOA | 132-64-9 | DIBENZOFURAN | No | 0 | 0 | 0.076 | MTCA PRO GW SAT |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| S | Soil | SVOA | 84-66-2 | DIETHYLPHTHALATE | No | 0 | 0 | 0.074 | MTCA PRO GW TO MW SAT |  | No | MAX<ARAR; PAST RL>ARAR | n | YES | YES |
| S | Soil | SVOA | 131-11-3 | DIMETHYL PHTHALATE | Yes | 1600 | MTCA B PRO DW | 0.19 | MTCA PRO GW TO MW SAT |  | No | MAX<ARAR; PAST RL>ARAR | n | YES | YES |
| S | Soil | SVOA | 84-74-2 | DI-N-BUTYLPHTHALATE | Yes | 160 | MTCA B PRO DW | 0.015 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | YES | 0 | YES |
| S | Soil | SVOA | 117-84-0 | DI-N-OCTYLPHTHALATE | Yes | 32 | MTCA B PRO DW | 23 | MTCA PRO GW SAT |  | No | MAX<ARAR | n | n | YES |
| S | Soil | SVOA | 206-44-0 | FLUORANTHENE | No | 0 | 0 | 0.3 | MTCA PRO GW TO MW SAT |  | Yes | MAX<ARAR; PAST RL>ARAR | n | YES | YES |
| S | Soil | SVOA | 86-73-7 | FLUORENE | No | 0 | 0 | 0.08 | MTCA PRO GW TO MW SAT |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| S | Soil | SVOA | 118-74-1 | HEXACHLOROBENZENE | No | 0 | 0 | 0.0000004 | MTCA PRO GW TO MW SAT |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 87-68-3 | HEXACHLOROBUTADIENE | No | 0 | 0 | 0.000011 | MTCA PRO GW TO MW SAT |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 77-47-4 | HEXACHLOROCYCLOPENTADIENE | No | 0 | 0 | 0.0017 | 40 CFR 131.45 PRO SW |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 67-72-1 | HEXACHLOROETHANE | No | 0 | 0 | 0.0000097 | 40 CFR 131.45 PRO SW |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | -63 | HPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 193-39-5 | INDENO[1,2,3-CD]PYRENE | No | 0 | 0 | 0.00031 | MTCA PRO GW TO MW SAT |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| S | Soil | SVOA | 78-59-1 | ISOPHORONE | No | 0 | 0 | 0.032 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | -64 | LPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 91-20-3 | NAPHTHALENE | No | 0 | 0 | 0.24 | MTCA PRO GW SAT |  | Yes | MAX>ARAR,PAST RL>ARAR | YES | YES | YES |
| S | Soil | SVOA | -150 | NCPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 98-95-3 | NITROBENZENE | No | 0 | 0 | 0.0065 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 621-64-7 | N-NITROSODINPROPYLAMINE | No | 0 | 0 | 0.000007 | MTCA PRO GW SAT |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 86-30-6 | N-NITROSODIPHENYLAMINE | No | 0 | 0 | 0.002 | MTCA PRO GW TO MW SAT |  | No | 3 ND Samples | 0 | YES | YES |
| S | Soil | SVOA | 87-86-5 | PENTACHLOROPHENOL | No | 0 | 0 | 0.0000018 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Soil | SVOA | 85-01-8 | PHENANTHRENE | No | 0 | 0 | 0 | 0 |  | Yes | Standard PAH List | 0 | 0 | 0 |
| S | Soil | SVOA | 108-95-2 | PHENOL | No | 0 | 0 | 2.3 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Soil | SVOA | 129-00-0 | PYRENE | No | 0 | 0 | 0.55 | MTCA PRO GW TO MW SAT |  | Yes | MAX<ARAR; PAST RL>ARAR | n | YES | YES |
| S | Soil | TPH | unavailable09 | TPH-DIESEL RANGE |  |  |  | 2000 | MTCA A |  | No | MAX<ARAR | n | 0 | YES |
| S | Soil | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL |  |  |  | 2000 | MTCA A |  | No | GW Not impacted | YES | 0 | YES |
| S | Soil | VOA | 71-55-6 | 1,1,1-TRICHLOROETHANE | Yes | 20 | MTCA B PRO DW | 0.084 | MTCA PRO GW SAT |  | Yes | PAST RL<ARAR | 0 | n | YES |
| S | Soil | VOA | 79-34-5 | 1,1,2,2-TETRACHLOROETHANE | No | 0 | 0 | 0.00008 | MTCA PRO GW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 79-00-5 | 1,1,2-TRICHLOROETHANE | Yes | 0.5 | MTCA B PRO DW | 0.00033 | MTCA PRO GW TO MW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 75-34-3 | 1,1-DICHLOROETHANE | Yes | 80 | MTCA B PRO DW | 0.0026 | MTCA PRO GW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 75-35-4 | 1,1-DICHLOROETHENE | Yes | 0.32 | MTCA B PRO SW | 0.0025 | MTCA PRO GW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 107-06-2 | 1,2-DICHLOROETHANE | Yes | 0.5 | MTCA B PRO DW | 0.0016 | MTCA PRO GW SAT |  | Yes | SAMPLE GW | 0 | YES | YES |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Soil | VOA | 78-87-5 | 1,2-DICHLOROPROPANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 542-75-6 | 1,3-DICHLOROPROPENE, TOTAL | | 3 | | | | MG_KG | | | 3 | 0.001 | 0.015 | MG_KG | 1995/05/17 | 1998/07/14 | 0 |
| S | Soil | VOA | 78-93-3 | 2-BUTANONE | | 4 | 3 | 0.011 | 0.096 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 0.05 | 0.05 | MG_KG | 1998/07/14 | 1998/07/14 | 0 |
| S | Soil | VOA | 110-75-8 | 2-CHLOROETHYL VINYL ETHER | | 1 | | | | MG_KG | | | 1 | 0.002 | 0.002 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | VOA | 591-78-6 | 2-HEXANONE | | 4 | | | | MG_KG | | | 4 | 0.002 | 0.05 | MG_KG | 1995/05/17 | 1998/07/14 | 0 |
| S | Soil | VOA | 108-10-1 | 4-METHYL-2-PENTANONE | | 3 | 2 | 0.029 | 0.052 | MG_KG | 1998/07/14 | 1998/07/14 | 1 | 0.002 | 0.002 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | VOA | 67-64-1 | ACETONE | | 4 | 3 | 0.19 | 0.44 | MG_KG | 1998/07/14 | 1998/07/14 | 1 | 0.083 | 0.083 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | VOA | 71-43-2 | BENZENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 75-27-4 | BROMODICHLOROMETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |
| S | Soil | VOA | 75-25-2 | BROMOFORM | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 74-83-9 | BROMOMETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |
| S | Soil | VOA | -71 | BTEX, TOTAL | | 3 | 2 | 0.045 | 0.069 | MG_KG | 1998/07/14 | 1998/07/14 | 1 | 0.001 | 0.001 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | VOA | 75-15-0 | CARBON DISULFIDE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0 |
| S | Soil | VOA | 56-23-5 | CARBON TETRACHLORIDE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 108-90-7 | CHLOROBENZENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |
| S | Soil | VOA | 75-00-3 | CHLOROETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 67-66-3 | CHLOROFORM | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 74-87-3 | CHLOROMETHANE | | 4 | 3 | 0.007 | 0.03 | MG_KG | 1998/07/14 | 1998/07/14 | 1 | 0.001 | 0.001 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00200 |
| S | Soil | VOA | 156-59-2 | CIS-1,2-DICHLOROETHENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 10061-01-5 | CIS-1,3-DICHLOROPROPENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.000500 |
| S | Soil | VOA | 124-48-1 | DIBROMOCHLOROMETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 75-71-8 | DICHLORODIFLUOROMETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 100-41-4 | ETHYLBENZENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 1330-20-7 | M- AND P-XYLENE | | 3 | 1 | 0.02 | 0.02 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.015 | 0.03 | MG_KG | 1998/07/14 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 75-09-2 | METHYLENE CHLORIDE | | 4 | 3 | 0.002 | 0.021 | MG_KG | 1995/05/17 | 1998/07/14 | 1 | 0.017 | 0.017 | MG_KG | 1998/07/14 | 1998/07/14 | 0.0200 |
| S | Soil | VOA | 108-38-3 | M-XYLENE | | 1 | | | | MG_KG | | | 1 | 0.001 | 0.001 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00200 |
| S | Soil | VOA | 95-47-6 | O-XYLENE | | 4 | 1 | 0.01 | 0.01 | MG_KG | 1998/07/14 | 1998/07/14 | 3 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 100-42-5 | STYRENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 127-18-4 | TETRACHLOROETHENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 108-88-3 | TOLUENE | | 4 | 3 | 0.012 | 0.045 | MG_KG | 1998/07/14 | 1998/07/14 | 1 | 0.001 | 0.001 | MG_KG | 1995/05/17 | 1995/05/17 | 0.00300 |
| S | Soil | VOA | 156-60-5 | TRANS-1,2-DICHLOROETHENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 10061-02-6 | TRANS-1,3-DICHLOROPROPENE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Soil | VOA | 79-01-6 | TRICHLOROETHENE | | 4 | 1 | 0.007 | 0.007 | MG_KG | 1998/07/14 | 1998/07/14 | 3 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 75-69-4 | TRICHLOROFLUOROMETHANE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 108-05-4 | VINYL ACETATE | | 1 | | | | MG_KG | | | 1 | 0.001 | 0.001 | MG_KG | 1995/05/17 | 1995/05/17 | 0 |
| S | Soil | VOA | 75-01-4 | VINYL CHLORIDE | | 4 | | | | MG_KG | | | 4 | 0.001 | 0.03 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00100 |
| S | Soil | VOA | 1330-20-7 | XYLENES, TOTAL | | 3 | 1 | 0.03 | 0.03 | MG_KG | 1998/07/14 | 1998/07/14 | 2 | 0.001 | 0.015 | MG_KG | 1995/05/17 | 1998/07/14 | 0.00200 |
| S | Sub-surface soil ( > 6") | HERB | 93-76-5 | 2,4,5-T | | 1 | | | | MG_KG | | | 1 | 0.047 | 0.047 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 94-75-7 | 2,4-D | | 1 | | | | MG_KG | | | 1 | 0.28 | 0.28 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 75-99-0 | DALAPON | | 1 | | | | MG_KG | | | 1 | 1.4 | 1.4 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 1918-00-9 | DICAMBA | | 1 | | | | MG_KG | | | 1 | 0.063 | 0.063 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 120-36-5 | DICHLOROPROP | | 1 | | | | MG_KG | | | 1 | 0.15 | 0.15 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 94-74-6 | MCPA | | 1 | | | | MG_KG | | | 1 | 58 | 58 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 93-65-2 | MCPP | | 1 | | | | MG_KG | | | 1 | 45 | 45 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 93-72-1 | SILVEX | | 1 | | | | MG_KG | | | 1 | 0.04 | 0.04 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | INO | 57-12-5 | CYANIDE | | 39 | 15 | 0.1 | 8.7 | MG_KG | 1990/06/21 | 1999/03/04 | 24 | 0.05 | 1.1 | MG_KG | 1990/06/21 | 1999/03/05 | 50 |
| S | Sub-surface soil ( > 6") | MET | 7429-90-5 | ALUMINUM | | 177 | 177 | 2270 | 76500 | MG_KG | 1990/06/21 | 1999/03/08 | | | | | | | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-36-0 | ANTIMONY | | 146 | 34 | 2.3 | 205 | MG_KG | 1996/06/10 | 1999/03/05 | 112 | 1.8 | 13.7 | MG_KG | 1991/06/12 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-38-2 | ARSENIC | HH | 179 | 176 | 0.49 | 35.8 | MG_KG | 1990/06/21 | 1999/03/08 | 3 | 0.001 | 9.3 | MG_KG | 1990/06/21 | 1991/06/12 | 0.992 |
| S | Sub-surface soil ( > 6") | MET | 7440-39-3 | BARIUM | | 162 | 162 | 8.1 | 256 | MG_KG | 1991/04/02 | 1999/03/08 | | | | | | | 0.316 |
| S | Sub-surface soil ( > 6") | MET | 7440-41-7 | BERYLLIUM | | 146 | 142 | 0.11 | 0.86 | MG_KG | 1992/06/16 | 1999/03/08 | 4 | 0.17 | 0.23 | MG_KG | 1991/06/12 | 1992/07/03 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-43-9 | CADMIUM | HH | 199 | 145 | 0.24 | 3480 | MG_KG | 1990/06/21 | 1999/03/05 | 54 | 0.002 | 0.46 | MG_KG | 1990/06/21 | 1999/03/08 | 0.196 |
| S | Sub-surface soil ( > 6") | MET | 7440-70-2 | CALCIUM | | 146 | 146 | 347 | 41300 | MG_KG | 1991/06/12 | 1999/03/08 | | | | | | | 0 |
| S | Sub-surface soil ( > 6") | MET | 18540-29-9 | CHROMIUM VI | | 23 | 21 | 0.005 | 2.9 | MG_KG | 1992/06/16 | 1995/05/17 | 2 | 0.01 | 0.01 | MG_KG | 1992/06/16 | 1992/06/16 | 0 |

**Appendix C: Screening Level Data Summary**

**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Soil | VOA | 78-87-5 | 1,2-DICHLOROPROPANE | No | 0 | 0 | 0.001 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 542-75-6 | 1,3-DICHLOROPROPENE, TOTAL | No | 0 | 0 | 0.00014 | MTCA PRO GW SAT | | No | SAMPLE GW | 0 | YES | 0 |
| S | Soil | VOA | 78-93-3 | 2-BUTANONE | No | 0 | 0 | 1.4 | MTCA PRO GW SAT | | No | MAX<ARAR | n | n | 0 |
| S | Soil | VOA | 110-75-8 | 2-CHLOROETHYL VINYL ETHER | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | VOA | 591-78-6 | 2-HEXANONE | No | 0 | 0 | 0.012 | MTCA PRO GW SAT | | No | PAST RL>ARAR BUT NOT IN SB | 0 | YES | 0 |
| S | Soil | VOA | 108-10-1 | 4-METHYL-2-PENTANONE | No | 0 | 0 | 0.19 | MTCA PRO GW SAT | | No | MAX<ARAR | n | n | 0 |
| S | Soil | VOA | 67-64-1 | ACETONE | Yes | 80 | MTCA B PRO DW | 2.1 | MTCA PRO GW SAT | | No | MAX<ARAR | n | n | 0 |
| S | Soil | VOA | 71-43-2 | BENZENE | Yes | 0.5 | MTCA B PRO DW | 0.00056 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 75-27-4 | BROMODICHLOROMETHANE | No | 0 | 0 | 0.00089 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 75-25-2 | BROMOFORM | No | 0 | 0 | 0.005 | MTCA PRO GW TO MW SAT | | Yes | Not above lowest ARAR in SW | 0 | YES | YES |
| S | Soil | VOA | 74-83-9 | BROMOMETHANE | No | 0 | 0 | 0.0033 | MTCA PRO GW SAT | | Yes | GW Not impacted | 0 | YES | YES |
| S | Soil | VOA | -71 | BTEX, TOTAL | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | VOA | 75-15-0 | CARBON DISULFIDE | No | 0 | 0 | 0.25 | MTCA PRO GW SAT | | Yes | PAST RL<ARAR | 0 | n | 0 |
| S | Soil | VOA | 56-23-5 | CARBON TETRACHLORIDE | Yes | 0.034 | MTCA B PRO DW | 0.00015 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 108-90-7 | CHLOROBENZENE | No | 0 | 0 | 0.051 | MTCA PRO GW SAT | | Yes | PAST RL<ARAR | 0 | n | YES |
| S | Soil | VOA | 75-00-3 | CHLOROETHANE | No | 0 | 0 | 0 | 0 | | Yes | Max RL>ARAR | 0 | 0 | 0 |
| S | Soil | VOA | 67-66-3 | CHLOROFORM | Yes | 0.72 | MTCA B PRO DW | 0.0048 | MTCA PRO GW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 74-87-3 | CHLOROMETHANE | No | 0 | 0 | 0 | 0 | | Yes | Max RL>ARAR | 0 | 0 | 0 |
| S | Soil | VOA | 156-59-2 | CIS-1,2-DICHLOROETHENE | Yes | 7 | MTCA B PRO DW | 0.0052 | MTCA PRO GW SAT | | Yes | Not above lowest ARAR in SW | 0 | YES | YES |
| S | Soil | VOA | 10061-01-5 | CIS-1,3-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | VOA | 124-48-1 | DIBROMOCHLOROMETHANE | No | 0 | 0 | 0.0007 | MTCA PRO GW TO MW SAT | | Yes | GW Not impacted | 0 | YES | YES |
| S | Soil | VOA | 75-71-8 | DICHLORODIFLUOROMETHANE | No | 0 | 0 | 0.53 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | YES |
| S | Soil | VOA | 100-41-4 | ETHYLBENZENE | Yes | 70 | MTCA B PRO DW | 0.01 | MTCA PRO GW TO MW SAT | | Yes | | 0 | YES | YES |
| S | Soil | VOA | 1330-20-7 | M- AND P-XYLENE | Yes | 1000 | MTCA B PRO DW | 0.055 | MTCA PRO GW TO MW SAT | | No | MAX<ARAR | n | n | YES |
| S | Soil | VOA | 75-09-2 | METHYLENE CHLORIDE | No | 0 | 0 | 0.0015 | MTCA PRO GW SAT | | Yes | | YES | YES | YES |
| S | Soil | VOA | 108-38-3 | M-XYLENE | No | 0 | 0 | 0.77 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | YES |
| S | Soil | VOA | 95-47-6 | O-XYLENE | No | 0 | 0 | 0.84 | MTCA PRO GW SAT | | No | MAX<ARAR | n | n | YES |
| S | Soil | VOA | 100-42-5 | STYRENE | Yes | 0.15 | MTCA B PRO DW | 0.12 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | YES |
| S | Soil | VOA | 127-18-4 | TETRACHLOROETHENE | Yes | 0.5 | MTCA B PRO DW | 0.0016 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 108-88-3 | TOLUENE | Yes | 100 | MTCA B PRO DW | 0.044 | MTCA PRO GW TO MW SAT | | Yes | | YES | n | YES |
| S | Soil | VOA | 156-60-5 | TRANS-1,2-DICHLOROETHENE | Yes | 10 | MTCA B PRO DW | 0.032 | MTCA PRO GW TO MW SAT | | Yes | Possible GW Presence | 0 | n | YES |
| S | Soil | VOA | 10061-02-6 | TRANS-1,3-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 | | No | No current ARAR, all ND | 0 | 0 | 0 |
| S | Soil | VOA | 79-01-6 | TRICHLOROETHENE | Yes | 0.5 | MTCA B PRO DW | 0.00027 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | YES | YES | YES |
| S | Soil | VOA | 75-69-4 | TRICHLOROFLUOROMETHANE | No | 0 | 0 | 0.79 | MTCA PRO GW SAT | | Yes | PAST RL<ARAR | 0 | n | YES |
| S | Soil | VOA | 108-05-4 | VINYL ACETATE | No | 0 | 0 | 2.3 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | 0 |
| S | Soil | VOA | 75-01-4 | VINYL CHLORIDE | No | 0 | 0 | 0.000056 | MTCA PRO GW TO MW SAT | | Yes | SAMPLE GW | 0 | YES | YES |
| S | Soil | VOA | 1330-20-7 | XYLENES, TOTAL | Yes | 1000 | MTCA B PRO DW | 0.055 | MTCA PRO GW TO MW SAT | | Yes | MAX<ARAR | n | n | YES |
| S | Sub-surface soil ( > 6") | HERB | 93-76-5 | 2,4,5-T | No | 0 | 0 | 0.063 | MTCA PRO GW | | No | PAST RL<ARAR | 0 | n | 0 |
| S | Sub-surface soil ( > 6") | HERB | 94-75-7 | 2,4-D | No | 0 | 0 | 0.022 | MTCA PRO GW SAT | | No | | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | HERB | 75-99-0 | DALAPON | No | 0 | 0 | 0.058 | MTCA PRO GW SAT | | No | | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | HERB | 1918-00-9 | DICAMBA | No | 0 | 0 | 0.15 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | 0 |
| S | Sub-surface soil ( > 6") | HERB | 120-36-5 | DICHLOROPROP | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | HERB | 94-74-6 | MCPA | No | 0 | 0 | 0.0025 | MTCA PRO GW SAT | | No | | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | HERB | 93-65-2 | MCPP | No | 0 | 0 | 0.0054 | MTCA PRO GW SAT | | No | | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | HERB | 93-72-1 | SILVEX | No | 0 | 0 | 0.023 | MTCA PRO GW SAT | | No | | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | INO | 57-12-5 | CYANIDE | Yes | 0.1 | MTCA B PRO SW | 0.01 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | MET | 7429-90-5 | ALUMINUM | No | 0 | 0 | 24000 | MTCA PRO GW SAT | | No | Naturally occurring, not considered a risk driver | YES | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-36-0 | ANTIMONY | No | 0 | 0 | 0.27 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-38-2 | ARSENIC | Yes | 0.005 | MTCA B PRO DW | 0.15 | MTCA PRO GW TO MW SAT | | No | | YES | YES | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-39-3 | BARIUM | Yes | 100 | MTCA B PRO DW | 83 | MTCA PRO GW SAT | | No | GW Not impacted | YES | 0 | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-41-7 | BERYLLIUM | No | 0 | 0 | 3.2 | MTCA PRO GW SAT | | No | MAX<ARAR | n | n | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-43-9 | CADMIUM | Yes | 0.5 | MTCA B PRO DW | 0.035 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-70-2 | CALCIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 18540-29-9 | CHROMIUM VI | Yes | 5 | MTCA B PRO SW | 0.00089 | MTCA PRO GW SAT | after 2000 | No | SAMPLE GW | YES | YES | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | MET | 16065-83-1 | CHROMIUM, TOTAL (7440-47-3) | HH | 199 | 197 | 3.9 | 962 | MG_KG | 1990/06/21 | 1999/03/08 | 2 | 0.013 | 0.013 | MG_KG | 1990/06/21 | 1990/06/21 | 0.372 |
| S | Sub-surface soil ( > 6") | MET | 7440-48-4 | COBALT |  | 146 | 146 | 2 | 57.4 | MG_KG | 1991/06/12 | 1999/03/08 |  |  |  |  |  |  | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-50-8 | COPPER |  | 179 | 179 | 0.011 | 2250 | MG_KG | 1990/06/21 | 1999/03/08 |  |  |  |  |  |  | 1.5 |
| S | Sub-surface soil ( > 6") | MET | 7439-89-6 | IRON |  | 161 | 161 | 2510 | 158000 | MG_KG | 1990/06/21 | 1999/03/08 |  |  |  |  |  |  | 0 |
| S | Sub-surface soil ( > 6") | MET | 7439-92-1 | LEAD | HH | 179 | 177 | 0.003 | 7520 | MG_KG | 1990/06/21 | 1999/03/08 | 2 | 2.1 | 2.7 | MG_KG | 1991/04/04 | 1991/06/12 | 0.880 |
| S | Sub-surface soil ( > 6") | MET | 7439-95-4 | MAGNESIUM |  | 146 | 146 | 669 | 23900 | MG_KG | 1991/06/12 | 1999/03/08 |  |  |  |  |  |  | 0 |
| S | Sub-surface soil ( > 6") | MET | 7439-96-5 | MANGANESE |  | 146 | 146 | 62.1 | 2130 | MG_KG | 1991/06/12 | 1999/03/08 |  |  |  |  |  |  | 0 |
| S | Sub-surface soil ( > 6") | MET | 7439-97-6 | MERCURY | HH | 179 | 68 | 0.03 | 1.9 | MG_KG | 1990/06/21 | 1999/03/08 | 111 | 0.0002 | 0.14 | MG_KG | 1990/06/21 | 1999/03/04 | 0.0170 |
| S | Sub-surface soil ( > 6") | MET | 7440-02-0 | NICKEL |  | 179 | 177 | 8.03 | 427 | MG_KG | 1990/06/21 | 1999/03/08 | 2 | 0.012 | 0.012 | MG_KG | 1990/06/21 | 1990/06/21 | 0.5 |
| S | Sub-surface soil ( > 6") | MET | 7440-09-7 | POTASSIUM |  | 146 | 145 | 315 | 5600 | MG_KG | 1992/06/16 | 1999/03/08 | 1 | 152 | 152 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7782-49-2 | SELENIUM |  | 152 | 10 | 0.16 | 0.75 | MG_KG | 1998/04/09 | 1999/01/27 | 142 | 0.0015 | 6.7 | MG_KG | 1990/06/21 | 1999/03/08 | 1.58 |
| S | Sub-surface soil ( > 6") | MET | 7440-22-4 | SILVER |  | 179 | 18 | 0.56 | 3.7 | MG_KG | 1990/06/21 | 1998/05/12 | 161 | 0.011 | 2.6 | MG_KG | 1990/06/21 | 1999/03/08 | 2.24 |
| S | Sub-surface soil ( > 6") | MET | 7440-23-5 | SODIUM |  | 146 | 145 | 96.2 | 2420 | MG_KG | 1992/06/16 | 1999/03/08 | 1 | 116 | 116 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-28-0 | THALLIUM |  | 146 | 19 | 0.08 | 0.59 | MG_KG | 1992/06/16 | 1999/01/27 | 127 | 0.02 | 12.1 | MG_KG | 1991/06/12 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-31-5 | TIN | HH | 27 | 12 | 3.7 | 57.7 | MG_KG | 1991/04/02 | 1991/04/04 | 15 | 3.9 | 75.6 | MG_KG | 1991/04/04 | 1996/06/12 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-62-2 | VANADIUM |  | 146 | 146 | 5 | 110 | MG_KG | 1991/06/12 | 1999/03/08 |  |  |  |  |  |  | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-66-6 | ZINC |  | 180 | 177 | 18.3 | 1750 | MG_KG | 1990/06/21 | 1999/03/08 | 3 | 0.007 | 5.9 | MG_KG | 1990/06/21 | 1991/06/12 | 1.5 |
| S | Sub-surface soil ( > 6") | ORD | 6423-43-4 | PROPYLENE GLYCOL DINITRATE |  | 1 |  |  |  | MG_KG |  |  | 1 | 0.000136 | 0.000136 | MG_KG | 1991/06/12 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 72-54-8 | 4,4-DDD |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 72-55-9 | 4,4-DDE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 50-29-3 | 4,4-DDT |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 309-00-2 | ALDRIN |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 319-84-6 | ALPHA-BHC |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000400 |
| S | Sub-surface soil ( > 6") | P_A | 12789-03-6 | ALPHA-CHLORDANE (5103-71-9) |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.083 | 0.13 | MG_KG | 1991/04/03 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 12674-11-2 | AROCLOR-1016 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.13 | MG_KG | 1991/04/03 | 1996/06/07 | 0.0150 |
| S | Sub-surface soil ( > 6") | P_A | 11104-28-2 | AROCLOR-1221 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.13 | MG_KG | 1991/04/03 | 1996/06/07 | 0.0100 |
| S | Sub-surface soil ( > 6") | P_A | 11141-16-5 | AROCLOR-1232 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.13 | MG_KG | 1991/04/03 | 1996/06/07 | 0.0100 |
| S | Sub-surface soil ( > 6") | P_A | 53469-21-9 | AROCLOR-1242 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.13 | MG_KG | 1991/04/03 | 1996/06/07 | 0.0100 |
| S | Sub-surface soil ( > 6") | P_A | 12672-29-6 | AROCLOR-1248 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.13 | MG_KG | 1991/04/03 | 1996/06/07 | 0.00600 |
| S | Sub-surface soil ( > 6") | P_A | 11097-69-1 | AROCLOR-1254 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.26 | MG_KG | 1991/04/03 | 1996/06/07 | 0.0100 |
| S | Sub-surface soil ( > 6") | P_A | 11096-82-5 | AROCLOR-1260 |  | 8 |  |  |  | MG_KG |  |  | 8 | 0.039 | 0.26 | MG_KG | 1991/04/03 | 1996/06/07 | 0.0150 |
| S | Sub-surface soil ( > 6") | P_A | 319-85-7 | BETA-BHC |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 319-86-8 | DELTA-BHC |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 60-57-1 | DIELDRIN |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 959-98-8 | ENDOSULFAN I |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 33213-65-9 | ENDOSULFAN II |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 1031-07-8 | ENDOSULFAN SULFATE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 72-20-8 | ENDRIN |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.00150 |
| S | Sub-surface soil ( > 6") | P_A | 53494-70-5 | ENDRIN KETONE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.017 | 0.026 | MG_KG | 1991/04/03 | 1991/06/12 | 0.00150 |
| S | Sub-surface soil ( > 6") | P_A | 5566-34-7 | GAMMA-CHLORDANE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.083 | 0.13 | MG_KG | 1991/04/03 | 1991/06/12 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 76-44-8 | HEPTACHLOR |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000400 |
| S | Sub-surface soil ( > 6") | P_A | 1024-57-3 | HEPTACHLOR EPOXIDE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 58-89-9 | LINDANE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.0083 | 0.013 | MG_KG | 1991/04/03 | 1991/06/12 | 0.00150 |
| S | Sub-surface soil ( > 6") | P_A | 72-43-5 | METHOXYCHLOR |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.083 | 0.13 | MG_KG | 1991/04/03 | 1991/06/12 | 0.000750 |
| S | Sub-surface soil ( > 6") | P_A | 1336-36-3 | PCB, TOTAL |  | 1 |  |  |  | MG_KG |  |  | 1 | 0.039 | 0.039 | MG_KG | 1996/06/07 | 1996/06/07 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 8001-35-2 | TOXAPHENE |  | 7 |  |  |  | MG_KG |  |  | 7 | 0.17 | 0.26 | MG_KG | 1991/04/03 | 1991/06/12 | 0.0800 |
| W | Ground water | SVOA | 106-46-7 | 1,4-DICHLOROBENZENE |  | 15 |  |  |  | UG_L |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00200 |
| W | Ground water | VOA | 106-46-7 | 1,4-DICHLOROBENZENE |  | 38 |  |  |  | UG_L |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00200 |
| S | Sub-surface soil ( > 6") | SVOA | 108-60-1 | 2,2'-OXYBIS(1-CHLOROPROPANE) |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 95-95-4 | 2,4,5-TRICHLOROPHENOL |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 88-06-2 | 2,4,6-TRICHLOROPHENOL |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 120-83-2 | 2,4-DICHLOROPHENOL |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 105-67-9 | 2,4-DIMETHYLPHENOL |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 51-28-5 | 2,4-DINITROPHENOL |  | 13 |  |  |  | MG_KG |  |  | 13 | 0.94 | 4.9 | MG_KG | 1991/06/12 | 1999/01/27 | 1.20 |
| S | Sub-surface soil ( > 6") | SVOA | 121-14-2 | 2,4-DINITROTOLUENE |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.100 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | MET | 16065-83-1 | CHROMIUM, TOTAL (7440-47-3) | Yes | 1600 | MTCA B PRO DW | 2000 | MTCA A |  | No | MAX<ARAR | n | n | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-48-4 | COBALT | No | 0 | 0 | 0.22 | MTCA PRO GW SAT |  | No |  | YES | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-50-8 | COPPER | Yes | 0.25 | MTCA B PRO SW | 0.069 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | 0 | YES |
| S | Sub-surface soil ( > 6") | MET | 7439-89-6 | IRON | No | 0 | 0 | 280 | MTCA PRO GW SAT |  | No | Naturally occurring | YES | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7439-92-1 | LEAD | Yes | 0.58 | MTCA B PRO SW | 56 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | n | YES |
| S | Sub-surface soil ( > 6") | MET | 7439-95-4 | MAGNESIUM | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7439-96-5 | MANGANESE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7439-97-6 | MERCURY | Yes | 0.0025 | MTCA B PRO SW | 0.0013 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-02-0 | NICKEL | Yes | 0.79 | MTCA B PRO SW | 0.54 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | n | n |
| S | Sub-surface soil ( > 6") | MET | 7440-09-7 | POTASSIUM | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7782-49-2 | SELENIUM | No | 0 | 0 | 0.26 | MTCA PRO GW SAT |  | No |  | YES | YES | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-22-4 | SILVER | Yes | 0.12 | MTCA B PRO SW | 0.016 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | MET | 7440-23-5 | SODIUM | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-28-0 | THALLIUM | Yes | 0.11 | MTCA B PRO DW | 0.011 | MTCA PRO GW SAT |  | No | SAMPLE GW | YES | YES | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-31-5 | TIN | Yes | 960 | MTCA B PRO DW | 2400 | MTCA PRO GW SAT |  | No | MAX<ARAR | n | n | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-62-2 | VANADIUM | No | 0 | 0 | 80 | MTCA PRO GW SAT |  | No | SAMPLE GW | YES | 0 | 0 |
| S | Sub-surface soil ( > 6") | MET | 7440-66-6 | ZINC | Yes | 7.7 | MTCA B PRO SW | 5 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | n |
| S | Sub-surface soil ( > 6") | ORD | 6423-43-4 | PROPYLENE GLYCOL DINITRATE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 72-54-8 | 4,4-DDD | No | 0 | 0 | 0.00000036 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 72-55-9 | 4,4-DDE | No | 0 | 0 | 0.000000076 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 50-29-3 | 4,4-DDT | No | 0 | 0 | 0.00000081 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 309-00-2 | ALDRIN | No | 0 | 0 | 0.000000002 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 319-84-6 | ALPHA-BHC | No | 0 | 0 | 0.000000098 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 12789-03-6 | ALPHA-CHLORDANE (5103-71-9) | No | 0 | 0 | 0.0000011 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | P_A | 12674-11-2 | AROCLOR-1016 | No | 0 | 0 | 0.00032 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 11104-28-2 | AROCLOR-1221 | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 11141-16-5 | AROCLOR-1232 | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 53469-21-9 | AROCLOR-1242 | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 12672-29-6 | AROCLOR-1248 | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 11097-69-1 | AROCLOR-1254 | No | 0 | 0 | 0.000014 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 11096-82-5 | AROCLOR-1260 | No | 0 | 0 | 0.018 | MTCA PRO GW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 319-85-7 | BETA-BHC | No | 0 | 0 | 0.0000034 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 319-86-8 | DELTA-BHC | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 60-57-1 | DIELDRIN | No | 0 | 0 | 1.8E-09 | MTCA PRO GW TO MW SAT |  | No | SD NOT IMPACTED | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 959-98-8 | ENDOSULFAN I | No | 0 | 0 | 0.000061 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 33213-65-9 | ENDOSULFAN II | No | 0 | 0 | 0.000061 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 1031-07-8 | ENDOSULFAN SULFATE | No | 0 | 0 | 0.1 | MTCA PRO GW TO MW SAT |  | No | PAST RL<ARAR | 0 | n | YES |
| S | Sub-surface soil ( > 6") | P_A | 72-20-8 | ENDRIN | No | 0 | 0 | 0.000022 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 53494-70-5 | ENDRIN KETONE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 5566-34-7 | GAMMA-CHLORDANE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | P_A | 76-44-8 | HEPTACHLOR | No | 0 | 0 | 3.3E-09 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 1024-57-3 | HEPTACHLOR EPOXIDE | No | 0 | 0 | 0.000000025 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 58-89-9 | LINDANE | No | 0 | 0 | 0.00026 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 72-43-5 | METHOXYCHLOR | No | 0 | 0 | 0.0016 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | P_A | 1336-36-3 | PCB, TOTAL | No | 0 | 0 | 0.00000055 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | P_A | 8001-35-2 | TOXAPHENE | No | 0 | 0 | 0.0000031 | MTCA PRO GW TO MW SAT |  | No |  | 0 | YES | YES |
| W | Ground water | SVOA | 106-46-7 | 1,4-DICHLOROBENZENE | No | 0 | 0 | 0.0013 | MTCA PRO GW TO MW SAT |  | No | PAST GW RL APPROX ARAR | 0 | YES | YES |
| W | Ground water | VOA | 106-46-7 | 1,4-DICHLOROBENZENE | No | 0 | 0 | 0.068 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 108-60-1 | 2,2'-OXYBIS(1-CHLOROPROPANE) | No | 0 | 0 | 0.00023 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 95-95-4 | 2,4,5-TRICHLOROPHENOL | No | 0 | 0 | 1.1 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 88-06-2 | 2,4,6-TRICHLOROPHENOL | No | 0 | 0 | 0.00019 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 120-83-2 | 2,4-DICHLOROPHENOL | No | 0 | 0 | 0.0043 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 105-67-9 | 2,4-DIMETHYLPHENOL | No | 0 | 0 | 0.076 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 51-28-5 | 2,4-DINITROPHENOL | No | 0 | 0 | 0.0092 | MTCA PRO GW SAT |  | No | PAST GW RL APPROX ARAR | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 121-14-2 | 2,4-DINITROTOLUENE | No | 0 | 0 | 0.00016 | MTCA PRO GW TO MW SAT |  | No | 29 ND Samples | 0 | YES | YES |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | SVOA | 606-20-2 | 2,6-DINITROTOLUENE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 91-58-7 | 2-CHLORONAPHTHALENE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 95-57-8 | 2-CHLOROPHENOL | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 91-57-6 | 2-METHYLNAPHTHALENE | | 39 | 13 | 0.0182 | 156 | MG_KG | 1998/05/27 | 1999/01/26 | 26 | 0.01 | 0.77 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00300 |
| S | Sub-surface soil ( > 6") | SVOA | 95-48-7 | 2-METHYLPHENOL | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 88-74-4 | 2-NITROANILINE | | 29 | | | | MG_KG | | | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 88-75-5 | 2-NITROPHENOL | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 91-94-1 | 3,3-DICHLOROBENZIDINE | | 29 | | | | MG_KG | | | 29 | 0.38 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.200 |
| S | Sub-surface soil ( > 6") | SVOA | 99-09-2 | 3-NITROANILINE | | 29 | | | | MG_KG | | | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.200 |
| S | Sub-surface soil ( > 6") | SVOA | 534-52-1 | 4,6-DINITRO-2-METHYLPHENOL | | 29 | | | | MG_KG | | | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.400 |
| S | Sub-surface soil ( > 6") | SVOA | 101-55-3 | 4-BROMOPHENYL-PHENYLETHER | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 59-50-7 | 4-CHLORO-3-METHYLPHENOL | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 106-47-8 | 4-CHLOROANILINE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.200 |
| S | Sub-surface soil ( > 6") | SVOA | 7005-72-3 | 4-CHLOROPHENYL-PHENYLETHER | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 106-44-5 | 4-METHYLPHENOL | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 100-01-6 | 4-NITROANILINE | | 29 | | | | MG_KG | | | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 100-02-7 | 4-NITROPHENOL | | 29 | | | | MG_KG | | | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.400 |
| S | Sub-surface soil ( > 6") | SVOA | 83-32-9 | ACENAPHTHENE | | 39 | 7 | 0.01 | 9.33 | MG_KG | 1998/05/27 | 1999/01/25 | 32 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 208-96-8 | ACENAPHTHYLENE | | 39 | 5 | 0.01 | 2.87 | MG_KG | 1998/05/27 | 1999/01/25 | 34 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 120-12-7 | ANTHRACENE | | 39 | 8 | 0.01 | 15.6 | MG_KG | 1998/05/27 | 1999/01/25 | 31 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 56-55-3 | BENZO[A]ANTHRACENE | | 39 | 10 | 0.01 | 12.9 | MG_KG | 1998/05/27 | 1999/01/25 | 29 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00400 |
| S | Sub-surface soil ( > 6") | SVOA | 50-32-8 | BENZO[A]PYRENE | | 39 | 9 | 0.008 | 6.1 | MG_KG | 1998/05/27 | 1999/01/25 | 30 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00300 |
| S | Sub-surface soil ( > 6") | SVOA | 205-99-2 | BENZO[B]FLUORANTHENE | | 39 | 7 | 0.01 | 3.23 | MG_KG | 1998/05/27 | 1999/01/25 | 32 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00300 |
| S | Sub-surface soil ( > 6") | SVOA | 191-24-2 | BENZO[G,H,I]PERYLENE | | 39 | 8 | 0.01 | 2 | MG_KG | 1998/05/27 | 1999/01/25 | 31 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 207-08-9 | BENZO[K]FLUORANTHENE | | 39 | 2 | 0.01 | 0.01 | MG_KG | 1999/01/14 | 1999/01/25 | 37 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 56832-73-6 | BENZOFLUORANTHENE | | 14 | 3 | 0.02 | 0.501 | MG_KG | 1998/12/07 | 1999/01/25 | 11 | 0.01 | 2 | MG_KG | 1998/12/07 | 1999/01/27 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 65-85-0 | BENZOIC ACID | | 1 | | | | MG_KG | | | 1 | 1.8 | 1.8 | MG_KG | 1991/04/02 | 1991/04/02 | 2.00 |
| S | Sub-surface soil ( > 6") | SVOA | 100-51-6 | BENZYL ALCOHOL | | 17 | | | | MG_KG | | | 17 | 0.33 | 0.77 | MG_KG | 1991/04/02 | 1991/06/12 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 111-91-1 | BIS(2-CHLOROETHOXY)METHANE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0500 |
| S | Sub-surface soil ( > 6") | SVOA | 111-44-4 | BIS(2-CHLOROETHYL)ETHER | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 117-81-7 | BIS(2-ETHYLHEXYL)PHTHALATE | | 29 | 22 | 0.013 | 0.44 | MG_KG | 1991/04/02 | 1999/01/27 | 7 | 0.025 | 0.77 | MG_KG | 1991/04/03 | 1999/01/26 | 0.200 |
| S | Sub-surface soil ( > 6") | SVOA | 85-68-7 | BUTYLBENZYLPHTHALATE | | 29 | 1 | 0.083 | 0.083 | MG_KG | 1991/04/04 | 1991/04/04 | 28 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 86-74-8 | CARBAZOLE | | 13 | | | | MG_KG | | | 13 | 0.38 | 2 | MG_KG | 1991/06/12 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 218-01-9 | CHRYSENE | | 39 | 10 | 0.01 | 17 | MG_KG | 1998/05/27 | 1999/01/25 | 29 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00300 |
| S | Sub-surface soil ( > 6") | SVOA | -61 | CPAH, TOTAL | | 14 | 4 | 0.047 | 7.66 | MG_KG | 1998/12/07 | 1999/01/25 | 10 | 0.01 | 2 | MG_KG | 1998/12/07 | 1999/01/27 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 53-70-3 | DIBENZ[A,H]ANTHRACENE | | 39 | 2 | 0.01 | 0.01 | MG_KG | 1999/01/14 | 1999/01/25 | 37 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 132-64-9 | DIBENZOFURAN | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 84-66-2 | DIETHYLPHTHALATE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0500 |
| S | Sub-surface soil ( > 6") | SVOA | 131-11-3 | DIMETHYL PHTHALATE | | 29 | 1 | 0.034 | 0.034 | MG_KG | 1991/04/02 | 1991/04/02 | 28 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | 84-74-2 | DI-N-BUTYLPHTHALATE | | 29 | 5 | 0.014 | 3.1 | MG_KG | 1991/04/02 | 1999/01/25 | 24 | 0.049 | 2 | MG_KG | 1991/04/03 | 1999/01/27 | 0.100 |
| S | Sub-surface soil ( > 6") | SVOA | 117-84-0 | DI-N-OCTYLPHTHALATE | | 29 | 2 | 0.046 | 0.085 | MG_KG | 1991/04/02 | 1991/04/04 | 27 | 0.016 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 206-44-0 | FLUORANTHENE | | 39 | 12 | 0.01 | 6.1 | MG_KG | 1998/05/27 | 1999/01/25 | 27 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00300 |
| S | Sub-surface soil ( > 6") | SVOA | 86-73-7 | FLUORENE | | 39 | 8 | 0.01 | 17.8 | MG_KG | 1998/05/27 | 1999/01/25 | 31 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 118-74-1 | HEXACHLOROBENZENE | | 25 | | | | MG_KG | | | 25 | 0.33 | 2 | MG_KG | 1991/04/03 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 87-68-3 | HEXACHLOROBUTADIENE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00200 |
| S | Sub-surface soil ( > 6") | SVOA | 77-47-4 | HEXACHLOROCYCLOPENTADIENE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 67-72-1 | HEXACHLOROETHANE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0150 |
| S | Sub-surface soil ( > 6") | SVOA | -63 | HPAH, TOTAL | | 15 | 5 | 0.000102 | 20.069 | MG_KG | 1998/12/07 | 1999/01/25 | 10 | 0.01 | 2 | MG_KG | 1998/12/07 | 1999/01/27 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 193-39-5 | INDENO[1,2,3-CD]PYRENE | | 39 | 3 | 0.01 | 0.219 | MG_KG | 1998/12/07 | 1999/01/25 | 36 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00150 |
| S | Sub-surface soil ( > 6") | SVOA | 78-59-1 | ISOPHORONE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | -64 | LPAH, TOTAL | | 15 | 7 | 0.011 | 19.637 | MG_KG | 1998/12/07 | 1999/01/26 | 8 | 0.01 | 0.41 | MG_KG | 1998/12/07 | 1999/01/27 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 91-20-3 | NAPHTHALENE | | 39 | 11 | 0.011 | 17.1 | MG_KG | 1998/05/27 | 1999/01/26 | 28 | 0.01 | 0.77 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00400 |
| S | Sub-surface soil ( > 6") | SVOA | -150 | NCPAH, TOTAL | | 14 | 6 | 0.011 | 36.586 | MG_KG | 1998/12/07 | 1999/01/26 | 8 | 0.01 | 0.41 | MG_KG | 1998/12/07 | 1999/01/27 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 98-95-3 | NITROBENZENE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0500 |
| S | Sub-surface soil ( > 6") | SVOA | 621-64-7 | N-NITROSODINPROPYLAMINE | | 29 | | | | MG_KG | | | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0500 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | SVOA | 606-20-2 | 2,6-DINITROTOLUENE | No | 0 | 0 | 0.000051 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 91-58-7 | 2-CHLORONAPHTHALENE | No | 0 | 0 | 0.28 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 95-57-8 | 2-CHLOROPHENOL | No | 0 | 0 | 0.011 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 91-57-6 | 2-METHYLNAPHTHALENE | No | 0 | 0 | 0.088 | MTCA PRO GW SAT |  | No | MAX>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 95-48-7 | 2-METHYLPHENOL | No | 0 | 0 | 0.47 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 88-74-4 | 2-NITROANILINE | No | 0 | 0 | 0.064 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 88-75-5 | 2-NITROPHENOL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 91-94-1 | 3,3-DICHLOROBENZIDINE | No | 0 | 0 | 0.000011 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 99-09-2 | 3-NITROANILINE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 534-52-1 | 4,6-DINITRO-2-METHYLPHENOL | No | 0 | 0 | 0.0013 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 101-55-3 | 4-BROMOPHENYL-PHENYLETHER | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 59-50-7 | 4-CHLORO-3-METHYLPHENOL | No | 0 | 0 | 0.028 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 106-47-8 | 4-CHLOROANILINE | No | 0 | 0 | 0.00017 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 7005-72-3 | 4-CHLOROPHENYL-PHENYLETHER | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 106-44-5 | 4-METHYLPHENOL | No | 0 | 0 | 0.94 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 100-01-6 | 4-NITROANILINE | No | 0 | 0 | 0.0017 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 100-02-7 | 4-NITROPHENOL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 83-32-9 | ACENAPHTHENE | No | 0 | 0 | 0.16 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 208-96-8 | ACENAPHTHYLENE | No | 0 | 0 | 0 | 0 |  | No | Standard PAH List | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 120-12-7 | ANTHRACENE | No | 0 | 0 | 2.4 | MTCA PRO GW TO MW SAT |  | No |  | YES | n | YES |
| S | Sub-surface soil ( > 6") | SVOA | 56-55-3 | BENZO[A]ANTHRACENE | No | 0 | 0 | 0.000057 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 50-32-8 | BENZO[A]PYRENE | No | 0 | 0 | 0.000016 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 205-99-2 | BENZO[B]FLUORANTHENE | No | 0 | 0 | 0.000096 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 191-24-2 | BENZO[G,H,I]PERYLENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 207-08-9 | BENZO[K]FLUORANTHENE | No | 0 | 0 | 0.00094 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 56832-73-6 | BENZOFLUORANTHENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 65-85-0 | BENZOIC ACID | No | 0 | 0 | 18 | MTCA PRO GW SAT |  | No | PAST RL<ARAR | 0 | n | YES |
| S | Sub-surface soil ( > 6") | SVOA | 100-51-6 | BENZYL ALCOHOL | No | 0 | 0 | 0.49 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 111-91-1 | BIS(2-CHLOROETHOXY)METHANE | No | 0 | 0 | 0.014 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 111-44-4 | BIS(2-CHLOROETHYL)ETHER | No | 0 | 0 | 0.000014 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 117-81-7 | BIS(2-ETHYLHEXYL)PHTHALATE | Yes | 0.59 | MTCA B PRO SW | 0.0051 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 85-68-7 | BUTYLBENZYLPHTHALATE | Yes | 130 | MTCA B PRO SW | 0.00018 | MTCA PRO GW TO MW SAT |  | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 86-74-8 | CARBAZOLE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 218-01-9 | CHRYSENE | No | 0 | 0 | 0.0029 | MTCA PRO GW TO MW SAT |  | No | PAST RL>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | -61 | CPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 53-70-3 | DIBENZ[A,H]ANTHRACENE | No | 0 | 0 | 0.000029 | MTCA PRO GW TO MW SAT |  | No | PAST RL>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 132-64-9 | DIBENZOFURAN | No | 0 | 0 | 0.076 | MTCA PRO GW SAT |  | No | PAST RL>ARAR | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 84-66-2 | DIETHYLPHTHALATE | No | 0 | 0 | 0.074 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 131-11-3 | DIMETHYL PHTHALATE | Yes | 1600 | MTCA B PRO DW | 0.19 | MTCA PRO GW TO MW SAT |  | No | MAX<ARAR; PAST RL>ARAR | n | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 84-74-2 | DI-N-BUTYLPHTHALATE | Yes | 160 | MTCA B PRO DW | 0.015 | MTCA PRO GW TO MW SAT |  | No | GW Not impacted | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 117-84-0 | DI-N-OCTYLPHTHALATE | Yes | 32 | MTCA B PRO DW | 23 | MTCA PRO GW SAT |  | No | MAX<ARAR | n | n | YES |
| S | Sub-surface soil ( > 6") | SVOA | 206-44-0 | FLUORANTHENE | No | 0 | 0 | 0.3 | MTCA PRO GW TO MW SAT |  | No | MAX>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 86-73-7 | FLUORENE | No | 0 | 0 | 0.08 | MTCA PRO GW TO MW SAT |  | No | PAST RL>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 118-74-1 | HEXACHLOROBENZENE | No | 0 | 0 | 0.0000004 | MTCA PRO GW TO MW SAT |  | No | 25 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 87-68-3 | HEXACHLOROBUTADIENE | No | 0 | 0 | 0.000011 | MTCA PRO GW TO MW SAT |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 77-47-4 | HEXACHLOROCYCLOPENTADIENE | No | 0 | 0 | 0.0017 | 40 CFR 131.45 PRO SW |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 67-72-1 | HEXACHLOROETHANE | No | 0 | 0 | 0.0000097 | 40 CFR 131.45 PRO SW |  | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | -63 | HPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 193-39-5 | INDENO[1,2,3-CD]PYRENE | No | 0 | 0 | 0.00031 | MTCA PRO GW TO MW SAT |  | No | PAST RL>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 78-59-1 | ISOPHORONE | No | 0 | 0 | 0.032 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | -64 | LPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 91-20-3 | NAPHTHALENE | No | 0 | 0 | 0.24 | MTCA PRO GW SAT |  | No | MAX>ARAR,PAST RL>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | -150 | NCPAH, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 98-95-3 | NITROBENZENE | No | 0 | 0 | 0.0065 | MTCA PRO GW SAT |  | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 621-64-7 | N-NITROSODINPROPYLAMINE | No | 0 | 0 | 0.000007 | MTCA PRO GW SAT |  | No | 29 ND Samples | 0 | YES | YES |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | SVOA | 86-30-6 | N-NITROSODIPHENYLAMINE |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0300 |
| S | Sub-surface soil ( > 6") | SVOA | 87-86-5 | PENTACHLOROPHENOL |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.94 | 4.9 | MG_KG | 1991/04/02 | 1999/01/27 | 0.200 |
| S | Sub-surface soil ( > 6") | SVOA | 85-01-8 | PHENANTHRENE |  | 39 | 13 | 0.01 | 77.9 | MG_KG | 1998/05/27 | 1999/01/26 | 26 | 0.01 | 0.77 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00400 |
| S | Sub-surface soil ( > 6") | SVOA | 108-95-2 | PHENOL |  | 29 |  |  |  | MG_KG |  |  | 29 | 0.33 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.0500 |
| S | Sub-surface soil ( > 6") | SVOA | 129-00-0 | PYRENE |  | 39 | 12 | 0.009 | 37.1 | MG_KG | 1998/05/27 | 1999/01/25 | 27 | 0.01 | 2 | MG_KG | 1991/04/02 | 1999/01/27 | 0.00300 |
| S | Sub-surface soil ( > 6") | TPH | 71-43-2 | BENZENE |  | 5 |  |  |  | MG_KG |  |  | 5 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00100 |
| S | Sub-surface soil ( > 6") | TPH | -71 | BTEX, TOTAL |  | 5 | 2 | 0.3 | 3.7 | MG_KG | 1997/07/23 | 1997/07/23 | 3 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0 |
| S | Sub-surface soil ( > 6") | TPH | 100-41-4 | ETHYLBENZENE |  | 5 | 1 | 0.9 | 0.9 | MG_KG | 1997/07/23 | 1997/07/23 | 4 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00100 |
| S | Sub-surface soil ( > 6") | TPH | 1330-20-7 | M- AND P-XYLENE |  | 5 | 1 | 1.3 | 1.3 | MG_KG | 1997/07/23 | 1997/07/23 | 4 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00200 |
| S | Sub-surface soil ( > 6") | TPH | 1634-04-4 | METHYL TERT-BUTYL ETHER |  | 5 |  |  |  | MG_KG |  |  | 5 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00100 |
| S | Sub-surface soil ( > 6") | TPH | 95-47-6 | O-XYLENE |  | 5 | 2 | 0.3 | 1.5 | MG_KG | 1997/07/23 | 1997/07/23 | 3 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00200 |
| S | Sub-surface soil ( > 6") | TPH | 108-88-3 | TOLUENE |  | 5 |  |  |  | MG_KG |  |  | 5 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00300 |
| S | Sub-surface soil ( > 6") | TPH | unavailable09 | TPH |  | 5 | 5 | 61.6 | 45300 | MG_KG | 1998/05/27 | 1998/06/25 |  |  |  |  |  |  | 0 |
| S | Sub-surface soil ( > 6") | TPH | -93 | TPH-C10-C12 ALIPHATICS |  | 30 | 17 | 21 | 1550 | MG_KG | 1997/07/23 | 1999/01/25 | 13 | 2.7 | 250 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -98 | TPH-C10-C12 AROMATICS |  | 30 | 15 | 4.3 | 314 | MG_KG | 1997/07/23 | 1999/01/25 | 15 | 2.7 | 56 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -116 | TPH-C10-C25 ALIPHATICS |  | 10 | 6 | 135.8 | 3040 | MG_KG | 1997/07/23 | 1999/01/25 | 4 | 5 | 6.6 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -117 | TPH-C10-C25 AROMATICS |  | 11 | 8 | 28 | 1370 | MG_KG | 1997/07/23 | 1999/01/25 | 3 | 5 | 5.5 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -105 | TPH-C12-C13 AROMATICS |  | 11 | 7 | 20.5 | 825 | MG_KG | 1998/05/27 | 1999/01/25 | 4 | 2.8 | 5 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -94 | TPH-C12-C16 ALIPHATICS |  | 15 | 11 | 5 | 7080 | MG_KG | 1997/07/23 | 1999/01/25 | 4 | 5 | 6.6 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -99 | TPH-C12-C16 AROMATICS |  | 15 | 10 | 5 | 3560 | MG_KG | 1997/07/23 | 1999/01/25 | 5 | 5 | 6.6 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -95 | TPH-C16-C21 ALIPHATICS |  | 15 | 11 | 6.28 | 4480 | MG_KG | 1997/07/23 | 1999/01/25 | 4 | 5 | 6.6 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -100 | TPH-C16-C21 AROMATICS |  | 15 | 12 | 5 | 6010 | MG_KG | 1997/07/23 | 1999/01/25 | 3 | 5 | 5.5 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -96 | TPH-C21-C34 ALIPHATICS |  | 15 | 14 | 6.26 | 7530 | MG_KG | 1997/07/23 | 1999/01/25 | 1 | 5 | 5 | MG_KG | 1998/12/07 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -101 | TPH-C21-C34 AROMATICS |  | 15 | 12 | 7.08 | 14600 | MG_KG | 1997/07/23 | 1999/01/25 | 3 | 5 | 5.5 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -102 | TPH-C5-C6 ALIPHATICS |  | 15 | 2 | 25 | 50 | MG_KG | 1999/01/14 | 1999/01/25 | 13 | 2.7 | 250 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -114 | TPH-C6-C10 ALIPHATICS |  | 10 | 5 | 14 | 208 | MG_KG | 1997/07/23 | 1999/01/25 | 5 | 2.7 | 5 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -103 | TPH-C6-C8 ALIPHATICS |  | 15 | 6 | 2.9 | 250 | MG_KG | 1997/07/23 | 1999/01/25 | 9 | 2.7 | 250 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -104 | TPH-C8-C10 ALIPHATICS |  | 30 | 13 | 14 | 250 | MG_KG | 1997/07/23 | 1999/01/25 | 17 | 2.7 | 250 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -97 | TPH-C8-C10 AROMATICS |  | 20 | 6 | 21 | 250 | MG_KG | 1997/07/23 | 1999/01/25 | 14 | 2.7 | 250 | MG_KG | 1997/07/23 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | TPH | unavailable09 | TPH-DIESEL RANGE |  | 303 | 74 | 13 | 20000 | MG_KG | 1996/06/11 | 1999/01/26 | 229 | 11 | 37 | MG_KG | 1996/06/10 | 1999/03/08 | 30.0 |
| S | Sub-surface soil ( > 6") | TPH | unavailable25 | TPH-GASOLINE RANGE C7-C12 |  | 8 | 1 | 10 | 10 | MG_KG | 1998/04/09 | 1998/04/09 | 7 | 5.3 | 5.8 | MG_KG | 1998/04/09 | 1998/04/09 | 1.1 |
| S | Sub-surface soil ( > 6") | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL |  | 304 | 86 | 58 | 20000 | MG_KG | 1996/06/10 | 1999/01/26 | 218 | 43 | 150 | MG_KG | 1996/06/11 | 1999/03/08 | 30.0 |
| S | Sub-surface soil ( > 6") | TPH | 1330-20-7 | XYLENES, TOTAL |  | 5 | 2 | 0.3 | 2.8 | MG_KG | 1997/07/23 | 1997/07/23 | 3 | 0.27 | 0.33 | MG_KG | 1997/07/23 | 1997/07/23 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 71-55-6 | 1,1,1-TRICHLOROETHANE |  | 118 | 7 | 0.001 | 0.48 | MG_KG | 1999/01/26 | 1999/03/08 | 111 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/05 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 79-34-5 | 1,1,2,2-TETRACHLOROETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 79-00-5 | 1,1,2-TRICHLOROETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | 75-34-3 | 1,1-DICHLOROETHANE |  | 118 | 2 | 0.002 | 0.011 | MG_KG | 1999/01/26 | 1999/03/08 | 116 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/05 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | 75-35-4 | 1,1-DICHLOROETHENE |  | 118 | 4 | 0.001 | 0.062 | MG_KG | 1999/01/26 | 1999/03/08 | 114 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/05 | 0.00300 |
| S | Sub-surface soil ( > 6") | VOA | 107-06-2 | 1,2-DICHLOROETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | 540-59-0 | 1,2-DICHLOROETHENE, TOTAL |  | 97 | 5 | 0.001 | 0.018 | MG_KG | 1992/07/03 | 1999/03/08 | 92 | 0.005 | 56 | MG_KG | 1990/06/21 | 1999/03/05 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 78-87-5 | 1,2-DICHLOROPROPANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 542-75-6 | 1,3-DICHLOROPROPENE, TOTAL |  | 72 | 3 | 0.005 | 0.11 | MG_KG | 1990/06/21 | 1999/01/25 | 69 | 0.011 | 56 | MG_KG | 1998/04/08 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 78-93-3 | 2-BUTANONE |  | 118 | 9 | 0.004 | 0.032 | MG_KG | 1998/04/08 | 1998/04/15 | 109 | 0.0001 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 110-75-8 | 2-CHLOROETHYL VINYL ETHER |  | 5 |  |  |  | MG_KG |  |  | 5 | 0.011 | 0.012 | MG_KG | 1995/10/24 | 1995/11/16 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 591-78-6 | 2-HEXANONE |  | 118 | 1 | 0.002 | 0.002 | MG_KG | 1998/04/15 | 1998/04/15 | 117 | 0.00005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 108-10-1 | 4-METHYL-2-PENTANONE |  | 118 | 23 | 0.001 | 0.09 | MG_KG | 1998/04/08 | 1998/04/15 | 95 | 0.00005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 67-64-1 | ACETONE |  | 118 | 38 | 0.00004 | 0.22 | MG_KG | 1991/04/03 | 1998/04/15 | 80 | 0.0001 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 71-43-2 | BENZENE |  | 128 | 3 | 0.001 | 1 | MG_KG | 1998/04/14 | 1999/01/25 | 125 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 75-27-4 | BROMODICHLOROMETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | 75-25-2 | BROMOFORM |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.00003 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 74-83-9 | BROMOMETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.00005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | -71 | BTEX, TOTAL |  | 77 | 38 | 0.001 | 18.5 | MG_KG | 1990/06/21 | 1999/03/08 | 39 | 0.011 | 11 | MG_KG | 1998/04/08 | 1999/03/05 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 75-15-0 | CARBON DISULFIDE |  | 118 | 8 | 0.001 | 0.028 | MG_KG | 1998/04/08 | 1999/01/26 | 110 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 56-23-5 | CARBON TETRACHLORIDE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | SVOA | 86-30-6 | N-NITROSODIPHENYLAMINE | No | 0 | 0 | 0.002 | MTCA PRO GW TO MW SAT | | No | 29 ND Samples | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 87-86-5 | PENTACHLOROPHENOL | No | 0 | 0 | 0.0000018 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | SVOA | 85-01-8 | PHENANTHRENE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 108-95-2 | PHENOL | No | 0 | 0 | 2.3 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | YES |
| S | Sub-surface soil ( > 6") | SVOA | 129-00-0 | PYRENE | No | 0 | 0 | 0.55 | MTCA PRO GW TO MW SAT | | No | MAX<ARAR; PAST RL>ARAR | YES | YES | YES |
| S | Sub-surface soil ( > 6") | TPH | 71-43-2 | BENZENE | Yes | 0.5 | MTCA B PRO DW | 0.00056 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | TPH | -71 | BTEX, TOTAL | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | 100-41-4 | ETHYLBENZENE | Yes | 70 | MTCA B PRO DW | 0.01 | MTCA PRO GW TO MW SAT | | No | | YES | YES | YES |
| S | Sub-surface soil ( > 6") | TPH | 1330-20-7 | M- AND P-XYLENE | Yes | 1000 | MTCA B PRO DW | 0.055 | MTCA PRO GW TO MW SAT | | No | GW NOT IMPACTED;SS NOT IMPACTED | YES | YES | YES |
| S | Sub-surface soil ( > 6") | TPH | 1634-04-4 | METHYL TERT-BUTYL ETHER | No | 0 | 0 | 0.0072 | MTCA PRO GW SAT | | No | | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | TPH | 95-47-6 | O-XYLENE | No | 0 | 0 | 0.84 | MTCA PRO GW SAT | | No | GW NOT IMPACTED;SS NOT IMPACTED | YES | n | YES |
| S | Sub-surface soil ( > 6") | TPH | 108-88-3 | TOLUENE | Yes | 100 | MTCA B PRO DW | 0.044 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | TPH | unavailable09 | TPH | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -93 | TPH-C10-C12 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -98 | TPH-C10-C12 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -116 | TPH-C10-C25 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -117 | TPH-C10-C25 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -105 | TPH-C12-C13 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -94 | TPH-C12-C16 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -99 | TPH-C12-C16 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -95 | TPH-C16-C21 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -100 | TPH-C16-C21 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -96 | TPH-C21-C34 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -101 | TPH-C21-C34 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -102 | TPH-C5-C6 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -114 | TPH-C6-C10 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -103 | TPH-C6-C8 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -104 | TPH-C8-C10 ALIPHATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | -97 | TPH-C8-C10 AROMATICS | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | TPH | unavailable09 | TPH-DIESEL RANGE | | | | 2000 | MTCA A | | No | SAMPLE GW | YES | n | YES |
| S | Sub-surface soil ( > 6") | TPH | unavailable25 | TPH-GASOLINE RANGE C7-C12 | | | | 30 | MTCA A | | No | MAX<ARAR | n | n | n |
| S | Sub-surface soil ( > 6") | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL | | | | 2000 | MTCA A | | No | GW Not impacted | YES | n | YES |
| S | Sub-surface soil ( > 6") | TPH | 1330-20-7 | XYLENES, TOTAL | Yes | 1000 | MTCA B PRO DW | 0.055 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 71-55-6 | 1,1,1-TRICHLOROETHANE | Yes | 20 | MTCA B PRO DW | 0.084 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 79-34-5 | 1,1,2,2-TETRACHLOROETHANE | No | 0 | 0 | 0.00008 | MTCA PRO GW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 79-00-5 | 1,1,2-TRICHLOROETHANE | Yes | 0.5 | MTCA B PRO DW | 0.00033 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 75-34-3 | 1,1-DICHLOROETHANE | Yes | 80 | MTCA B PRO DW | 0.0026 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 75-35-4 | 1,1-DICHLOROETHENE | Yes | 0.32 | MTCA B PRO SW | 0.0025 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 107-06-2 | 1,2-DICHLOROETHANE | Yes | 0.5 | MTCA B PRO DW | 0.0016 | MTCA PRO GW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 540-59-0 | 1,2-DICHLOROETHENE, TOTAL | No | 0 | 0 | 0.023 | MTCA PRO GW | | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 78-87-5 | 1,2-DICHLOROPROPANE | No | 0 | 0 | 0.001 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 542-75-6 | 1,3-DICHLOROPROPENE, TOTAL | No | 0 | 0 | 0.00014 | MTCA PRO GW SAT | | No | SAMPLE GW | YES | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 78-93-3 | 2-BUTANONE | No | 0 | 0 | 1.4 | MTCA PRO GW SAT | | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 110-75-8 | 2-CHLOROETHYL VINYL ETHER | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 591-78-6 | 2-HEXANONE | No | 0 | 0 | 0.012 | MTCA PRO GW SAT | | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 108-10-1 | 4-METHYL-2-PENTANONE | No | 0 | 0 | 0.19 | MTCA PRO GW SAT | | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 67-64-1 | ACETONE | Yes | 80 | MTCA B PRO DW | 2.1 | MTCA PRO GW SAT | | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 71-43-2 | BENZENE | Yes | 0.5 | MTCA B PRO DW | 0.00056 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 75-27-4 | BROMODICHLOROMETHANE | No | 0 | 0 | 0.00089 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 75-25-2 | BROMOFORM | No | 0 | 0 | 0.005 | MTCA PRO GW TO MW SAT | | No | Not above lowest ARAR in SW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 74-83-9 | BROMOMETHANE | No | 0 | 0 | 0.0033 | MTCA PRO GW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | -71 | BTEX, TOTAL | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 75-15-0 | CARBON DISULFIDE | No | 0 | 0 | 0.25 | MTCA PRO GW SAT | | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 56-23-5 | CARBON TETRACHLORIDE | Yes | 0.034 | MTCA B PRO DW | 0.00015 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | VOA | 108-90-7 | CHLOROBENZENE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | 75-00-3 | CHLOROETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 67-66-3 | CHLOROFORM |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 74-87-3 | CHLOROMETHANE |  | 118 | 2 | 0.001 | 0.013 | MG_KG | 1998/04/08 | 1998/04/14 | 116 | 0.00005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 156-59-2 | CIS-1,2-DICHLOROETHENE |  | 16 |  |  |  | MG_KG |  |  | 16 | 0.000005 | 0.000007 | MG_KG | 1991/04/02 | 1991/04/05 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 10061-01-5 | CIS-1,3-DICHLOROPROPENE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.000500 |
| S | Sub-surface soil ( > 6") | VOA | 124-48-1 | DIBROMOCHLOROMETHANE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 100-41-4 | ETHYLBENZENE |  | 128 | 14 | 0.002 | 4.13 | MG_KG | 1990/06/21 | 1999/03/08 | 114 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/05 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | -64 | LPAH, TOTAL |  | 5 | 3 | 0.312 | 2.46 | MG_KG | 1998/12/07 | 1999/01/25 | 2 | 0.1 | 0.1 | MG_KG | 1998/12/07 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 1330-20-7 | M- AND P-XYLENE |  | 10 | 5 | 1.77 | 7.34 | MG_KG | 1998/05/27 | 1999/01/25 | 5 | 0.2 | 4 | MG_KG | 1998/06/24 | 1998/12/07 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 1634-04-4 | METHYL TERT-BUTYL ETHER |  | 10 | 2 | 10 | 10 | MG_KG | 1999/01/14 | 1999/01/25 | 8 | 1 | 10 | MG_KG | 1998/05/27 | 1998/12/07 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 75-09-2 | METHYLENE CHLORIDE |  | 118 | 68 | 0.001 | 3.1 | MG_KG | 1998/04/08 | 1999/03/08 | 50 | 0.00003 | 15 | MG_KG | 1990/06/21 | 1999/01/25 | 0.0200 |
| S | Sub-surface soil ( > 6") | VOA | 91-20-3 | NAPHTHALENE |  | 10 | 7 | 0.312 | 58.4 | MG_KG | 1998/05/27 | 1999/01/25 | 3 | 0.1 | 0.1 | MG_KG | 1998/06/25 | 1998/12/07 | 0.00400 |
| S | Sub-surface soil ( > 6") | VOA | -150 | NCPAH, TOTAL |  | 5 | 3 | 0.312 | 2.46 | MG_KG | 1998/12/07 | 1999/01/25 | 2 | 0.1 | 0.1 | MG_KG | 1998/12/07 | 1998/12/07 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 95-47-6 | O-XYLENE |  | 10 | 6 | 1 | 9.12 | MG_KG | 1998/05/27 | 1999/01/25 | 4 | 0.01 | 0.1 | MG_KG | 1998/06/25 | 1998/12/07 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 100-42-5 | STYRENE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 127-18-4 | TETRACHLOROETHENE |  | 118 | 1 | 0.001 | 0.001 | MG_KG | 1992/06/16 | 1992/06/16 | 117 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 108-88-3 | TOLUENE |  | 127 | 29 | 0.001 | 2.5 | MG_KG | 1990/06/21 | 1999/01/25 | 98 | 0.00001 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00300 |
| S | Sub-surface soil ( > 6") | VOA | 156-60-5 | TRANS-1,2-DICHLOROETHENE |  | 21 |  |  |  | MG_KG |  |  | 21 | 0.000005 | 0.006 | MG_KG | 1991/04/02 | 1995/11/16 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 10061-02-6 | TRANS-1,3-DICHLOROPROPENE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00200 |
| S | Sub-surface soil ( > 6") | VOA | 79-01-6 | TRICHLOROETHENE |  | 118 | 20 | 0.001 | 0.043 | MG_KG | 1990/06/21 | 1999/03/08 | 98 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/05 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 108-05-4 | VINYL ACETATE |  | 39 |  |  |  | MG_KG |  |  | 39 | 0.00005 | 30 | MG_KG | 1990/06/21 | 1995/11/16 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 75-01-4 | VINYL CHLORIDE |  | 118 |  |  |  | MG_KG |  |  | 118 | 0.000005 | 56 | MG_KG | 1990/06/21 | 1999/03/08 | 0.00100 |
| S | Sub-surface soil ( > 6") | VOA | 1330-20-7 | XYLENES, TOTAL |  | 122 | 33 | 0.001 | 17 | MG_KG | 1998/04/08 | 1999/03/08 | 89 | 0.000005 | 15 | MG_KG | 1990/06/21 | 1999/03/05 | 0.00200 |
| W | Surface water | VOA | 106-46-7 | 1,4-DICHLOROBENZENE |  | 12 |  |  |  | UG_L |  |  | 13 | 0.0018 | 0.045 | MG_KG | 2004/06/03 | 2019/06/04 |  |
| S | Soil | SVOA | 541-73-1 | 1,3-DICHLOROBENZENE |  | 3 |  |  |  | MG_KG |  |  | 12 | 0.002 | 0.0022 | MG_KG | 2004/06/03 | 2004/06/03 |  |
| S | Sub-surface soil ( > 6") | SVOA | 541-73-1 | 1,3-DICHLOROBENZENE |  | 29 |  |  |  | MG_KG |  |  | 13 | 0.0023 | 0.089 | MG_KG | 2004/06/03 | 2019/06/04 |  |
| W | Ground water | SVOA | 541-73-1 | 1,3-DICHLOROBENZENE |  | 15 |  |  |  | UG_L |  |  | 35 | 0.035 | 0.039 | MG_KG | 2008/07/30 | 2008/07/30 |  |
| W | Ground water | VOA | 541-73-1 | 1,3-DICHLOROBENZENE |  | 38 |  |  |  | UG_L |  |  | 35 | 0.035 | 0.039 | MG_KG | 2008/07/30 | 2008/07/30 |  |
| W | Surface water | VOA | 541-73-1 | 1,3-DICHLOROBENZENE |  | 12 |  |  |  | UG_L |  |  | 35 | 0.035 | 0.039 | MG_KG | 2008/07/30 | 2008/07/30 |  |
| S | Soil | SVOA | 95-50-1 | 1,2-DICHLOROBENZENE |  | 3 |  |  |  | MG_KG |  |  | 20 | 0.0048 | 0.01 | MG_KG | 2000/06/01 | 2004/06/03 |  |
| S | Sub-surface soil ( > 6") | SVOA | 95-50-1 | 1,2-DICHLOROBENZENE |  | 29 |  |  |  | MG_KG |  |  | 20 | 0.005 | 0.01 | MG_KG | 2000/06/01 | 2004/06/03 |  |
| W | Ground water | INO | 57-12-5 | CYANIDE |  | 82 | 18 | 0.016 | 60 | UG_L | 1991/07/01 | 2002/06/20 | 64 | 0.01 | 10 | UG_L | 1991/07/01 | 2000/06/12 | 9 |
| W | Ground water | MET | 7429-90-5 | ALUMINUM |  | 239 | 139 | 1.6 | 566000 | UG_L | 1991/07/01 | 2008/05/06 | 100 | 10 | 1230 | UG_L | 1991/04/05 | 2007/06/12 | 0 |
| W | Ground water | MET | 7440-36-0 | ANTIMONY | HH | 228 | 51 | 0.05 | 65.7 | UG_L | 1992/04/06 | 2008/05/06 | 177 | 0.02 | 560 | UG_L | 1991/07/01 | 2008/05/06 | 0 |
| W | Ground water | MET | 7440-38-2 | ARSENIC | HH | 382 | 235 | 0.13 | 71.3 | UG_L | 1991/04/05 | 2019/06/25 | 147 | 0.3 | 20 | UG_L | 1991/07/01 | 2005/06/22 | 0.4 |
| W | Ground water | MET | 7440-39-3 | BARIUM |  | 380 | 331 | 1.2 | 3020 | UG_L | 1991/04/05 | 2017/06/21 | 49 | 2.7 | 410 | UG_L | 1991/07/01 | 2014/06/18 | 0.5 |
| W | Ground water | MET | 7440-41-7 | BERYLLIUM |  | 245 | 52 | 0.001 | 14.5 | UG_L | 1992/04/06 | 2008/05/06 | 193 | 0.001 | 20 | UG_L | 1991/07/01 | 2008/05/05 | 0 |
| W | Ground water | MET | 7440-42-8 | BORON |  | 10 | 10 | 70 | 3600 | UG_L | 2005/06/22 | 2005/06/24 |  |  |  |  |  |  | 0 |
| W | Ground water | MET | 7440-43-9 | CADMIUM | HH | 400 | 284 | 0.006 | 1780 | UG_L | 1991/04/05 | 2019/06/25 | 116 | 0.02 | 36.8 | UG_L | 1991/07/01 | 2019/06/11 | 0.07 |
| W | Ground water | MET | 7440-70-2 | CALCIUM |  | 241 | 241 | 1220 | 1240000 | UG_L | 1991/07/01 | 2008/05/06 |  |  |  |  |  |  | 0 |
| W | Ground water | MET | 18540-29-9 | CHROMIUM VI | HH | 137 | 92 | 1 | 21000 | UG_L | 1992/04/06 | 2000/06/12 | 45 | 1 | 11 | UG_L | 1992/04/07 | 2000/06/08 | 0 |
| W | Ground water | MET | 16065-83-1 | CHROMIUM, TOTAL |  | 397 | 320 | 0.06 | 13900 | UG_L | 1991/04/05 | 2019/06/25 | 77 | 0.04 | 70 | UG_L | 1991/07/01 | 2016/06/20 | 0.5 |
| W | Ground water | MET | 7440-48-4 | COBALT | HH | 245 | 152 | 0.02 | 919 | UG_L | 1991/07/01 | 2008/05/06 | 93 | 0.02 | 160 | UG_L | 1991/07/01 | 2005/06/24 | 0 |
| W | Ground water | MET | 7440-50-8 | COPPER |  | 398 | 295 | 0.043 | 1930 | UG_L | 1991/07/01 | 2019/06/25 | 103 | 0.1 | 180 | UG_L | 1991/04/05 | 2019/06/11 | 0.02 |
| W | Ground water | MET | 7439-89-6 | IRON |  | 241 | 154 | 9.2 | 796000 | UG_L | 1991/07/01 | 2008/05/06 | 87 | 5 | 500 | UG_L | 1992/04/06 | 2008/05/05 | 0 |
| W | Ground water | MET | 7439-92-1 | LEAD | HH | 428 | 209 | 0.008 | 449 | UG_L | 1991/07/01 | 2019/06/25 | 219 | 0.011 | 25.4 | UG_L | 1991/04/05 | 2019/06/25 | 0.08 |
| W | Ground water | MET | 7439-95-4 | MAGNESIUM |  | 238 | 236 | 812 | 1260000 | UG_L | 1991/07/01 | 2008/05/06 | 2 | 24900 | 24900 | UG_L | 1991/07/01 | 1991/07/01 | 0 |
| W | Ground water | MET | 7439-96-5 | MANGANESE | HH | 241 | 214 | 0.2 | 28700 | UG_L | 1991/07/01 | 2008/05/06 | 27 | 0.4 | 63.4 | UG_L | 1992/04/06 | 2008/05/05 | 0 |
| W | Ground water | MET | 7439-97-6 | MERCURY |  | 363 | 69 | 0.0003 | 2200 | NG_L | 1991/04/05 | 2016/06/20 | 294 | 40 | 2000 | NG_L | 1991/07/01 | 2013/06/18 | 200 |
| W | Ground water | MET | 7439-98-7 | MOLYBDENUM |  | 10 | 8 | 7 | 70 | UG_L | 2005/06/22 | 2005/06/24 | 2 | 5 | 5 | UG_L | 2005/06/22 | 2005/06/22 | 0 |
| W | Ground water | MET | 7440-02-0 | NICKEL | HH | 395 | 324 | 0.26 | 3550 | UG_L | 1991/04/05 | 2019/06/25 | 71 | 1.3 | 320 | UG_L | 1991/07/01 | 2005/06/23 | 5 |
| W | Ground water | MET | 7440-09-7 | POTASSIUM |  | 238 | 233 | 800 | 366000 | UG_L | 1991/07/01 | 2008/05/06 | 5 | 2000 | 13000 | UG_L | 1991/07/01 | 2007/06/11 | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | Sub-surface soil ( > 6") | VOA | 108-90-7 | CHLOROBENZENE | No | 0 | 0 | 0.051 | MTCA PRO GW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 75-00-3 | CHLOROETHANE | No | 0 | 0 | 0 | 0 | | No | Max RL>ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 67-66-3 | CHLOROFORM | Yes | 0.72 | MTCA B PRO DW | 0.0048 | MTCA PRO GW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 74-87-3 | CHLOROMETHANE | No | 0 | 0 | 0 | 0 | | No | Max RL>ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 156-59-2 | CIS-1,2-DICHLOROETHENE | Yes | 7 | MTCA B PRO DW | 0.0052 | MTCA PRO GW SAT | | No | PAST RL<ARAR | 0 | n | YES |
| S | Sub-surface soil ( > 6") | VOA | 10061-01-5 | CIS-1,3-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 124-48-1 | DIBROMOCHLOROMETHANE | No | 0 | 0 | 0.0007 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 100-41-4 | ETHYLBENZENE | Yes | 70 | MTCA B PRO DW | 0.01 | MTCA PRO GW TO MW SAT | | No | | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | -64 | LPAH, TOTAL | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 1330-20-7 | M- AND P-XYLENE | Yes | 1000 | MTCA B PRO DW | 0.055 | MTCA PRO GW TO MW SAT | | No | GW NOT IMPACTED; SS NOT IMPACTED | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 1634-04-4 | METHYL TERT-BUTYL ETHER | No | 0 | 0 | 0.0072 | MTCA PRO GW SAT | | No | | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 75-09-2 | METHYLENE CHLORIDE | No | 0 | 0 | 0.0015 | MTCA PRO GW SAT | | No | | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 91-20-3 | NAPHTHALENE | No | 0 | 0 | 0.24 | MTCA PRO GW SAT | | No | GW Not impacted | YES | n | YES |
| S | Sub-surface soil ( > 6") | VOA | -150 | NCPAH, TOTAL | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 95-47-6 | O-XYLENE | No | 0 | 0 | 0.84 | MTCA PRO GW SAT | | No | GW NOT IMPACTED; SS NOT IMPACTED | YES | n | YES |
| S | Sub-surface soil ( > 6") | VOA | 100-42-5 | STYRENE | Yes | 0.15 | MTCA B PRO DW | 0.12 | MTCA PRO GW SAT | | No | GW Not impacted | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 127-18-4 | TETRACHLOROETHENE | Yes | 0.5 | MTCA B PRO DW | 0.0016 | MTCA PRO GW TO MW SAT | | No | MAX<ARAR; PAST RL>ARAR | n | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 108-88-3 | TOLUENE | Yes | 100 | MTCA B PRO DW | 0.044 | MTCA PRO GW TO MW SAT | | No | | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 156-60-5 | TRANS-1,2-DICHLOROETHENE | Yes | 10 | MTCA B PRO DW | 0.032 | MTCA PRO GW TO MW SAT | | No | Possible GW Presence | 0 | n | YES |
| S | Sub-surface soil ( > 6") | VOA | 10061-02-6 | TRANS-1,3-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 | | No | No current ARAR, all ND | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | VOA | 79-01-6 | TRICHLOROETHENE | Yes | 0.5 | MTCA B PRO DW | 0.00027 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | YES | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 108-05-4 | VINYL ACETATE | No | 0 | 0 | 2.3 | MTCA PRO GW SAT | | No | GW NOT IMPACTED | 0 | YES | 0 |
| S | Sub-surface soil ( > 6") | VOA | 75-01-4 | VINYL CHLORIDE | No | 0 | 0 | 0.000056 | MTCA PRO GW TO MW SAT | | No | SAMPLE GW | 0 | YES | YES |
| S | Sub-surface soil ( > 6") | VOA | 1330-20-7 | XYLENES, TOTAL | Yes | 1000 | MTCA B PRO DW | 0.055 | MTCA PRO GW TO MW SAT | | No | GW Not impacted | YES | YES | YES |
| W | Surface water | VOA | 106-46-7 | 1,4-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 541-73-1 | 1,3-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 541-73-1 | 1,3-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 541-73-1 | 1,3-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 541-73-1 | 1,3-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| W | Surface water | VOA | 541-73-1 | 1,3-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| S | Soil | SVOA | 95-50-1 | 1,2-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 95-50-1 | 1,2-DICHLOROBENZENE | | | | | | after 2008 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | INO | 57-12-5 | CYANIDE | Yes | 1 | MTCA B SW | 1 | 173-201A WAC | after 2002 | No | ND after 2002, RL < ARAR | YES | YES | YES |
| W | Ground water | MET | 7429-90-5 | ALUMINUM | No | 0 | 0 | 16000 | MTCA B GW | | No | Naturally occurring, not considered a risk driver | YES | n | 0 |
| W | Ground water | MET | 7440-36-0 | ANTIMONY | No | 0 | 0 | 6 | 246-290 WAC MCL | | No | SW NOT IMPACTED | YES | YES | 0 |
| W | Ground water | MET | 7440-38-2 | ARSENIC | Yes | 0.05 | MTCA B DW | 0.058 | MTCA B GW | | Yes | | YES | YES | YES |
| W | Ground water | MET | 7440-39-3 | BARIUM | Yes | 1000 | MTCA B DW | 2000 | 246-290 WAC MCL | after 2017 | No | LEVELS REDUCED IN 2017 | YES | n | n |
| W | Ground water | MET | 7440-41-7 | BERYLLIUM | No | 0 | 0 | 4 | 246-290 WAC MCL | | No | SOIL/SW NOT IMPACTED | YES | YES | 0 |
| W | Ground water | MET | 7440-42-8 | BORON | No | 0 | 0 | 3200 | MTCA B GW | | No | MAX>ARAR BUT CLOSE & OLD | YES | 0 | 0 |
| W | Ground water | MET | 7440-43-9 | CADMIUM | Yes | 5 | MTCA B DW | 5 | STATE MCL | | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | MET | 7440-70-2 | CALCIUM | No | 0 | 0 | 0 | 0 | | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | MET | 18540-29-9 | CHROMIUM VI | Yes | 50 | MTCA B SW | 0.046 | MTCA B GW | after 2000 | Yes | MAX>ARAR | YES | YES | 0 |
| W | Ground water | MET | 16065-83-1 | CHROMIUM, TOTAL | Yes | 16000 | MTCA B DW | 24000 | MTCA B | | Yes | MAX<ARAR | n | n | n |
| W | Ground water | MET | 7440-48-4 | COBALT | No | 0 | 0 | 4.8 | MTCA B GW | | Yes | | YES | YES | 0 |
| W | Ground water | MET | 7440-50-8 | COPPER | Yes | 2.5 | MTCA B SW | 3.1 | CWA | | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | MET | 7439-89-6 | IRON | No | 0 | 0 | 11000 | MTCA B GW | | No | Naturally occurring, not considered a risk driver | YES | n | 0 |
| W | Ground water | MET | 7439-92-1 | LEAD | Yes | 5.8 | MTCA B SW | 5.6 | CWA | | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | MET | 7439-95-4 | MAGNESIUM | No | 0 | 0 | | | | Yes | No current ARAR | 0 | 0 | 0 |
| W | Ground water | MET | 7439-96-5 | MANGANESE | No | 0 | 0 | 100 | CWA | | Yes | Naturally occurring | YES | n | 0 |
| W | Ground water | MET | 7439-97-6 | MERCURY | Yes | 25 | MTCA B SW | 25 | 173-201A WAC | after 2016 | Yes | | YES | YES | YES |
| W | Ground water | MET | 7439-98-7 | MOLYBDENUM | No | 0 | 0 | 80 | MTCA B GW | | Yes | MAX<ARAR | n | n | 0 |
| W | Ground water | MET | 7440-02-0 | NICKEL | Yes | 7.9 | MTCA B SW | 8.2 | CWA | | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | MET | 7440-09-7 | POTASSIUM | No | 0 | 0 | 0 | 0 | | Yes | No current ARAR | 0 | 0 | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | MET | 7782-49-2 | SELENIUM | | 195 | 28 | 0.39 | 142 | UG_L | 1992/04/07 | 2008/05/06 | 167 | 0.2 | 100 | UG_L | 1991/07/01 | 2008/05/06 | 5 |
| W | Ground water | MET | 7440-21-3 | SILICON | | 10 | 10 | 2100 | 14900 | UG_L | 2005/06/22 | 2005/06/24 | | | | | | | 0 |
| W | Ground water | MET | 7440-22-4 | SILVER | | 389 | 179 | 0.001 | 55.1 | UG_L | 1992/04/06 | 2019/06/25 | 210 | 0.005 | 100 | UG_L | 1991/04/05 | 2019/06/11 | 0.1 |
| W | Ground water | MET | 7440-23-5 | SODIUM | | 238 | 237 | 11800 | 9250000 | UG_L | 1991/07/01 | 2008/05/06 | 1 | 460 | 460 | UG_L | 1993/07/01 | 1993/07/01 | 0 |
| W | Ground water | MET | 7440-24-6 | STRONTIUM | | 10 | 10 | 13 | 6260 | UG_L | 2005/06/22 | 2005/06/24 | | | | | | | 0 |
| W | Ground water | MET | 7440-28-0 | THALLIUM | | 355 | 59 | 0.003 | 134 | UG_L | 1992/04/07 | 2016/06/20 | 296 | 0.001 | 40 | UG_L | 1991/07/01 | 2016/06/20 | 0 |
| W | Ground water | MET | 7440-31-5 | TIN | | 135 | 14 | 2.1 | 117 | UG_L | 1995/11/19 | 2015/06/26 | 121 | 4 | 100 | UG_L | 1991/04/05 | 2016/06/20 | 0 |
| W | Ground water | MET | 7440-32-6 | TITANIUM | | 10 | 1 | 10 | 10 | UG_L | 2005/06/23 | 2005/06/23 | 9 | 5 | 20 | UG_L | 2005/06/22 | 2005/06/24 | 0 |
| W | Ground water | MET | 7440-62-2 | VANADIUM | | 238 | 176 | 2.1 | 1300 | UG_L | 1991/07/01 | 2008/05/06 | 62 | 2 | 200 | UG_L | 1991/07/01 | 2008/05/06 | 0 |
| W | Ground water | MET | 7440-66-6 | ZINC | | 397 | 309 | 0.1 | 3870 | UG_L | 1991/04/05 | 2019/06/25 | 88 | 0.5 | 500 | UG_L | 1991/07/01 | 2019/06/10 | 10 |
| W | Ground water | PFOAS | 2991-50-6 | N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (N-ETFOSAA) | | 16 | | | | NG_L | | | 16 | 0.018 | 0.021 | NG_L | 2018/09/17 | 2019/06/25 | 0 |
| W | Ground water | PFOAS | 2355-31-9 | N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (N-MEFOSAA) | | 16 | | | | NG_L | | | 16 | 0.018 | 0.021 | NG_L | 2018/09/17 | 2019/06/25 | 2 |
| W | Ground water | PFOAS | 375-73-5 | PERFLUOROBUTANESULFONIC ACID (PFBS) | | 16 | 12 | 0.00074 | 0.0048 | NG_L | 2018/09/17 | 2019/06/25 | 4 | 0.0018 | 0.002 | NG_L | 2018/09/18 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 335-76-2 | PERFLUORODECANOIC ACID (PFDA) | | 16 | 10 | 0.00053 | 0.0039 | NG_L | 2018/09/17 | 2019/06/25 | 6 | 0.0018 | 0.002 | NG_L | 2018/09/17 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 307-55-1 | PERFLUORODODECANOIC ACID (PFDOA) | | 16 | | | | NG_L | | | 16 | 0.0018 | 0.0021 | NG_L | 2018/09/17 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 375-85-9 | PERFLUOROHEPTANOIC ACID (PFHPA) | | 16 | 12 | 0.00072 | 0.0084 | NG_L | 2018/09/17 | 2019/06/25 | 4 | 0.0018 | 0.002 | NG_L | 2018/09/18 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 355-46-4 | PERFLUOROHEXANESULFONIC ACID (PFHXS) | | 16 | 14 | 0.0006 | 0.0046 | NG_L | 2018/09/17 | 2019/06/25 | 2 | 0.0019 | 0.002 | NG_L | 2018/09/18 | 2019/06/10 | 1 |
| W | Ground water | PFOAS | 307-24-4 | PERFLUOROHEXANOIC ACID (PFHXA) | | 16 | 13 | 0.00046 | 0.013 | NG_L | 2018/09/17 | 2019/06/25 | 3 | 0.0019 | 0.002 | NG_L | 2018/09/18 | 2019/06/10 | 1 |
| W | Ground water | PFOAS | 375-95-1 | PERFLUORONONANOIC ACID (PFNA) | | 16 | 10 | 0.00055 | 0.0037 | NG_L | 2018/09/17 | 2019/06/25 | 6 | 0.0018 | 0.002 | NG_L | 2018/09/17 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 1763-23-1 | PERFLUOROOCTANESULFONIC ACID (PFOS) | | 16 | 14 | 0.0017 | 0.063 | NG_L | 2018/09/17 | 2019/06/25 | 2 | 0.0038 | 0.004 | NG_L | 2018/09/18 | 2019/06/10 | 1 |
| W | Ground water | PFOAS | 335-67-1 | PERFLUOROOCTANOIC ACID (PFOA) | | 16 | 14 | 0.00062 | 0.017 | NG_L | 2018/09/17 | 2019/06/25 | 2 | 0.0019 | 0.002 | NG_L | 2018/09/18 | 2019/06/10 | 1 |
| W | Ground water | PFOAS | 376-06-7 | PERFLUOROTETRADECANOIC ACID (PFTEDA) | | 16 | | | | NG_L | | | 16 | 0.0035 | 0.0041 | NG_L | 2018/09/17 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 2058-94-8 | PERFLUOROUNDECANOIC ACID (PFUNA) | | 16 | | | | NG_L | | | 16 | 0.0018 | 0.0021 | NG_L | 2018/09/17 | 2019/06/25 | 1 |
| W | Ground water | PFOAS | 72629-94-8 | PERLUOROTRIDECANOIC ACID (PFTRA) | | 16 | | | | NG_L | | | 16 | 0.0035 | 0.0041 | NG_L | 2018/09/17 | 2019/06/25 | 1 |
| W | Ground water | SVOA | 95-50-1 | 1,2-DICHLOROBENZENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | VOA | 95-50-1 | 1,2-DICHLOROBENZENE | | 38 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 123-91-1 | 1,4-DIOXANE | | 71 | 37 | 0.16 | 39 | UG_L | 2007/06/11 | 2019/06/25 | 34 | 0.19 | 1 | UG_L | 2007/06/11 | 2019/06/25 | 0.3 |
| W | Ground water | SVOA | 108-60-1 | 2,2'-OXYBIS(1-CHLOROPROPANE) | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 95-95-4 | 2,4,5-TRICHLOROPHENOL | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 88-06-2 | 2,4,6-TRICHLOROPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 120-83-2 | 2,4-DICHLOROPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.5 |
| W | Ground water | SVOA | 105-67-9 | 2,4-DIMETHYLPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.5 |
| W | Ground water | SVOA | 51-28-5 | 2,4-DINITROPHENOL | | 14 | | | | UG_L | | | 14 | 50 | 50 | UG_L | 1995/11/19 | 1995/11/22 | 3.2 |
| W | Ground water | SVOA | 121-14-2 | 2,4-DINITROTOLUENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 606-20-2 | 2,6-DINITROTOLUENE | | 15 | 1 | 4 | 4 | UG_L | 1995/11/20 | 1995/11/20 | 14 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 91-58-7 | 2-CHLORONAPHTHALENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 95-57-8 | 2-CHLOROPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 91-57-6 | 2-METHYLNAPHTHALENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.08 |
| W | Ground water | SVOA | 95-48-7 | 2-METHYLPHENOL | | 15 | 1 | 2 | 2 | UG_L | 1995/11/20 | 1995/11/20 | 14 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 88-74-4 | 2-NITROANILINE | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 88-75-5 | 2-NITROPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 91-94-1 | 3,3-DICHLOROBENZIDINE | | 15 | | | | UG_L | | | 15 | 10 | 20 | UG_L | 1991/04/05 | 1995/11/22 | 0.6 |
| W | Ground water | SVOA | 99-09-2 | 3-NITROANILINE | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 0.5 |
| W | Ground water | SVOA | 534-52-1 | 4,6-DINITRO-2-METHYLPHENOL | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 1.2 |
| W | Ground water | SVOA | 101-55-3 | 4-BROMOPHENYL-PHENYLETHER | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 59-50-7 | 4-CHLORO-3-METHYLPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 106-47-8 | 4-CHLOROANILINE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 1.6 |
| W | Ground water | SVOA | 7005-72-3 | 4-CHLOROPHENYL-PHENYLETHER | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |

**Appendix C: Screening Level Data Summary**

**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | MET | 7782-49-2 | SELENIUM | No | 0 | 0 | 50 | 246-290 WAC MCL | | Yes | 167 of 195 ND | YES | YES | n |
| W | Ground water | MET | 7440-21-3 | SILICON | No | 0 | 0 | 0 | 0 | | Yes | No current ARAR | 0 | 0 | 0 |
| W | Ground water | MET | 7440-22-4 | SILVER | Yes | 1.2 | MTCA B SW | 1.9 | CWA | | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | MET | 7440-23-5 | SODIUM | No | 0 | 0 | 0 | 0 | | Yes | No current ARAR | 0 | 0 | 0 |
| W | Ground water | MET | 7440-24-6 | STRONTIUM | No | 0 | 0 | 9600 | MTCA B GW | | Yes | MAX<ARAR | n | 0 | 0 |
| W | Ground water | MET | 7440-28-0 | THALLIUM | Yes | 1.1 | MTCA B DW | 0.16 | MTCA B GW | after 2016 | Yes | | YES | YES | 0 |
| W | Ground water | MET | 7440-31-5 | TIN | Yes | 9600 | MTCA B DW | 9600 | MTCA B GW | after 2016 | Yes | MAX<ARAR | n | n | 0 |
| W | Ground water | MET | 7440-32-6 | TITANIUM | No | 0 | 0 | 0 | 0 | | Yes | No current ARAR | 0 | 0 | 0 |
| W | Ground water | MET | 7440-62-2 | VANADIUM | No | 0 | 0 | 80 | MTCA B GW | | Yes | | YES | YES | 0 |
| W | Ground water | MET | 7440-66-6 | ZINC | Yes | 77 | MTCA B SW | 81 | 173-201A WAC | | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | PFOAS | 2991-50-6 | N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (N-ETFOSAA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 2355-31-9 | N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (N-MEFOSAA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 375-73-5 | PERFLUOROBUTANESULFONIC ACID (PFBS) | No | 0 | 0 | 600 | DOD TAPWATER | | Yes | MAX<ARAR | n | n | n |
| W | Ground water | PFOAS | 335-76-2 | PERFLUORODECANOIC ACID (PFDA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 307-55-1 | PERFLUORODODECANOIC ACID (PFDOA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 375-85-9 | PERFLUOROHEPTANOIC ACID (PFHPA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 355-46-4 | PERFLUOROHEXANESULFONIC ACID (PFHXS) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 307-24-4 | PERFLUOROHEXANOIC ACID (PFHXA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 375-95-1 | PERFLUORONONANOIC ACID (PFNA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 1763-23-1 | PERFLUOROOCTANESULFONIC ACID (PFOS) | No | 0 | 0 | 40 | DOD TAPWATER | | Yes | MAX<ARAR | n | n | n |
| W | Ground water | PFOAS | 335-67-1 | PERFLUOROOCTANOIC ACID (PFOA) | No | 0 | 0 | 40 | DOD TAPWATER | | Yes | MAX<ARAR | n | n | n |
| W | Ground water | PFOAS | 376-06-7 | PERFLUOROTETRADECANOIC ACID (PFTEDA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 2058-94-8 | PERFLUOROUNDECANOIC ACID (PFUNA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | PFOAS | 72629-94-8 | PERLUOROTRIDECANOIC ACID (PFTRA) | No | 0 | 0 | 0 | 0 | | Yes | Emerging Contaminants | 0 | 0 | 0 |
| W | Ground water | SVOA | 95-50-1 | 1,2-DICHLOROBENZENE | No | 0 | 0 | 2 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL APPROX ARAR | 0 | YES | n |
| W | Ground water | VOA | 95-50-1 | 1,2-DICHLOROBENZENE | No | 0 | 0 | 8.1 | MTCA B GW | after 1995 | No | PAST RL>ARAR BUT OK FOR VO | 0 | YES | n |
| W | Ground water | SVOA | 123-91-1 | 1,4-DIOXANE | No | 0 | 0 | 0.44 | MTCA B GW | after 1995 | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | SVOA | 108-60-1 | 2,2'-OXYBIS(1-CHLOROPROPANE) | No | 0 | 0 | 0.63 | MTCA B GW | after 1995 | No | 15 ND samples | 0 | YES | n |
| W | Ground water | SVOA | 95-95-4 | 2,4,5-TRICHLOROPHENOL | No | 0 | 0 | 600 | CWA | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 88-06-2 | 2,4,6-TRICHLOROPHENOL | No | 0 | 0 | 0.28 | 173-201A WAC | after 1995 | No | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 120-83-2 | 2,4-DICHLOROPHENOL | No | 0 | 0 | 10 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 105-67-9 | 2,4-DIMETHYLPHENOL | No | 0 | 0 | 97 | 173-201A WAC | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 51-28-5 | 2,4-DINITROPHENOL | No | 0 | 0 | 32 | MTCA B GW | after 1995 | No | PAST RL APPROX ARAR | 0 | YES | n |
| W | Ground water | SVOA | 121-14-2 | 2,4-DINITROTOLUENE | No | 0 | 0 | 0.18 | 173-201A WAC | after 1995 | No | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 606-20-2 | 2,6-DINITROTOLUENE | No | 0 | 0 | 0.058 | MTCA B GW | after 1995 | No | 14 of 15 ND Samples | YES | YES | YES |
| W | Ground water | SVOA | 91-58-7 | 2-CHLORONAPHTHALENE | No | 0 | 0 | 100 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 95-57-8 | 2-CHLOROPHENOL | No | 0 | 40 | 17 | 173-201A WAC | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 91-57-6 | 2-METHYLNAPHTHALENE | No | 0 | 0 | 32 | MTCA B GW | after 1995 | No | Soil Max>ARAR | 0 | n | n |
| W | Ground water | SVOA | 95-48-7 | 2-METHYLPHENOL | No | 0 | 0 | 800 | MTCA B POT GW CUL | after 1995 | No | MAX<ARAR | n | n | n |
| W | Ground water | SVOA | 88-74-4 | 2-NITROANILINE | No | 0 | 0 | 160 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 88-75-5 | 2-NITROPHENOL | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 91-94-1 | 3,3-DICHLOROBENZIDINE | No | 0 | 0 | 0.0033 | 173-201A WAC | after 1995 | Yes | PAST RL > ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 99-09-2 | 3-NITROANILINE | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 534-52-1 | 4,6-DINITRO-2-METHYLPHENOL | No | 0 | 0 | 1.3 | MTCA B GW | after 1995 | Yes | 15 ND Samples | 0 | YES | n |
| W | Ground water | SVOA | 101-55-3 | 4-BROMOPHENYL-PHENYLETHER | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 59-50-7 | 4-CHLORO-3-METHYLPHENOL | No | 0 | 0 | 36 | 173-201A WAC | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 106-47-8 | 4-CHLOROANILINE | No | 0 | 0 | 0.44 | MTCA B GW | after 1995 | No | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 7005-72-3 | 4-CHLOROPHENYL-PHENYLETHER | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | SVOA | 106-44-5 | 4-METHYLPHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0 |
| W | Ground water | SVOA | 100-01-6 | 4-NITROANILINE | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 0.5 |
| W | Ground water | SVOA | 100-02-7 | 4-NITROPHENOL | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 6 |
| W | Ground water | SVOA | 83-32-9 | ACENAPHTHENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 208-96-8 | ACENAPHTHYLENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 120-12-7 | ANTHRACENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.08 |
| W | Ground water | SVOA | 56-55-3 | BENZO[A]ANTHRACENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 50-32-8 | BENZO[A]PYRENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 205-99-2 | BENZO[B]FLUORANTHENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 191-24-2 | BENZO[G,H,I]PERYLENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 207-08-9 | BENZO[K]FLUORANTHENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 56832-73-6 | BENZOFLUORANTHENE | | 1 | 1 | 10 | 10 | UG_L | 1995/11/19 | 1995/11/19 | | | | | | | 0 |
| W | Ground water | SVOA | 65-85-0 | BENZOIC ACID | | 14 | | | | UG_L | | | 14 | 50 | 50 | UG_L | 1995/11/19 | 1995/11/22 | 3.2 |
| W | Ground water | SVOA | 100-51-6 | BENZYL ALCOHOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.5 |
| W | Ground water | SVOA | 111-91-1 | BIS(2-CHLOROETHOXY)METHANE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 111-44-4 | BIS(2-CHLOROETHYL)ETHER | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.09 |
| W | Ground water | SVOA | 117-81-7 | BIS(2-ETHYLHEXYL)PHTHALATE | | 15 | 4 | 3 | 17 | UG_L | 1991/04/05 | 1995/11/21 | 11 | 5 | 10 | UG_L | 1995/11/19 | 1995/11/22 | 1.6 |
| W | Ground water | SVOA | 85-68-7 | BUTYLBENZYLPHTHALATE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.6 |
| W | Ground water | SVOA | 218-01-9 | CHRYSENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | -61 | CPAH, TOTAL | | 1 | 1 | 10 | 10 | UG_L | 1995/11/19 | 1995/11/19 | | | | | | | 0 |
| W | Ground water | SVOA | 53-70-3 | DIBENZ[A,H]ANTHRACENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 132-64-9 | DIBENZOFURAN | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 84-66-2 | DIETHYLPHTHALATE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 131-11-3 | DIMETHYL PHTHALATE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 84-74-2 | DI-N-BUTYLPHTHALATE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.5 |
| W | Ground water | SVOA | 117-84-0 | DI-N-OCTYLPHTHALATE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 206-44-0 | FLUORANTHENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 86-73-7 | FLUORENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 118-74-1 | HEXACHLOROBENZENE | | 14 | | | | UG_L | | | 14 | 10 | 10 | UG_L | 1995/11/19 | 1995/11/22 | 0.09 |
| W | Ground water | SVOA | 87-68-3 | HEXACHLOROBUTADIENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 77-47-4 | HEXACHLOROCYCLOPENTADIENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | 67-72-1 | HEXACHLOROETHANE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | -63 | HPAH, TOTAL | | 1 | 1 | 10 | 10 | UG_L | 1995/11/19 | 1995/11/19 | | | | | | | 0 |
| W | Ground water | SVOA | 193-39-5 | INDENO[1,2,3-CD]PYRENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.032 |
| W | Ground water | SVOA | 78-59-1 | ISOPHORONE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.3 |
| W | Ground water | SVOA | -64 | LPAH, TOTAL | | 1 | 1 | 10 | 10 | UG_L | 1995/11/19 | 1995/11/19 | | | | | | | 0 |
| W | Ground water | SVOA | 91-20-3 | NAPHTHALENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.08 |
| W | Ground water | SVOA | -150 | NCPAH, TOTAL | | 1 | 1 | 10 | 10 | UG_L | 1995/11/19 | 1995/11/19 | | | | | | | 0 |
| W | Ground water | SVOA | 98-95-3 | NITROBENZENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.09 |
| W | Ground water | SVOA | 621-64-7 | N-NITROSODINPROPYLAMINE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.09 |
| W | Ground water | SVOA | 86-30-6 | N-NITROSODIPHENYLAMINE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.15 |
| W | Ground water | SVOA | 87-86-5 | PENTACHLOROPHENOL | | 15 | | | | UG_L | | | 15 | 50 | 50 | UG_L | 1991/04/05 | 1995/11/22 | 1 |
| W | Ground water | SVOA | 85-01-8 | PHENANTHRENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.08 |
| W | Ground water | SVOA | 108-95-2 | PHENOL | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.6 |
| W | Ground water | SVOA | 129-00-0 | PYRENE | | 15 | | | | UG_L | | | 15 | 10 | 10 | UG_L | 1991/04/05 | 1995/11/22 | 0.08 |
| W | Ground water | TPH | unavailable09 | TPH | | 2 | | | | UG_L | | | 2 | 500 | 500 | UG_L | 2000/06/12 | 2000/06/13 | 0 |
| W | Ground water | TPH | -93 | TPH-C10-C12 ALIPHATICS | | 1 | 1 | 782 | 782 | UG_L | 1998/05/08 | 1998/05/08 | | | | | | | 0 |
| W | Ground water | TPH | -98 | TPH-C10-C12 AROMATICS | | 1 | 1 | 744 | 744 | UG_L | 1998/05/08 | 1998/05/08 | | | | | | | 0 |
| W | Ground water | TPH | -117 | TPH-C10-C25 AROMATICS | | 1 | 1 | 2344 | 2344 | UG_L | 1998/05/08 | 1998/05/08 | | | | | | | 0 |
| W | Ground water | TPH | -105 | TPH-C12-C13 AROMATICS | | 1 | 1 | 1600 | 1600 | UG_L | 1998/05/08 | 1998/05/08 | | | | | | | 0 |
| W | Ground water | TPH | -102 | TPH-C5-C6 ALIPHATICS | | 1 | | | | UG_L | | | 1 | 100 | 100 | UG_L | 1998/05/08 | 1998/05/08 | 0 |
| W | Ground water | TPH | -114 | TPH-C6-C10 ALIPHATICS | | 1 | | | | UG_L | | | 1 | 100 | 100 | UG_L | 1998/05/08 | 1998/05/08 | 0 |
| W | Ground water | TPH | -103 | TPH-C6-C8 ALIPHATICS | | 1 | | | | UG_L | | | 1 | 100 | 100 | UG_L | 1998/05/08 | 1998/05/08 | 0 |
| W | Ground water | TPH | -104 | TPH-C8-C10 ALIPHATICS | | 1 | | | | UG_L | | | 1 | 100 | 100 | UG_L | 1998/05/08 | 1998/05/08 | 0 |
| W | Ground water | TPH | -97 | TPH-C8-C10 AROMATICS | | 1 | 1 | 200 | 200 | UG_L | 1998/05/08 | 1998/05/08 | | | | | | | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | SVOA | 106-44-5 | 4-METHYLPHENOL | No | 0 | 0 | 1600 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | 0 |
| W | Ground water | SVOA | 100-01-6 | 4-NITROANILINE | No | 0 | 0 | 4.4 | MTCA B GW | after 1995 | Yes | 15 ND Samples | 0 | YES | n |
| W | Ground water | SVOA | 100-02-7 | 4-NITROPHENOL | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 83-32-9 | ACENAPHTHENE | No | 0 | 0 | 30 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 208-96-8 | ACENAPHTHYLENE | No | 0 | 0 | 0 | 0 | after 1995 | Yes | Standard PAH List | 0 | 0 | 0 |
| W | Ground water | SVOA | 120-12-7 | ANTHRACENE | No | 0 | 0 | 100 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 56-55-3 | BENZO[A]ANTHRACENE | No | 0 | 0 | 0.00016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 50-32-8 | BENZO[A]PYRENE | No | 0 | 0 | 0.000016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 205-99-2 | BENZO[B]FLUORANTHENE | No | 0 | 0 | 0.00016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 191-24-2 | BENZO[G,H,I]PERYLENE | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 207-08-9 | BENZO[K]FLUORANTHENE | No | 0 | 0 | 0.0016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 56832-73-6 | BENZOFLUORANTHENE | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 65-85-0 | BENZOIC ACID | No | 0 | 0 | 64000 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 100-51-6 | BENZYL ALCOHOL | No | 0 | 0 | 1600 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 111-91-1 | BIS(2-CHLOROETHOXY)METHANE | No | 0 | 0 | 48 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 111-44-4 | BIS(2-CHLOROETHYL)ETHER | No | 0 | 0 | 0.04 | MTCA B GW | after 1995 | Yes | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 117-81-7 | BIS(2-ETHYLHEXYL)PHTHALATE | Yes | 3.6 | MTCA B SW FORM | 0.046 | 40 CFR 131.45 PRO SW | after 1995 | No |  | YES | YES | YES |
| W | Ground water | SVOA | 85-68-7 | BUTYLBENZYLPHTHALATE | Yes | 1300 | MTCA B SW | 0.013 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 218-01-9 | CHRYSENE | No | 0 | 0 | 0.016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | -61 | CPAH, TOTAL | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 53-70-3 | DIBENZ[A,H]ANTHRACENE | No | 0 | 0 | 0.000016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 132-64-9 | DIBENZOFURAN | No | 0 | 0 | 8 | MTCA B GW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | n |
| W | Ground water | SVOA | 84-66-2 | DIETHYLPHTHALATE | No | 0 | 0 | 200 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 131-11-3 | DIMETHYL PHTHALATE | Yes | 16000 | MTCA B DW | 600 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 84-74-2 | DI-N-BUTYLPHTHALATE | Yes | 1600 | MTCA B DW | 8 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL APPROX ARAR | 0 | YES | n |
| W | Ground water | SVOA | 117-84-0 | DI-N-OCTYLPHTHALATE | Yes | 320 | MTCA B DW | 160 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 206-44-0 | FLUORANTHENE | No | 0 | 0 | 6 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL<ARAR | 0 | YES | n |
| W | Ground water | SVOA | 86-73-7 | FLUORENE | No | 0 | 0 | 10 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL=ARAR | 0 | n | n |
| W | Ground water | SVOA | 118-74-1 | HEXACHLOROBENZENE | No | 0 | 0 | 0.000005 | 40 CFR 131.45 PRO SW | after 1995 | Yes | 14 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 87-68-3 | HEXACHLOROBUTADIENE | No | 0 | 0 | 0.01 | 40 CFR 131.45 PRO SW | after 1995 | No | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 77-47-4 | HEXACHLOROCYCLOPENTADIENE | No | 0 | 0 | 1 | 40 CFR 131.45 PRO SW | after 1995 | No | 15 ND Samples | 0 | YES | n |
| W | Ground water | SVOA | 67-72-1 | HEXACHLOROETHANE | No | 0 | 0 | 0.02 | 40 CFR 131.45 PRO SW | after 1995 | No | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | -63 | HPAH, TOTAL | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 193-39-5 | INDENO[1,2,3-CD]PYRENE | No | 0 | 0 | 0.00016 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 78-59-1 | ISOPHORONE | No | 0 | 0 | 92 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | -64 | LPAH, TOTAL | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 91-20-3 | NAPHTHALENE | No | 0 | 0 | 160 | MTCA B GW | after 1995 | Yes | Soil | 0 | n | n |
| W | Ground water | SVOA | -150 | NCPAH, TOTAL | No | 0 | 0 | 0 | 0 | after 1995 | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | SVOA | 98-95-3 | NITROBENZENE | No | 0 | 0 | 16 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 621-64-7 | N-NITROSODINPROPYLAMINE | No | 0 | 0 | 0.013 | MTCA B GW | after 1995 | No | 15 ND Samples | 0 | YES | YES |
| W | Ground water | SVOA | 86-30-6 | N-NITROSODIPHENYLAMINE | No | 0 | 0 | 0.69 | 173-201A WAC | after 1995 | Yes | 15 ND Samples | 0 | YES | n |
| W | Ground water | SVOA | 87-86-5 | PENTACHLOROPHENOL | No | 0 | 0 | 0.002 | 40 CFR 131.45 PRO SW | after 1995 | No | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | SVOA | 85-01-8 | PHENANTHRENE | No | 0 | 0 | 0 | 0 | after 1995 | Yes | Standard PAH List | 0 | 0 | 0 |
| W | Ground water | SVOA | 108-95-2 | PHENOL | No | 0 | 0 | 4800 | MTCA B GW | after 1995 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | SVOA | 129-00-0 | PYRENE | No | 0 | 0 | 8 | 40 CFR 131.45 PRO SW | after 1995 | Yes | PAST RL>ARAR | 0 | YES | n |
| W | Ground water | TPH | unavailable09 | TPH | No | 0 | 0 | 500 | MTCA A | 2006 | No | PAST RL<ARAR | 0 | n | 0 |
| W | Ground water | TPH | -93 | TPH-C10-C12 ALIPHATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -98 | TPH-C10-C12 AROMATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -117 | TPH-C10-C25 AROMATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -105 | TPH-C12-C13 AROMATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -102 | TPH-C5-C6 ALIPHATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -114 | TPH-C6-C10 ALIPHATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -103 | TPH-C6-C8 ALIPHATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -104 | TPH-C8-C10 ALIPHATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | TPH | -97 | TPH-C8-C10 AROMATICS | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | TPH | unavailable09 | TPH-DIESEL RANGE | | 14 | 4 | 250 | 10000 | UG_L | 1992/06/25 | 1992/07/01 | 10 | 36 | 250 | UG_L | 1992/06/30 | 2004/06/15 | 100 |
| W | Ground water | TPH | unavailable25 | TPH-GASOLINE RANGE C7-C12 | | 9 | 3 | 310 | 1400 | UG_L | 1992/06/25 | 1992/07/09 | 6 | 250 | 250 | UG_L | 1992/06/30 | 1992/07/14 | 40 |
| W | Ground water | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL | | 3 | | | | UG_L | | | 3 | 54 | 54 | UG_L | 2004/06/14 | 2004/06/15 | 300 |
| W | Ground water | VOA | 630-20-6 | 1,1,1,2-TETRACHLOROETHANE | | 38 | | | | UG_L | | | 38 | 0.12 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 71-55-6 | 1,1,1-TRICHLOROETHANE | HH | 319 | 253 | 0.074 | 3100 | UG_L | 1991/04/05 | 2019/06/25 | 66 | 0.12 | 100 | UG_L | 1991/07/01 | 2019/06/25 | 0.07 |
| W | Ground water | VOA | 79-34-5 | 1,1,2,2-TETRACHLOROETHANE | | 266 | | | | UG_L | | | 266 | 0.14 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 79-00-5 | 1,1,2-TRICHLOROETHANE | HH | 341 | 13 | 0.032 | 89 | UG_L | 1991/07/01 | 2018/09/18 | 328 | 0.01 | 100 | UG_L | 1991/04/05 | 2019/06/25 | 0.15 |
| W | Ground water | VOA | 75-34-3 | 1,1-DICHLOROETHANE | | 319 | 127 | 0.063 | 100 | UG_L | 1991/07/01 | 2019/06/25 | 192 | 0.091 | 100 | UG_L | 1991/04/05 | 2019/06/25 | 0.07 |
| W | Ground water | VOA | 75-35-4 | 1,1-DICHLOROETHENE | HH | 343 | 190 | 0.043 | 390 | UG_L | 1991/07/01 | 2019/06/11 | 153 | 0.02 | 100 | UG_L | 1991/04/05 | 2019/06/25 | 0.07 |
| W | Ground water | VOA | 563-58-6 | 1,1-DICHLOROPROPENE | | 38 | | | | UG_L | | | 38 | 0.13 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 87-61-6 | 1,2,3-TRICHLOROBENZENE | | 38 | | | | UG_L | | | 38 | 0.33 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 96-18-4 | 1,2,3-TRICHLOROPROPANE | | 38 | | | | UG_L | | | 38 | 0.22 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 95-63-6 | 1,2,4-TRIMETHYLBENZENE | | 38 | 2 | 1 | 3.4 | UG_L | 2000/06/12 | 2002/06/21 | 36 | 0.15 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 96-12-8 | 1,2-DIBROMO-3-CHLOROPROPANE | | 24 | | | | UG_L | | | 24 | 1 | 10 | UG_L | 2000/06/08 | 2003/06/17 | 0.0057 |
| W | Ground water | VOA | 106-93-4 | 1,2-DIBROMOETHANE | | 38 | | | | UG_L | | | 38 | 0.073 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.0057 |
| W | Ground water | VOA | 107-06-2 | 1,2-DICHLOROETHANE | HH | 324 | 36 | 0.0061 | 10 | UG_L | 1992/04/06 | 2018/09/18 | 288 | 0.02 | 100 | UG_L | 1991/04/05 | 2019/06/25 | 0.15 |
| W | Ground water | VOA | 540-59-0 | 1,2-DICHLOROETHENE, TOTAL | HH | 107 | 80 | 1 | 71 | UG_L | 1991/07/01 | 1994/01/28 | 27 | 2 | 100 | UG_L | 1991/07/01 | 1994/01/27 | 0 |
| W | Ground water | VOA | 78-87-5 | 1,2-DICHLOROPROPANE | | 267 | 1 | 3 | 3 | UG_L | 1996/09/30 | 1996/09/30 | 266 | 0.13 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 108-67-8 | 1,3,5-TRIMETHYLBENZENE | | 38 | 2 | 0.2 | 0.49 | UG_L | 2000/06/12 | 2002/06/21 | 36 | 0.13 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| S | Soil | SVOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | | 3 | | | | MG_KG | | | 38 | 0.11 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.3 |
| W | Ground water | VOA | 142-28-9 | 1,3-DICHLOROPROPANE | | 38 | | | | UG_L | | | 38 | 0.076 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.07 |
| W | Ground water | VOA | 542-75-6 | 1,3-DICHLOROPROPENE, TOTAL | | 77 | 12 | 1 | 3 | UG_L | 1992/09/28 | 1998/05/26 | 65 | 3 | 50 | UG_L | 1992/04/06 | 1994/01/28 | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | | 29 | | | | MG_KG | | | 38 | 0.087 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.3 |
| W | Ground water | VOA | 594-20-7 | 2,2-DICHLOROPROPANE | | 38 | | | | UG_L | | | 38 | 0.18 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 78-93-3 | 2-BUTANONE | | 215 | 3 | 5 | 8 | UG_L | 1991/07/02 | 1993/07/01 | 212 | 3 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0 |
| W | Ground water | VOA | 110-75-8 | 2-CHLOROETHYL VINYL ETHER | | 53 | | | | UG_L | | | 53 | 1 | 100 | UG_L | 1995/11/19 | 1998/05/26 | 0 |
| W | Ground water | VOA | 95-49-8 | 2-CHLOROTOLUENE | | 38 | | | | UG_L | | | 38 | 0.12 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 591-78-6 | 2-HEXANONE | | 260 | | | | UG_L | | | 260 | 1 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0 |
| W | Ground water | VOA | 106-43-4 | 4-CHLOROTOLUENE | | 38 | | | | UG_L | | | 38 | 0.089 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.25 |
| W | Ground water | VOA | 99-87-6 | 4-ISOPROPYLTOLUENE | | 38 | 2 | 0.2 | 0.28 | UG_L | 2000/06/12 | 2002/06/21 | 36 | 0.13 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 108-10-1 | 4-METHYL-2-PENTANONE | | 237 | | | | UG_L | | | 237 | 1 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0 |
| W | Ground water | VOA | 67-64-1 | ACETONE | | 277 | 27 | 1 | 360 | UG_L | 1991/04/05 | 2016/06/20 | 250 | 1.2 | 200 | UG_L | 1991/07/01 | 2017/06/21 | 0 |
| W | Ground water | VOA | 71-43-2 | BENZENE | HH | 327 | 10 | 0.06 | 28 | UG_L | 1991/07/01 | 2010/06/14 | 317 | 0.11 | 100 | UG_L | 1991/04/05 | 2017/06/21 | 0.07 |
| W | Ground water | VOA | 108-86-1 | BROMOBENZENE | | 38 | | | | UG_L | | | 38 | 0.098 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 74-97-5 | BROMOCHLOROMETHANE | | 38 | | | | UG_L | | | 38 | 0.13 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 75-27-4 | BROMODICHLOROMETHANE | HH | 267 | 9 | 0.16 | 2 | UG_L | 1991/07/02 | 2014/06/17 | 258 | 0.085 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 75-25-2 | BROMOFORM | | 267 | | | | UG_L | | | 267 | 0.2 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.35 |
| W | Ground water | VOA | 74-83-9 | BROMOMETHANE | | 267 | 1 | 0.13 | 0.13 | UG_L | 2013/06/18 | 2013/06/18 | 266 | 0.2 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | -71 | BTEX, TOTAL | | 79 | 20 | 1 | 8 | UG_L | 1992/04/07 | 1999/05/17 | 59 | 2 | 50 | UG_L | 1992/04/06 | 1994/01/28 | 0 |
| W | Ground water | VOA | 75-15-0 | CARBON DISULFIDE | | 267 | 13 | 0.16 | 7 | UG_L | 1993/07/01 | 2006/06/22 | 254 | 0.16 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0 |
| W | Ground water | VOA | 56-23-5 | CARBON TETRACHLORIDE | HH | 394 | 9 | 0.029 | 8.4 | UG_L | 1991/07/01 | 2018/09/18 | 385 | 0.01 | 100 | UG_L | 1991/04/05 | 2019/06/25 | 0.07 |
| W | Ground water | VOA | 108-90-7 | CHLOROBENZENE | | 267 | | | | UG_L | | | 267 | 0.094 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 75-00-3 | CHLOROETHANE | | 253 | 1 | 29 | 29 | UG_L | 1992/07/02 | 1992/07/02 | 252 | 0.2 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0.25 |
| W | Ground water | VOA | 67-66-3 | CHLOROFORM | HH | 343 | 160 | 0.0093 | 10.8 | UG_L | 1991/07/01 | 2019/06/25 | 183 | 0.01 | 100 | UG_L | 1991/04/05 | 2019/06/25 | 0.07 |
| W | Ground water | VOA | 74-87-3 | CHLOROMETHANE | | 267 | 5 | 0.13 | 0.35 | UG_L | 2009/06/17 | 2009/06/18 | 262 | 0.14 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0.35 |
| W | Ground water | VOA | 156-59-2 | CIS-1,2-DICHLOROETHENE | | 226 | 161 | 0.027 | 130 | UG_L | 1995/11/19 | 2019/06/25 | 65 | 0.02 | 50 | UG_L | 1991/04/05 | 2019/06/25 | 0.15 |
| W | Ground water | VOA | 10061-01-5 | CIS-1,3-DICHLOROPROPENE | | 267 | | | | UG_L | | | 267 | 0.081 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 124-48-1 | DIBROMOCHLOROMETHANE | | 267 | 1 | 0.09 | 0.09 | UG_L | 2000/06/12 | 2000/06/12 | 266 | 0.082 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 74-95-3 | DIBROMOMETHANE | | 38 | | | | UG_L | | | 38 | 0.098 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 75-71-8 | DICHLORODIFLUOROMETHANE | | 38 | | | | UG_L | | | 38 | 0.17 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 100-41-4 | ETHYLBENZENE | | 318 | 6 | 0.6 | 16 | UG_L | 1991/07/01 | 1999/11/22 | 312 | 0.098 | 100 | UG_L | 1991/04/05 | 2017/06/21 | 0.07 |
| W | Ground water | VOA | 87-68-3 | HEXACHLOROBUTADIENE | | 38 | | | | UG_L | | | 38 | 0.28 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.15 |
| W | Ground water | VOA | 98-82-8 | ISOPROPYLBENZENE | | 38 | 2 | 0.1 | 0.12 | UG_L | 2000/06/12 | 2002/06/21 | 36 | 0.068 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.5 |
| W | Ground water | VOA | 1330-20-7 | M- AND P-XYLENE | | 160 | 7 | 0.11 | 40 | UG_L | 1992/06/25 | 2015/06/26 | 153 | 0.19 | 50 | UG_L | 1992/06/30 | 2017/06/21 | 0.25 |
| W | Ground water | VOA | 75-09-2 | METHYLENE CHLORIDE | | 270 | 17 | 0.24 | 4 | UG_L | 1992/04/06 | 2002/06/20 | 253 | 0.2 | 50 | UG_L | 1991/04/05 | 2014/06/18 | 3.5 |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | TPH | unavailable09 | TPH-DIESEL RANGE | No | 0 | 0 | 500 | MTCA A | 2006 | No | REMOVED FROM PROGRAM | YES | n | n |
| W | Ground water | TPH | unavailable25 | TPH-GASOLINE RANGE C7-C12 | No | 0 | 0 | 800 | MTCA A | 2006 | No | REMOVED FROM PROGRAM | YES | n | n |
| W | Ground water | TPH | unavailable10 | TPH-HEAVY FRACTION/OIL | No | 0 | 0 | 500 | MTCA A | 2006 | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 630-20-6 | 1,1,1,2-TETRACHLOROETHANE | No | 0 | 0 | 1.7 | MTCA B GW |  | No | PAST RL APPROX ARAR | 0 | YES | n |
| W | Ground water | VOA | 71-55-6 | 1,1,1-TRICHLOROETHANE | Yes | 200 | MTCA B DW | 200 | STATE MCL |  | Yes | MAX>ARAR | YES | n | n |
| W | Ground water | VOA | 79-34-5 | 1,1,2,2-TETRACHLOROETHANE | No | 0 | 0 | 0.22 | MTCA B GW |  | Yes | PAST RL>ARAR | 0 | YES | n |
| W | Ground water | VOA | 79-00-5 | 1,1,2-TRICHLOROETHANE | Yes | 0.77 | MTCA B DW FORM | 0.77 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 75-34-3 | 1,1-DICHLOROETHANE | Yes | 800 | MTCA B DW | 7.7 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 75-35-4 | 1,1-DICHLOROETHENE | Yes | 0.073 | MTCA B DW FORM | 7 | STATE MCL |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 563-58-6 | 1,1-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 87-61-6 | 1,2,3-TRICHLOROBENZENE | No | 0 | 0 | 6.4 | MTCA B GW |  | No | PAST RL APPROX ARAR | 0 | YES | n |
| W | Ground water | VOA | 96-18-4 | 1,2,3-TRICHLOROPROPANE | No | 0 | 0 | 0.00038 | MTCA B GW |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | VOA | 95-63-6 | 1,2,4-TRIMETHYLBENZENE | No | 0 | 0 | 80 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 96-12-8 | 1,2-DIBROMO-3-CHLOROPROPANE | No | 0 | 0 | 0.014 | MTCA B GW |  | No | Gasoline additive | 0 | YES | n |
| W | Ground water | VOA | 106-93-4 | 1,2-DIBROMOETHANE | No | 0 | 0 | 0.01 | MTCA A |  | No | Gasoline additive | 0 | YES | n |
| W | Ground water | VOA | 107-06-2 | 1,2-DICHLOROETHANE | Yes | 0.48 | MTCA B DW FORM | 0.48 | MTCA B GW |  | Yes | SW NOT IMPACTED | YES | YES | n |
| W | Ground water | VOA | 540-59-0 | 1,2-DICHLOROETHENE, TOTAL | No | 0 | 0 | 72 | MTCA B GW |  | No | MAX<ARAR; PAST RL>ARAR | n | YES | 0 |
| W | Ground water | VOA | 78-87-5 | 1,2-DICHLOROPROPANE | No | 0 | 0 | 1.2 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 108-67-8 | 1,3,5-TRIMETHYLBENZENE | No | 0 | 0 | 80 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| S | Soil | SVOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | No | 0 | 0 | 2 | 40 CFR 131.45 PRO SW |  | No | PAST RL APPROX ARAR | 0 | YES | n |
| W | Ground water | VOA | 142-28-9 | 1,3-DICHLOROPROPANE | No | 0 | 0 | 160 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 542-75-6 | 1,3-DICHLOROPROPENE, TOTAL | No | 0 | 0 | 0.44 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | 0 |
| S | Sub-surface soil ( > 6") | SVOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | No | 0 | 0 | 8.1 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 594-20-7 | 2,2-DICHLOROPROPANE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 78-93-3 | 2-BUTANONE | No | 0 | 0 | 4800 | MTCA B POT GW CUL |  | No | MAX<ARAR | n | n | 0 |
| W | Ground water | VOA | 110-75-8 | 2-CHLOROETHYL VINYL ETHER | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 95-49-8 | 2-CHLOROTOLUENE | No | 0 | 0 | 160 | MTCA B POT GW CUL |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 591-78-6 | 2-HEXANONE | No | 0 | 0 | 40 | MTCA B GW |  | No | PAST RL APPROX ARAR | 0 | YES | 0 |
| W | Ground water | VOA | 106-43-4 | 4-CHLOROTOLUENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 99-87-6 | 4-ISOPROPYLTOLUENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 108-10-1 | 4-METHYL-2-PENTANONE | No | 0 | 0 | 640 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | 0 |
| W | Ground water | VOA | 67-64-1 | ACETONE | Yes | 800 | MTCA B DW | 7200 | MTCA B GW |  | No | MAX<ARAR | n | n | 0 |
| W | Ground water | VOA | 71-43-2 | BENZENE | Yes | 1.5 | MTCA B DW FORM | 0.8 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 108-86-1 | BROMOBENZENE | No | 0 | 0 | 64 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 74-97-5 | BROMOCHLOROMETHANE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 75-27-4 | BROMODICHLOROMETHANE | No | 0 | 0 | 0.71 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 75-25-2 | BROMOFORM | No | 0 | 0 | 5.5 | MTCA B GW |  | No | Not above lowest ARAR in SW | 0 | YES | n |
| W | Ground water | VOA | 74-83-9 | BROMOMETHANE | No | 0 | 0 | 11 | MTCA B GW |  | Yes | MAX<ARAR; PAST RL>ARAR | n | YES | n |
| W | Ground water | VOA | -71 | BTEX, TOTAL | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 75-15-0 | CARBON DISULFIDE | No | 0 | 0 | 800 | MTCA B GW |  | No | MAX<ARAR | n | n | 0 |
| W | Ground water | VOA | 56-23-5 | CARBON TETRACHLORIDE | Yes | 0.34 | MTCA B DW | 0.35 | 173-201A WAC |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 108-90-7 | CHLOROBENZENE | No | 0 | 0 | 100 | STATE MCL |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 75-00-3 | CHLOROETHANE | No | 0 | 0 | 0 | 0 |  | Yes | Max RL>ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 67-66-3 | CHLOROFORM | Yes | 7.2 | MTCA B DW | 1.4 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 74-87-3 | CHLOROMETHANE | No | 0 | 0 | 0 | 0 |  | Yes | Max RL>ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 156-59-2 | CIS-1,2-DICHLOROETHENE | Yes | 70 | MTCA B DW | 16 | MTCA B GW |  | No | Not above lowest ARAR in SW | YES | YES | n |
| W | Ground water | VOA | 10061-01-5 | CIS-1,3-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR | 0 | 0 | 0 |
| W | Ground water | VOA | 124-48-1 | DIBROMOCHLOROMETHANE | No | 0 | 0 | 0.52 | MTCA B GW |  | Yes | MAX<ARAR; PAST RL>ARAR | n | YES | n |
| W | Ground water | VOA | 74-95-3 | DIBROMOMETHANE | No | 0 | 0 | 80 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 75-71-8 | DICHLORODIFLUOROMETHANE | No | 0 | 0 | 1600 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 100-41-4 | ETHYLBENZENE | Yes | 700 | MTCA B DW | 31 | 40 CFR 131.45 PRO SW |  | Yes | MAX<ARAR; PAST RL>ARAR | n | YES | n |
| W | Ground water | VOA | 87-68-3 | HEXACHLOROBUTADIENE | No | 0 | 0 | 0.01 | 40 CFR 131.45 PRO SW | after 1995 | No | 38 ND Samples | 0 | YES | YES |
| W | Ground water | VOA | 98-82-8 | ISOPROPYLBENZENE | No | 0 | 0 | 800 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 1330-20-7 | M- AND P-XYLENE | Yes | 10000 | MTCA B DW | 1000 | STATE MCL |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 75-09-2 | METHYLENE CHLORIDE | No | 0 | 0 | 5 | STATE MCL |  | Yes | MAX<ARAR; PAST RL>ARAR | n | YES | n |

**Appendix C: Screening Level Data Summary**
**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | BRA COPC | Sample_Count | Det_Sample_Count | Det_Min_Value | Det_Max_Value | Units | Det_Min Sample Date | Det_Max_ Sample Date | ND Count | ND Min Value_RL | ND Max Value_RL | ND Units | ND Min Sample Date | ND Max Sample Date | Current RL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | VOA | 91-20-3 | NAPHTHALENE | | 38 | | | | UG_L | | | 38 | 0.29 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.08 |
| W | Ground water | VOA | 104-51-8 | N-BUTYLBENZENE | | 38 | 1 | 0.29 | 0.29 | UG_L | 2002/06/21 | 2002/06/21 | 37 | 0.23 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.5 |
| W | Ground water | VOA | 95-47-6 | O-XYLENE | | 160 | 1 | 28 | 28 | UG_L | 1992/06/25 | 1992/06/25 | 159 | 0.079 | 50 | UG_L | 1992/06/30 | 2017/06/21 | 0.35 |
| W | Ground water | VOA | 103-65-1 | PROPYLBENZENE | | 38 | 2 | 0.2 | 0.25 | UG_L | 2000/06/12 | 2002/06/21 | 36 | 0.097 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.25 |
| W | Ground water | VOA | 135-98-8 | SEC-BUTYLBENZENE | | 38 | 1 | 0.18 | 0.18 | UG_L | 2002/06/21 | 2002/06/21 | 37 | 0.13 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.5 |
| W | Ground water | VOA | 100-42-5 | STYRENE | | 309 | | | | UG_L | | | 309 | 0.095 | 100 | UG_L | 1991/04/05 | 2017/06/21 | 0.5 |
| W | Ground water | VOA | 98-06-6 | TERT-BUTYLBENZENE | | 38 | | | | UG_L | | | 38 | 0.13 | 10 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 127-18-4 | TETRACHLOROETHENE | HH | 354 | 205 | 0.014 | 140 | UG_L | 1991/04/05 | 2019/06/25 | 149 | 0.01 | 100 | UG_L | 1991/07/01 | 2019/06/25 | 0.25 |
| W | Ground water | VOA | 108-88-3 | TOLUENE | | 319 | 66 | 0.08 | 32 | UG_L | 1991/07/01 | 2016/06/20 | 253 | 0.098 | 100 | UG_L | 1991/04/05 | 2017/06/21 | 0.15 |
| W | Ground water | VOA | 156-60-5 | TRANS-1,2-DICHLOROETHENE | | 227 | 64 | 0.06 | 110 | UG_L | 2001/06/21 | 2019/06/11 | 163 | 0.02 | 50 | UG_L | 1991/04/05 | 2019/06/25 | 0.07 |
| W | Ground water | VOA | 10061-02-6 | TRANS-1,3-DICHLOROPROPENE | | 267 | | | | UG_L | | | 267 | 0.087 | 100 | UG_L | 1991/04/05 | 2014/06/18 | 0.15 |
| W | Ground water | VOA | 79-01-6 | TRICHLOROETHENE | HH | 342 | 287 | 0.031 | 3100 | UG_L | 1991/04/05 | 2019/06/25 | 55 | 0.01 | 25 | UG_L | 1991/07/01 | 2019/06/25 | 0.15 |
| W | Ground water | VOA | 75-69-4 | TRICHLOROFLUOROMETHANE | | 38 | | | | UG_L | | | 38 | 0.14 | 2.5 | UG_L | 2000/06/08 | 2004/06/15 | 0.35 |
| W | Ground water | VOA | 108-05-4 | VINYL ACETATE | | 64 | | | | UG_L | | | 64 | 1 | 200 | UG_L | 1991/04/05 | 1998/05/26 | 0 |
| W | Ground water | VOA | 75-01-4 | VINYL CHLORIDE | | 285 | 12 | 0.12 | 1.5 | UG_L | 2000/06/08 | 2010/06/14 | 273 | 0.01 | 200 | UG_L | 1991/04/05 | 2014/06/18 | 0.015 |
| W | Ground water | VOA | 1330-20-7 | XYLENES, TOTAL | | 176 | 8 | 1 | 54 | UG_L | 1991/07/01 | 1999/05/17 | 168 | 1 | 100 | UG_L | 1991/04/05 | 1999/11/22 | 0.25 |
| W | Ground water | SVOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | | 15 | | | | UG_L | | | 3 | 0.22 | 0.22 | UG_L | 2001/06/22 | 2001/06/22 | 0.3 |
| W | Ground water | VOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | | 38 | | | | UG_L | | | 3 | 0.085 | 0.085 | UG_L | 2001/06/22 | 2001/06/22 | 0.3 |

**Appendix C: Screening Level Data Summary**

**Draft Project-Specific QAPP Keyport Area 8 Supplemental RI Naval Base Kitsap Keyport WA (cont'd)**

| Medium | Matrix | Analyte Group | CASRN USED TO SCREEN | Analyte | Has ROD RG (yes/no)? | MIN ROD RG | ROD RG Source | Current ARAR | Current ARAR Source | Date removed from the program | Keep in Program (yes/no)? | Reason | Max Exceeds ARAR? (formula) | PAST RL Exceeds NEW ARAR? (formula) | NEW RL Exceeds NEW ARAR? (formula) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | Ground water | VOA | 91-20-3 | NAPHTHALENE | No | 0 | 0 | 160 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 104-51-8 | N-BUTYLBENZENE | No | 0 | 0 | 400 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 95-47-6 | O-XYLENE | No | 0 | 0 | 1600 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 103-65-1 | PROPYLBENZENE | No | 0 | 0 | 800 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 135-98-8 | SEC-BUTYLBENZENE | No | 0 | 0 | 800 | MTCA B GW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 100-42-5 | STYRENE | Yes | 1.5 | MTCA B DW | 100 | STATE MCL |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 98-06-6 | TERT-BUTYLBENZENE | No | 0 | 0 | 800 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 127-18-4 | TETRACHLOROETHENE | Yes | 0.86 | MTCA B DW FORM | 2.9 | 40 CFR 131.45 PRO SW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 108-88-3 | TOLUENE | Yes | 1000 | MTCA B DW | 130 | 40 CFR 131.45 PRO SW |  | No | MAX<ARAR | n | n | n |
| W | Ground water | VOA | 156-60-5 | TRANS-1,2-DICHLOROETHENE | Yes | 100 | MTCA B DW | 100 | STATE MCL |  | Yes | Past Max and max RL>ARAR | YES | n | n |
| W | Ground water | VOA | 10061-02-6 | TRANS-1,3-DICHLOROPROPENE | No | 0 | 0 | 0 | 0 |  | No | No current ARAR, all ND | 0 | 0 | 0 |
| W | Ground water | VOA | 79-01-6 | TRICHLOROETHENE | Yes | 4 | MTCA B DW FORM | 0.54 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 75-69-4 | TRICHLOROFLUOROMETHANE | No | 0 | 0 | 2400 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | n |
| W | Ground water | VOA | 108-05-4 | VINYL ACETATE | No | 0 | 0 | 8000 | MTCA B GW |  | No | PAST RL<ARAR | 0 | n | 0 |
| W | Ground water | VOA | 75-01-4 | VINYL CHLORIDE | No | 0 | 0 | 0.029 | MTCA B GW |  | Yes | MAX>ARAR | YES | YES | n |
| W | Ground water | VOA | 1330-20-7 | XYLENES, TOTAL | Yes | 10000 | MTCA B DW | 1000 | STATE MCL |  | No | MAX<ARAR | n | n | n |
| W | Ground water | SVOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | No | 0 | 0 | 0.037 | 40 CFR 131.45 PRO SW |  | Yes | PAST RL>ARAR | 0 | YES | YES |
| W | Ground water | VOA | 120-82-1 | 1,2,4-TRICHLOROBENZENE | No | 0 | 0 | 800 | 40 CFR 131.45 PRO SW |  | No | PAST RL<ARAR | 0 | n | n |

**Notes:**

Blank rows indicate no information available.

Highlighted orange rows have differing units than the majority of analytical results.

2018 LTM PFAS data not included.

ARAR = applicable or relevant and appropriate requirements
bgs = below ground surface
CASRN = Chemical Abstract Service Registry Number
CFR = Code of Federal Regulations
CLARC = Cleanup Levels and Risk Calculation
CWA = Clean Water Act
DoD = Department of Defense, United States
GW = groundwater
HERB = herbicide
HH = human health
INO = inorganics
ND = not detected
ng/L = nanogram per liter
OSD = Office of the Secretary of Defense
MAX = maximum
MCL = maximum contaminant level
MET = metals
mg/kg = milligram per kilogram
MIN = minimum
MTCA = Model Toxics Control Act
RG = remediation goal
RL = reporting limit
P_A = pesticides_aroclors
ROD = record of decision
S = soil
SVOA = semivolatile organic analyte
SW = surface water
TPH = total petroleum hydrocarbons
µg/L = microgram per liter
VOA = volatile organic analyte
W = Water
WAC = Washington Administrative Code

**Project action limit references for soil:**

OSD, 2021 – Assistant Secretary of Defense, 2021. Risk-Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater and Soil using USEPA's Regional Screening Level Calculator. Hazard quotient (HQ) = 0.1. September 15.

The project action limits are based on incidental ingestion of soil applied to the soil interval 2 to 15 feet bgs for the industrial/commercial worker scenario.

The project action limit for PFBS is based on the EPA reference USEPA, 2021. Risk-Based Screening Levels Calculated for PFBS in Groundwater and Soil using USEPA's Regional Screening Level Calculator. HQ = 0.1. April 8.

(MTCA Cleanup Regulation, Chapter 173-340 WAC; As presented on Washington State Department of Ecology (Ecology) website CLARC tables posted July 2021, (https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC/Data-tables). The lowest value reported for Soil for Protection of GW, Soil for Protection of GW to Marine SW, and direct contact is presented as the Project Action Limit.

The project action limit shown for cis-1,3-dichloropropene is based on the CLARC value for total 1,3-dichloropropene (CAS #542-75-6).

**Project action limit references for water:**

OSD, 2021 – Assistant Secretary of Defense, 2021. Risk Based Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater and Soil using USEPA's Regional Screening Level Calculator. Hazard quotient (HQ) = 0.1. September 15.

The project action limit for PFBS is based on the EPA reference USEPA, 2021. Risk Based Screening Levels Calculated for PFBS in Groundwater and Soil using USEPA's Regional Screening Level Calculator. HQ = 0.1. April 8.

MCL, 40 CFR141, National Primary Drinking Water Regulations.

MTCA Method B, cancer or MTCA Method B, non-cancer – MTCA Cleanup Regulation, Chapter 173-340 WAC; as presented on Washington State Department of Ecology (Ecology) website CLARC tables posted July 2021, (https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC/Data-tables). If values are presented in the CLARC for both cancer and non-cancer basis, the lower of the two values is identified as the project action limit. The project action limit shown for cis-1,3-dichloropropene and trans-1,3-dichloropropene is based on the CLARC value for total 1,3-dichloropropene (CAS #542-75-6).

WAC 173-201A, Water Quality Standards for Surface Waters of the State of Washington, update September 17, 2021.

WAC 246-290-310, MCLs and maximum residual disinfectant levels; Washington State-specific drinking water standards.

40 CFR 131.45, Revision of Certain Federal Water Quality Criteria Applicable to Washington State.

CWA section 304(a), Water Quality Criteria Standards, surface water, EPA.

**Table 4-5.** Summary of PFAS Results for Area 8 Groundwater Sampling Locations, September 2018

| **Well Identification** | **MW8-8** | **MW8-9** | **MW8-11** | **MW8-11 (Dup)** | **MW8-12** | **MW8-14** | **MW8-15** | **MW8-16** | **Field Blank** |
|---|---|---|---|---|---|---|---|---|---|
| | **AREA-8-18-200** | **AREA-8-18-201** | **AREA-8-18-202** | **AREA-8-18-203** | **AREA-8-18-204** | **AREA-8-18-205** | **AREA-8-18-207** | **AREA-8-18-206** | **AREA-8-18-210** |
| **Sample Date** | **09/17/2018** | **09/17/2018** | **09/18/2018** | **09/18/2018** | **09/17/2018** | **09/18/2018** | **09/18/2018** | **09/17/2018** | **09/17/2018** |
| **Units** | **ng/L** | **ng/L** | **ng/L** | **ng/L** | **ng/L** | **ng/L** | **ng/L** | **ng/L** | **ng/L** |
| **Analyte** | | | | | | | | | |
| N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA) | 19 U | 19 U M | 19 U | 19 U | 18 U | 19 U | 19 U | 19 U | 18 U |
| N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA) | 19 U | 19 U | 19 U | 19 U M | 18 U | 19 U M | 19 U | 19 U | 18 U M |
| Perfluorobutanesulfonic acid (PFBS) | **4.7** | **0.79 J M** | **1.2 J M** | **1.3 J** | **4.5** | 1.9 U M | 1.9 U | **0.77 J M** | 1.8 U |
| Perfluorodecanoic acid (PFDA) | **3.9** | 1.9 U | **0.53 J** | **0.79 J M** | **2.7** | 1.9 U M | 1.9 U | **0.75 J** | 1.8 U |
| Perfluorododecanoic acid (PFDoA) | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U |
| Perfluoroheptanoic acid (PFHpA) | **8.4** | **0.72 J** | **3.5** | **3.4** | **7.7** | 1.9 U | 1.9 U | **1.2 J** | 1.8 U |
| Perfluorohexanesulfonic acid (PFHxS) | **2.6** | **4.6** | **3.2** | **3.5** | **2.9** | **0.61 J M** | 1.9 U | **1.3 J M** | 1.8 U |
| Perfluorohexanoic acid (PFHxA) | **13** | **1.5 J M** | **3.5** | **3.5** | **13** | 1.9 U M | 1.9 U | **1.8 J M** | 1.8 U |
| Perfluorononanoic acid (PFNA) | **3.7** | 1.9 U M | **1.0 J M** | **1.3 J** | **3.7 M** | 1.9 U J1 M | 1.9 U | **0.60 J M** | 1.8 U |
| **Perfluorooctanesulfonic acid (PFOS)** | **47** | **7.6** | **63** | **57** | **60** | **1.9 J M** | 3.8 U M | **5.9** | 3.5 U M |
| **Perfluorooctanoic acid (PFOA)** | **17** | **1.7 J M** | **11** | **10 M** | **17 M** | **0.64 J M** | 1.9 U M | **2.4 M** | 1.8 U M |
| Perfluorotetradecanoic acid (PFTeA) | 3.7 U | 3.7 U | 3.8 U M | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 3.8 U | 3.5 U |
| Perfluorotridecanoic acid (PFTriA) | 3.7 U | 3.7 U | 3.8 U | 3.8 U | 3.6 U | 3.7 U | 3.8 U | 3.8 U | 3.5 U |
| Perfluoroundecanoic acid (PFUnA) | 1.9 U M | 1.9 U | 1.9 U | 1.9 U | 1.8 U M | 1.9 U J1 | 1.9 U | 1.9 U | 1.8 U |
| Total PFOS + PFOA | **64** | **9.3 J M** | **74** | **67 M** | **77 M** | **2.54 J M** | 5.7 U | **8.3** | 5.3 U M |
| EPA Heath Advisory Level for PFOA, PFOS, or PFOA+PFOS | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** |

*Notes*:
**Bold** indicates the analyte was detected in the groundwater sample.
Shading indicates detected value is equal to or exceeds EPA Health Advisory Level of 70 ng/L.
Dup – field duplicate
J – analyte was positively identified; but the result is estimated estimation
J1 – the result is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria
M – manual integrated compound
ng/L – nanograms per liter
U – not detected at value shown

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# Appendix D: Geophysical Workplan

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Naval Facilities Engineering Systems Command
NAVFAC Northwest

**FINAL**
10 June 2021

# Supplemental Remedial Investigation Geophysical Survey Work Plan

## Operable Unit 2, Area 8

## Naval Base Kitsap Keyport

Keyport, Washington

**Department of the Navy**
**Naval Facilities Engineering Systems Command Northwest**
1101 Tautog Circle
Silverdale, WA 98315-1101

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**APPENDIX**

**FIGURES**

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AC | alternating current |
| AECOM | AECOM Technical Services, Inc. |
| bgs | below ground surface |
| COC | chemical of concern |
| cVOC | chlorinated volatile organic compound |
| EM | electromagnetic |
| EM31 | Geonics EM31-MK2 ground conductivity meter |
| EM61 | Geonics EM61-MK2A metal detector |
| ERT | electrical resistivity tomography |
| GPR | ground-penetrating radar |
| GPS | global positioning system |
| IC | institutional control |
| LTM | long-term monitoring |
| mg/kg | milligram per kilogram |
| msl | mean sea level |
| MTCA | Model Toxics Control Act |
| Navy | Department of the Navy, United States |
| NBK | Naval Base Kitsap |
| OU | operable unit |
| PAL | project action level |
| pulseEKKO-100 | Sensors & Software pulseEKKO controller with a 100 megahertz antenna |
| ROD | record of decision |
| SRI | supplemental remedial investigation |
| U.S. | United States |
| UST | underground storage tank |
| VI | vapor intrusion |
| VOC | volatile organic compound |
| WP | work plan |

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# 1. Introduction

## 1.1 PURPOSE AND SCOPE

Naval Facilities Engineering Systems Command Northwest intends to conduct a supplemental remedial investigation (SRI) at Naval Base Kitsap (NBK) Keyport operable unit (OU) 2 Area 8 (Figure 1). The purpose of the SRI is to gain a better understanding of current site conditions and site hydrogeology in support of future remedial alternative selection to stop site contamination from seeping onto the adjacent beach, commonly referred to as the "Area 8 beach". As part of the SRI, a geophysical investigation will be conducted to: 1) locate underground utilities and any subsurface obstructions at the site, and 2) map the lateral and vertical extent of the saltwater wedge below the terrestrial portion of the site. As part of the Comprehensive Long-Term Environmental Action Navy V program under contract number N62742-17-D-1800, contract task order N4425520F4176, AECOM Technical Services, Inc. (AECOM) will conduct the underground utility and subsurface obstruction evaluation utilizing a pipe and cable locator, magnetic gradiometer, a ground conductivity meter, and ground-penetrating radar (GPR). The purpose of the obstruction evaluation is to delineate the presence of subsurface manmade objects, including utilities, walls, and foundations that could interfere with the saltwater wedge evaluation. The saltwater wedge evaluation will be conducted using electrical resistivity tomography (ERT), GPR, and ground conductivity. The purpose of this study is to assess the migration or flow of saltwater beneath the study area. This work plan (WP) is specific to the geophysical survey portion of this work, with a separate Uniform Federal Policy quality assurance project plan being prepared to guide the remaining SRI work.

## 1.2 ORGANIZATION OF WORK PLAN

Following this introductory section, the remainder of this WP is organized as follows:

- Section 2 provides the site history and how the geophysical survey area was determined for Area 8.
- Section 3 provides an overview of the pre-data collection activities in preparation for the geophysical survey.
- Section 4 describes the geophysical investigation methodology and approach used to perform this work.
- Section 5 summarizes the deliverable that will result from this investigation.
- Section 6 summarizes the schedule for data collection and reporting.
- Section 7 summarizes the assumptions made pertaining to the project and site specifics.
- Section 8 describes limitations associated with the proposed geophysical investigation.

# 2. Site Location and History

## 2.1 SITE HISTORY

NBK Keyport is the west coast Naval Undersea Warfare Center for the United States (U.S.) Department of the Navy (Navy). NBK Keyport occupies 340 acres (including tidelands) that lie adjacent to the town of Keyport in Kitsap County, Washington, on a small, manmade peninsula in the central portion of the east side of the Puget Sound (Figure 1). The peninsula is surrounded by Dogfish and Liberty Bays to the northwest and Port Orchard Bay to the north and east. Marine and brackish water bodies on and near the site consist of Liberty Bay, Dogfish Bay, the tide flats, a marsh, and a shallow lagoon. Freshwater bodies include two creeks discharging into the marsh pond and two creeks discharging into the lagoon. The topography of the site rises gently from the shoreline to an average of 25 to 30 feet above mean sea level (msl) and then rises steeply at the southeast corner of the site facility to approximately 130 feet above msl.

Area 8 occupies approximately 1 acre on the eastern portion of NBK Keyport (Figure 2), encompassing the location of the former plating shop (Building A). Area 8 is located on a manmade peninsula in a heavily industrialized part of the base. The area is predominantly flat and almost entirely paved or covered by buildings. A parking lot is currently present on the former site of Building A, which was demolished in 1999. From [redacted], the shoreline has an embankment that drops steeply approximately 12 feet to the Area 8 beach intertidal area (Figure 2). The embankment is reinforced by an armor rock wall on the south, beyond [redacted], and transitions to a seawall on the east, beyond [redacted]

Past releases at Area 8 included chrome plating solutions spilling onto the ground; plating wastes discharging to a utility trench; and plating solutions leaking through cracks in the Building A plating shop floor, waste disposal pipes, and sumps during plating shop operations. These chrome plating solutions and plating wastes contained chlorinated volatile organic compounds (cVOCs) and metals. Petroleum hydrocarbons (diesel and heavy oil) were also released to the environment from leaky underground storage tanks (USTs) and underground concrete vaults located within Area 8.

The OU 2 record of decision (ROD) was executed in September 1994 (Navy, EPA, and Ecology 1994) and identified volatile organic compounds (VOCs) and metals (arsenic, cadmium, and chromium) as the chemicals of concern (COCs) associated with Area 8. Additionally, the OU 2 ROD required long-term monitoring (LTM) of groundwater, seep water, sediment, and tissue and implementation of institutional controls (ICs).

VOCs and metals were identified as COCs for groundwater based on residential use of groundwater as drinking water and inhalation of water vapor during household use. Selected remedies for the site included removal of vadose zone soil hot spots for offsite disposal; continued groundwater, seep water, sediment and tissue monitoring; and implementing ICs to restrict residential use of the site.

For subsurface soil, arsenic and cadmium were identified as major contributors to future residents' risk from ingestion of produce grown in the soil.

Semivolatile organic compounds associated with the petroleum release were detected in soil at concentrations below Washington State Model Toxics Control Act (MTCA) Method B cleanup levels based on soil ingestion, protection of drinking water, and protection of surface water standards.

Following the signing of the OU 2 ROD, the Navy performed the following remedial actions:

1. Demolition of Building A, the former plating shop, and removal/disposal of soil hot spots above the water table in July 1998 and March 1999. Soil removal was based on cadmium and chromium concentrations exceeding 1999 MTCA Method B cleanup levels for soil ingestion (80 milligrams per kilogram [mg/kg] for cadmium and 400 mg/kg for chromium) (Navy 1999).
2. Removal of USTs associated with former Building A and excavation of petroleum-contaminated soil associated with these USTs. Slurry walls were constructed at the location of the former USTs (northeast and immediately south of the former plating shop) to provide shoring during UST removal (Figure 2). These slurry walls are believed to be controlling groundwater flow in their vicinities.

3. Implementation of ICs beginning in 2000 to prevent exposure to soil and groundwater containing site COCs at concentrations exceeding the thresholds for residential use.
4. Installation and LTM of four groundwater wells starting in 1995.
5. Sediment and tissue LTM in the Area 8 beach intertidal zone, starting in 1996 and continuing every 4 years or less thereafter: 2000, 2004, 2008, 2012 (sediment only), 2015, and 2016.
6. Evaluation of human health and ecological risks based on tissue and sediment data.
7. Execution of independent remedial actions under MTCA related to past petroleum releases (Navy 2000).

The OU 2 ROD also calls for implementation of contingent groundwater control actions if Area 8 groundwater is found to present an unacceptable risk to human health or the environment based on sediment and tissue monitoring on the adjacent beach. A human health and ecological risk assessment encompassing intertidal sediments and clam tissue was completed in 2015 and 2016 (Navy 2018b). No risk to human health was identified, but a potential ecological risk was identified. The 2019 ecological risk assessment addendum found that acute and chronic exposure to accumulated site COCs in intertidal zone sediment on the beach, adjacent to OU 2 Area 8, pose a current hazard to benthic organisms based on the bioassay results/endpoints (Navy 2020a). As a result, the Navy is conducting this SRI to support selection of a contingent groundwater control action to eliminate the risk on the adjacent beach.

Starting in 1995, groundwater samples were analyzed for inorganics, including arsenic, cadmium, chromium (total), hexavalent chromium, copper, lead, mercury, nickel, silver, thallium, zinc, and cyanide. Although an explanation of significant differences was signed in 1996 with the directive that in “determining the quantity of soils to be excavated during Phase 11, total chromium will be tested for and assumed to be all hexavalent chromium (Cr VI)” (Navy, EPA, and Ecology 1996), chromium speciation was discontinued only after the recommendation was made following the sampling event in 2000. Subsequently, all measured total chromium values were assumed to be 100 percent hexavalent chromium. Following the 2002 sampling event, analysis of groundwater for cyanide was discontinued because no cyanide was detected since 1998.

The fourth five-year review (Navy 2015) concluded that a vapor intrusion (VI) study was warranted based on new U.S. Environmental Protection Agency risk-based VI Guidance (EPA 2015) requiring a VI study if cVOC compounds in groundwater exceed current Washington State Department of Ecology MTCA Method C (Industrial) groundwater VI screening levels and are within 100 feet of occupied buildings. The primary potential human health VI pathway receptors for Area 8 are workers in buildings within 100 feet of contaminated groundwater, such as Buildings F and E. Although buildings like Building G and [redacted] are over 100 feet away, due to an abundance of caution they were included in the VI study. Building G houses a large number of employees. Building [redacted] is currently used for storage, but the Navy believed that the VI data would be necessary for future planning purposes.

In November 2017, a soil vapor investigation was conducted at Area 8 (Navy 2018a). Six soil vapor wells were installed and sampled at locations adjacent to Buildings F and E, nearest the cVOC exceedances in groundwater. The soil vapor wells were designed as dual-completion wells, screened immediately above the first occurrence of groundwater (typically 10 feet below ground surface [bgs]) and at 5 feet bgs. Due to encountering groundwater conditions that were shallower than expected, only five of the six deeper wells proposed were installed. Ultimately, a deep sample was collected at just one of the five locations due to higher than expected groundwater levels. Shallower samples were collected successfully from all six locations at approximately 5 feet bgs. Soil vapor samples were analyzed for VOCs based on the list of COCs associated with Area 8, as documented in the OU 2 ROD. The samples were also analyzed for 1,4-dioxane based on more recent detections of the chemical in groundwater. Detected concentrations of VOCs exceeded their respective project action levels (PALs) in five of seven samples. The 2017 soil vapor report recommended additional investigation of the VI pathway at Area 8, including VOC migration along preferential pathways and VOC sources in groundwater.

In 2019, an indoor vapor investigation was conducted at Buildings F, [redacted], E, and G (Navy 2020b). Indoor air, outdoor air, and sub-slab vapors samples were collected, and differential pressure was monitored in the early spring (April 2019) and summer (July 2019) to account for seasonal variability in VI potential. Indoor air samples were collected from areas regularly occupied by workers, and each sample was collocated with a sub-slab vapor sample to the extent possible. Outdoor air samples were collected for analysis of upwind outdoor air. The April 2019 sampling event included 6 outdoor air samples, 30 indoor air samples, and 28 sub-slab vapor samples. The July 2019 sampling event included 4 outdoor air samples, 29 indoor air samples, and 28 sub-slab vapor samples. Detected concentrations of VOCs exceeded their respective PALs in sub-slab vapor samples beneath Buildings F, [redacted] and E; however, VOCs were not detected in the paired indoor air samples, with the exception of trans-1,2-dichloroethene, which exceeded its PAL in Building E indoor air. The investigation concluded that the trans-1,2-dichloroethene concentration detected in indoor air was the result of an indoor background source. Although the VI pathway is not currently considered a complete exposure pathway, additional inspections and sampling were recommended to ensure that no future risks go undetected. Annual use monitoring was recommended for Building [redacted] which is used for general storage and is not regularly occupied. Annual building and foundation inspections and paired sub-slab vapor and indoor air monitoring every 5 years were recommended for Buildings F and E. No further actions were recommended for Building G as indoor air and sub-slab vapor exceedances were not observed.

# 3. Pre-collection Activities

## 3.1 DOCUMENT REVIEW

AECOM will coordinate with the Navy to acquire background information related to the site, including utility maps, as-builts/record drawings, historical data, and any other pertinent information as needed. AECOM will review and evaluate historical documents and existing data to determine where data gaps exist and whether the current scope of the project is sufficient to support any future feasibility study, including an evaluation of remedial technologies. AECOM will then review acquired information to support project understanding, planning, and execution.

## 3.2 SITE PREPARATION

The geophysical survey will be conducted in the general area identified on Figure 3. AECOM is considering conducting geophysical investigation of up to 3.5 acres of the total area. A refinement of the geophysical survey extent may occur during geophysical data collection based on site conditions encountered, such as site constraints or limited access areas identified by AECOM's project team.

Based on a review of the available aerial imagery, the proposed survey areas appear to comprise generally open, paved areas with few constraints on the extent of the investigation. Vegetation within the survey areas will be maintained to help facilitate comprehensive geophysical survey coverage. Anthropogenic constraints on the extents of the investigation appear to be present in several portions of Area 8. They include roads, parking lots and vehicles, fences, and various types of structures, including buildings and a seawall. Therefore, geophysical surveying will be limited to constraint-free areas or areas where these constraints do not have a negative impact on data quality. Site preparation, including grid stakeout, vegetation clearance, relocation of vehicles, and surface clearance, will be performed in advance of deploying the geophysical survey to minimize interference (such as by the presence of metal objects) with geophysical instrumentation.

# 4. Geophysical Investigation

## 4.1 METHODOLOGY

The geophysical survey of Area 8 will be conducted to collect sufficient data to determine the location and depth of subsurface utilities, slurry walls, and other possible impediments to groundwater flow and/or preferential pathways at the site. Preference will be given to methods that provide depth/cross-sectional information. The geophysical survey will also include mapping of the saltwater wedge at the site over a 24-hour tide cycle. The mapping of the saltwater wedge will be conducted in late June during the predicted highest and lowest tides of the year.

### 4.1.1 Geophysical Utility Designation and Subsurface Obstruction Evaluation

The geophysical utility designation and subsurface obstruction evaluation of the study area will include the use of a Geonics EM61-MK2A metal detector (EM61), GSSI SIR 3000 GPR, Schonstedt GA-52C magnetic gradiometer, Fisher M-Scope TW-6 pipe and cable locator, and Vivax vLoc3-Pro line tracer. These instruments provide real-time results and facilitate the delineation of subsurface features.

The EM61 instrument is a high resolution, electromagnetic (EM) time-domain device for detecting buried conductive objects. It consists of a powerful transmitter that generates a pulsed primary magnetic field when its coils are energized, which induces eddy currents in nearby conductive objects. The decay of the eddy currents, following the input pulse, is measured by the coils, which in turn serve as receiver coils. The decay rate is measured over two coils, mounted concentrically with one above the other. By making the measurements at a relatively long time interval (measured in milliseconds) after the termination of the primary pulse, the instrument provides a response nearly independent of the electrical conductivity of the ground. Thus, the instrument is a very sensitive metal detector. Due to its unique coil arrangement, the response curve is a single, well-defined positive peak directly over a buried conductive object. This facilitates quick and accurate location of targets. Conductive objects to a depth of approximately 11 feet can generally be detected.

The GPR instrument beams energy into the ground from its transducer/antenna in the form of EM waves. A portion of this energy is reflected back to the antenna at boundaries in the subsurface, across which there is an electrical contrast. The recorder continuously makes a record of the reflected energy as the antenna is moved across the ground surface. The greater the electrical contrast, the higher the amplitude of the returned energy. The EM wave travels at a velocity unique to the material properties of the ground being studied, and when these velocities are known, or closely estimated from ground conductivity values and other information, two-way travel times can be converted to depth. Penetration into the ground and resolution of the GPR images produced are a function of ground electrical conductivity and dielectric constant. This produces an image of subsurface soil composition with depth. Images tend to be graphic in sandy soils, even at considerable depth, but penetration and resolution may be limited in more conductive, fine grained, clayey and/or moist ground.

The magnetic gradiometer has two fluxgate magnetic fixed sensors that are passed close to and over the ground. When a magnetic object is not within the magnetic field of either of the two sensors (i.e., only in the earth's field), the instrument emits an audible signal at a low frequency. When the instrument passes over buried iron or steel objects so that the field at the two sensors is significantly different, the frequency of the emitted sound increases. The frequency emitted is a function of the gradient between the two sensors.

The M-Scope TW-6 device energizes the ground by producing an alternating primary magnetic field with alternating current (AC) in the transmitting coil. If conducting materials (including soils) are within the area of influence of the primary field, AC eddy currents are induced to flow in the conductors. A receiving coil senses the secondary magnetic field produced by these eddy currents and outputs an audio response. The strength of the secondary field is a function of the conductivity of the object, its size, its depth, and its position relative to the instrument's two coils. Conductive objects to a depth of approximately 10 feet are sensed; however, the device is somewhat focused in that it is more sensitive to conductors below (and above) the instrument than to conductors off to the side.

Where risers are present, the Vivax vLoc3-Pro utility locator transmitter can be connected to the object, and a current can be impressed on the conductor pipe or cable. The receiver unit is then tuned to this same frequency and used to trace the pipe's surface projection away from the riser. The transmitter and receiver can also be used in a non-connect (induction) mode, whereby the transmitter is positioned on the ground and an EM signal is emitted. In the presence of buried metal pipes and wires, a discrete signal will be induced on the conductor, which can be sensed by the receiver. In addition, the instrument may be used in the passive mode, whereby radio and 60 hertz EM signals produced by communication and live electric lines can be detected.

To facilitate the collection of EM61 data, a Trimble Pro XRS global positioning system (GPS) will be used for spatial control in the study area. The limits of the study area are defined on Figure 3. Traverses using the EM61 will be conducted along roughly east-west and/or north-south profiles spaced approximately 5 feet apart across accessible portions of the study area. GPR traverses will be conducted along roughly south-north and east-west profiles spaced approximately 5 to 10 feet apart. GPR traverses will be performed along profiles across and near detected features. Traverses using the M-Scope and gradiometer will be conducted along traverses spaced approximately 5 feet apart. The line tracer will be used in passive, direct connect, and inductive modes to delineate the presence of underground utilities in the study area. During this portion of the evaluation, vehicle traffic through the study area should be limited.

The recorded EM61 and GPR data will be downloaded to a portable computer in the field for preliminary analysis and significant anomalies. Detectable underground utilities will be marked on the ground surface with paint and reported at the end of the field study.

### 4.1.2 Saltwater Wedge Delineation

#### *4.1.2.1 HIGH-RESOLUTION ELECTRICAL RESISTIVITY TOMOGRAPHY*

High-resolution ERT data will be collected to delineate the location of and assess temporal changes in the saltwater/freshwater interface. The ERT profile will consist of 56 stainless steel electrodes installed through small holes (roughly 0.5 inch in diameter) drilled through the pavement using a hammer drill (with a generator); the holes are later patched with caulking. The electrodes deployed at a predetermined electrode spacing along the profile will be used to continuously collect data using a dipole-dipole array to develop a detailed electrical resistivity profile of the subsurface over a 32-hour period. The total study time will be approximately 32 hours, which will include a full 24-hour tide cycle and 4 hours on each side of the cycle to evaluate inland tidal lag effects.

Passive electrode cables will connect all 56 electrodes to the resistivity meter to continuously collect ERT data over a 32-hour period. During this portion of the evaluation, vehicles cannot travel over the deployed equipment along the ERT profile.

The precise location of the profile will depend on the results of the subsurface obstruction evaluation but will generally be oriented as shown on Figure 3. The profile must be straight and not exhibit any curved or kinked geometry. The spacing and total line length will be dependent on the accessibility of the site, location of underground obstructions and utilities, the desired depth of investigation, and level of resolution required for this study. ERT Transect A is oriented in a northwest to southeast orientation and is approximately 255 feet in length. ERT Transect B is oriented in a northeast to southwest orientation and is approximately 160 feet in length. Generally, the depth of view for an ERT survey is approximately 1/5 to 1/4 of the distance between the outer electrodes. Given the proposed transect lengths, this would result in a theoretical depth of view of 50 to 65 feet and 30 to 40 feet for Transect A and Transect B, respectively. Based on the parameters outlined above, it is expected that the study will capture the extent of the freshwater/saltwater interface beneath the study area.

Collected data will be processed and analyzed through the use of EarthImager, a two-dimensional resistivity modeling algorithm.

#### *4.1.2.2 EM31 AND GPR SURVEY*

In addition to high-resolution ERT, EM and GPR surveys will be conducted to aid in further delineating the location of the saltwater/freshwater interface and assessing temporal changes in the interface. The EM data will be collected using the Geonics EM31-MK2 ground conductivity meter (EM31). The GPR data will be collected using a Sensors & Software pulseEKKO controller with a 100 megahertz antenna (pulseEKKO-100), or equivalent GPR system. The EM31 and pulseEKKO-100 GPR data will be collected along the same profiles as the ERT data. Additional EM31 and GPR data will be collected along additional profile lines, totaling up to 1,500 feet. The locations and orientations of these additional EM31 and GPR profiles will be selected in the field based on the results of the utility mapping surveys and the associated site reconnaissance to avoid survey interference by metallic utilities. The EM31 and GPR data will be collected on maximum 2 feet spacings along each profile line. The EM31 data will be collected in the vertical dipole mode orientation, which provides a maximum depth of investigation of approximately 18 feet. Both quadrature and in-phase EM data will be collected, and the results will be presented as profiles depicting changes in the quadrature and inphase response amplitudes. The GPR data will be processed using the EKKO Project data analysis software package. The results will be presented as profiles (radargrams) depicting the GPR responses along the line to the maximum depth of penetration encountered at the site.

## 4.2 SURVEY APPROACH

All field work will be conducted in accordance with this WP. Photographs will be taken of work areas as work progresses, and a photographic log will be prepared describing the photo and indicating the direction taken, as applicable.

EM61 data will be collected along a series of parallel transect lines with a nominal spacing of 5 feet and covering the accessible portions of the approximately 3.5-acre survey area. Some transect deviations are expected due to immovable site features such as boulders, fences, and anthropogenic features. EM61 data will be recorded at a rate of eight readings per second, which generally corresponds to an along-transect data point spacing of less than 1 foot. EM61 data will be collected in differential mode (Channels 1, 2, 3, and D), which can provide some muting of potential signal interference from near-surface metal objects and enhanced delineation of deeper targets such as USTs. Simultaneous merging of GPS and EM61 data will be accomplished by streaming the positional data directly into the EM61 data collector.

Location control for the geophysical survey will be maintained using a GPS antenna affixed above the EM coils. Sub-meter horizontal accuracy of positional data is expected to be achieved via corrections in real time or during post-processing. Corrections will be provided by a satellite-based augmentation system or base station receiver setup.

Positional data will be recorded at 1-second intervals simultaneously with the EM61 data. Relevant site features and potential sources of EM interference may also be recorded using GPS. If GPS satellite coverage is inadequate within portions of the survey area, geophysical surveying may be conducted using marked grids established with survey tapes.

Geo-referenced data collected during the geophysical survey will be presented in the following projection: Washington State Plane, North American Datum 1983. Units of measurement will be U.S. survey feet.

Certain manmade features may affect geophysical data quality or data coverage. Manmade (e.g., buildings) and naturally occurring features (e.g., steep slopes or water bodies) potentially affecting the geophysical investigation will be determined for each area during visual inspection and geophysical data collection. The presence of features that cannot be removed will be noted and avoided during geophysical data collection to the extent possible.

## 4.3 QUALITY CONTROL

Quality control procedures will be followed to help facilitate the collection of accurate and reliable geophysical data. These procedures will include the proper operation and functioning of the geophysical instruments and positioning equipment.

At a minimum, the project geophysicist will follow the manufacturer's recommended equipment setup procedures; perform instrument nulling in ideal locations free of metal or other sources of potential signal interference; monitor background noise readings before and during data collection; assess for electronic drift; monitor for apparent issues with regard to positional data and instrument response inaccuracies; and perform daily tests in accordance with manufacturer's instructions and recommendations, as applicable.

Raw geophysical data will be downloaded from the EM61 data logger to a personal computer. Collected data, including field notes, photographs, site feature positional data, and any other documents or digital data will be transferred to external storage for backup. Evaluation of the validity of the datasets through draft processing and analysis will also be performed.

## 4.4 DATA PROCESSING AND ANALYSIS

The EM61 data will be processed using the contouring software Surfer 8.0; EM61 data will be pre-processed using the program DAT61MK2 or TrackMaker61 by Geonics Limited. Pre-processing involves converting the raw data files, filtering and editing the data as necessary, and exporting the data to the contouring software. Further corrections and final contouring of the data will be performed in the program Oasis montaj by Geosoft. The final presentation of the contoured datasets and accompanying analysis will be done in ArcMap by Esri (Environmental Systems Research Institute).

Positional data of relevant site features acquired during the GPS survey will be downloaded to a computer using the program GPS Pathfinder Office by Trimble. The data will be projected using the Washington Zone 10 State Plane Coordinate system and exported for presentation in ArcMap in conjunction with the EM data.

## 5. Deliverable

The geophysical survey methods, field investigation program, and results will be presented as part of the SRI report. The EM survey results will be presented as color-enhanced contour maps, with anomalies that represent buried metallic features, such as USTs or metal pipes, annotated accordingly on the maps and discussed in the report. The ERT survey results delineating the extent of the saltwater wedge will be presented as color-enhanced contour maps showing apparent resistivity.

## 6. Schedule

As stated in Section 4.1, mapping of the saltwater wedge will be conducted in June during the predicted highest and lowest tides of the year. The schedule for the activities associated with the Area 8 beach geophysical investigation is summarized in Table 1.

**Table 1: Schedule for Activities**

| Activity | Field Duration (Days) | Week Performed |
|---|---|---|
| Site Preparation | 0.5 | June 23 to June 28, 2021 |
| Utility Designation and Subsurface Obstruction Evaluation | 2 | |
| Saltwater Wedge Evaluation | 2 | |
| Demobilization (AECOM) | 1 | |

## 7. Assumptions

- Geophysical survey staff will be permitted to take photographs within the extents of the proposed survey areas.
- No geophysical surveying will be conducted in areas deemed potentially hazardous to personal safety or equipment or inside buildings.

## 8. Limitations

The geophysical data collection and analysis will be conducted in accordance with reasonable and accepted engineering geophysics practices, and the interpretations and conclusions will be rendered in a manner consistent with other consultants in our profession. However, all geophysical techniques are associated with some level of uncertainty and limitations. A discussion of these uncertainty and limitations will be included in the SRI Report.

## 9. References

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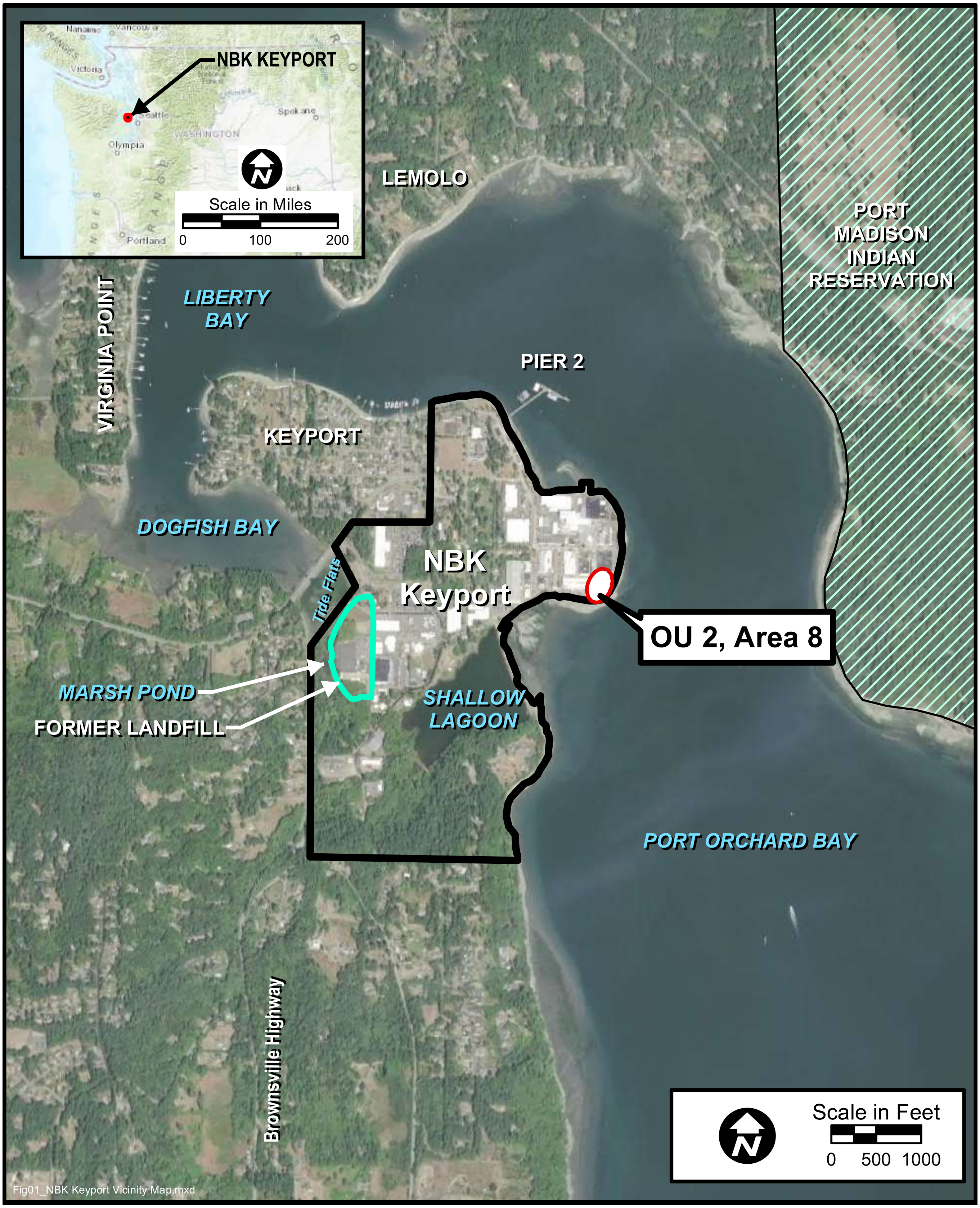

| **U.S. NAVY** | **Figure 1**<br>**NBK Keyport Vicinity Map** | CTO N4425520F4176<br>NBK Keyport, OU-2, Area 8<br>Supplemental RI<br>Geophysical Survey |
|---|---|---|

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**U.S. NAVY**

Figure 2
Area 8 Plan View

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NBK Keyport, Area 8
Supplemental RI
Geophysical Survey

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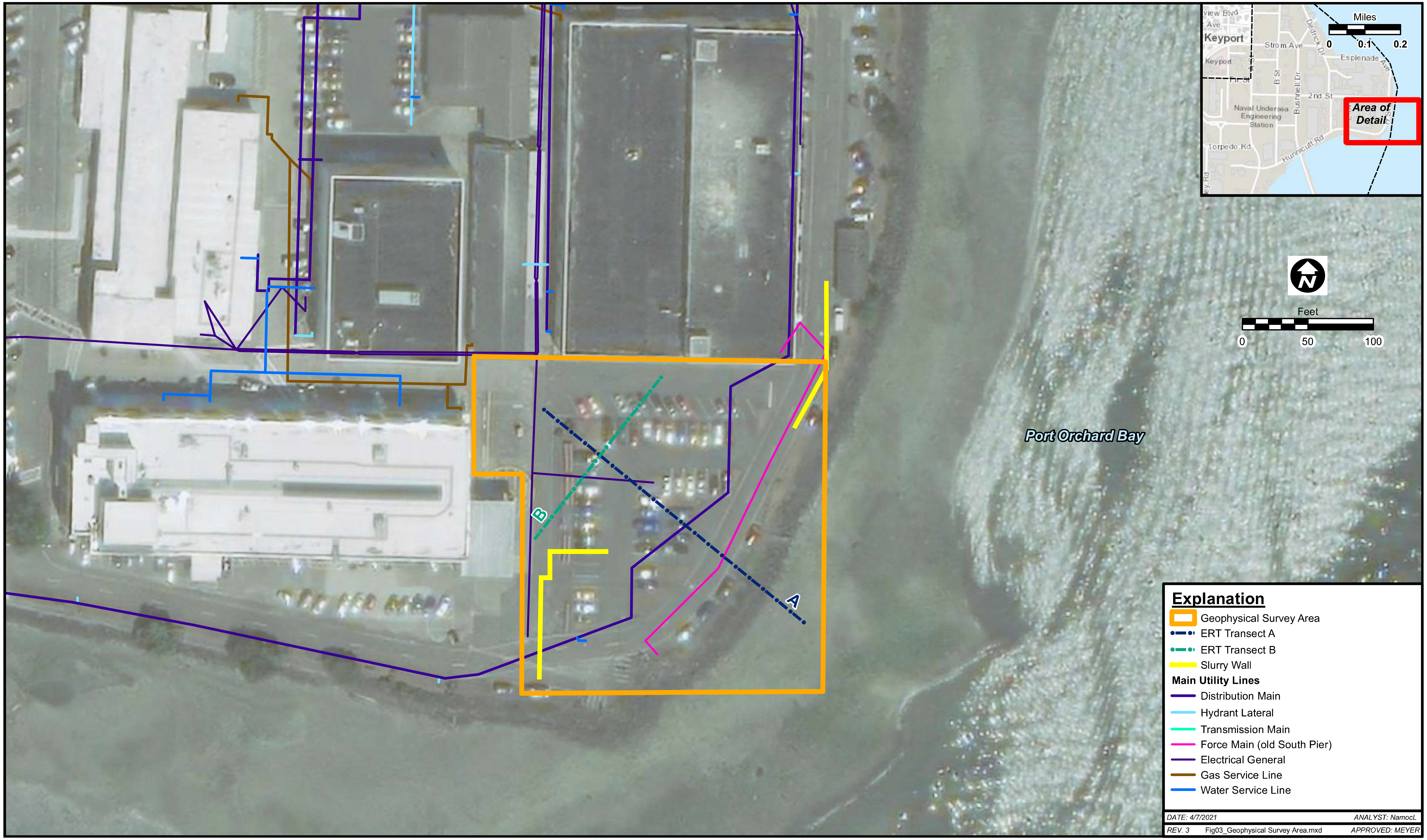

**U.S. NAVY**

**Figure 3**
**Geophysical Survey Area**

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Geophysical Survey

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# Appendix A:
# Geonics Limited Metal Detectors

**(Will be included in the Final version)**

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# METAL DETECTORS

GEONICS LIMITED

# Time Domain Metal Detection

The EM61-MK2 Metal Detector is a high power, high sensitivity metal detector suitable for applications in the detection of both ferrous and non-ferrous metal.

Based on the design principles of time domain electromagnetics, each system includes a single transmitter coil and two receiver coils. A primary magnetic field, generated by current supplied to the transmitter coil, induces eddy currents in nearby metallic objects. The induced eddy currents decay with time – at a rate that is dependent on the characteristics of the object – producing a secondary magnetic field with the same rate of decay. The time-decay of the secondary magnetic field generates a signal within each of the two receiver coils, thereby confirming the presence of metal.

Common applications, in several fields of geophysical practice, include the detection of environmental hazards such as drums and underground storage tanks; utilities and infrastructure; construction and industrial waste; and, unexploded ordnance (UXO).

Recent advances in design and application have enhanced system performance since the successful introduction of the original EM61 Metal Detector. Providing greater functionality and enhanced detection within a wider range of operating environments, the EM61-MK2 represents a superior choice for applications in the detection of buried metal.

## EM61-MK2 Metal Detector

The EM61-MK2 Metal Detector provides multiple measurements of the decay of the secondary magnetic field associated with any metallic object. Data available from as many as four time gates – geometrically spaced in time from 216 µs to 1,266 µs – provide recognizable improvements in both detection and characterization.

The earlier time gates available with the EM61-MK2 improve the detection of smaller targets most significantly. The decay rate of the secondary field associated with smaller targets is relatively quick; measurements at early times, therefore, are required to ensure the detection of secondary magnetic field response that may not be available at later times.

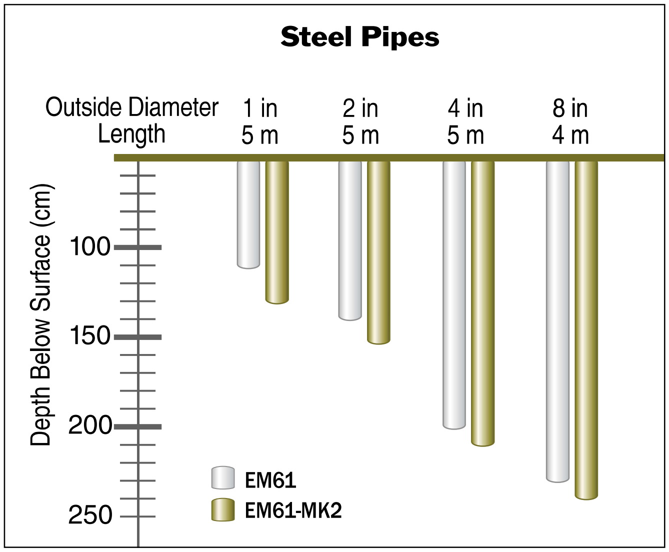

*Figure 1: Depth of Detection for Steel Pipes*

As an example, a 20 mm projectile (ordnance item), oriented horizontally, is not detectable with the original EM61; comparatively, the earliest gate of the EM61-MK2 can detect the same target at a depth of 8 cm (3 in.) below surface. A 20 mm cartridge, oriented horizontally, detectable at 3 cm (1 in.) with the EM61, can be detected to a depth of 38 cm (15 in.) with the EM61-MK2. (The same 20 mm cartridge is detectable at 68 cm (27 in.) when oriented vertically.)

Additionally, the early gates of the EM61-MK2 provide an increase in the response amplitude from any target, regardless of size, of two to five times the response from the original EM61. As a result, the depth at which any target can be detected is increased (*see Figure 1*).

A mid-range time gate is included to provide a response equivalent to the original EM61. Data from the mid-range gate allows for a comparison with, and/or the continuation of data sets generated with the original system.

A late time gate provides further description of the time-decay associated with any target – information for the development of an apparent time-constant to be associated with each target. The apparent time-constant data normalizes the complete time-decay to a single number. With the assumption that a unique apparent time-constant is associated with any target type, a simple level of discrimination becomes possible.

All data can be easily integrated with GPS data with support from the DAS70 Data Acquisition System (see facing page) and an optional GPS antenna mount.

In addition to many new features, the EM61-MK2 continues to provide the valuable benefits of features introduced with the original EM61, including a calculation of the 'differential' data – to reduce or remove the effects of noise associated with surface and near-surface metal – and a calculation of the apparent depth to the target.

## Towed Arrays

For a substantial increase in productivity, particularly over larger areas, multiple EM61-MK2 (or EM61) systems can be configured as a single array, to be towed behind a vehicle. Data collection is supported by the DAS70-ML Data Acquisition System that can receive data from as many as six individual inputs simultaneously. With a maximum data collection rate of 30 records (total) per second, travel speeds up to 10 kilometers/hr are possible.

***In addition to the standard configuration of the EM61-MK2, several modifications and variations are available to accommodate a broader range of applications.***

## High Power (HP) *Modification*

To increase the depth at which any target is detectable, the high power (HP) modification provides an eight fold increase in the amount of signal received by a standard transmitter coil, resulting in significant improvements in the signal-to-noise ratio. Relative to the standard EM61-MK2 (or EM61), the depth of detection for any target will increase between 45% and 80%, depending on target characteristics (*see Figure 2*).

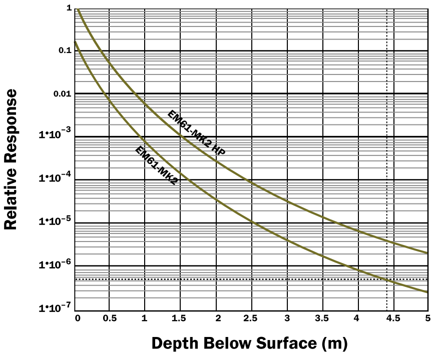

*Figure 2: Relative Response with Depth*

## EM61-HH *(Hand-Held)*

The EM61-HH is a “hand-held” complement to the EM61-MK2, available as either a complete system or an attachment only. With a smaller coil configuration, several benefits are provided including, an increase in spatial resolution; decreased sensitivity to cultural noise (creating the opportunity for applications indoors); and, improved access to areas of difficult terrain and/or dense vegetation.

Optional components available for the EM61-HH include a second receiver coil – for the determination of both “differential” data and an apparent depth to target – and a GPS antenna mount.

## EM61S *(Submersible)*

For operation in marine environments, the EM61S is a completely submersible coil and cable system capable of submersion to depths of more than 60 m. Available as an attachment to the standard EM61-MK2 (or EM61), the EM61S includes a single coincident transmitter / receiver coil, with cable, only; without the second receiver coil, calculations of differential data is not available.

Most commonly, the EM61S is secured to a submersible platform that is positioned and operated at the bed plane. Occasionally, environmental or other restrictions will require that the platform is removed some distance from the bed plane. In relatively shallow water environments, an alternate configuration of the EM61S combines a large (10 x 10 m) transmitter loop on the surface of the water, with a submersible receiver coil suspended at the required offset distance.

Importantly, the EM61S, in all configurations, has shown to be equally applicable in both freshwater and saltwater environments.

## EM63

The EM63 Metal Detector represents an important advance in the use of time domain electromagnetic methods for the detection and characterization of buried metal. Extending the benefits of data collection from multiple time gates, the EM63, operating over a wider dynamic range of time, provides a complete description of the time-decay (the *transient response*) associated with any target. Data collected from 26 time gates – geometrically spaced in time from 180 µs to 25 ms – offer further improvements in the detection of all targets, and provide information toward a more complete characterization of each target.

For applications in the discrimination of unexploded ordnance, current research is directed toward the development of algorithms that will enable the interpretation of any full transient response provided by the EM63 as the unique signature of a specific target item.

## DAS70 *Data Acquisition System*

Data collection and management with the EM61-MK2 is supported by the DAS70 Data Acquisition System, including the Allegro field computer as the principle component. A simple nulling algorithm and real-time graphic display of the data offer improvements in data review and quality control. A 486 AMD, 100 MHz processor provides for rapid data collection rates, to a maximum of 16 records per second. High capacity data storage (24 MB) allows for extended periods of data collection without interruption.

Additionally, and importantly, the Allegro includes two RS-232 serial input connections (and a user-accessible PC card slot) that facilitate the simultaneous collection of both EM and GPS data into a single data file. An optional Trimble Ag114 GPS, providing sub-metre accuracy, is available to support the requirement for position data.

## EM61-AB *(AirBorne)*

With the recent development of the EM61-AB, a prototype configuration is now available to address the requirements for large-scale reconnaissance of properties contaminated with unexploded ordnance. Incorporating a single, large transmitter loop with any of several possible receiver coil configurations, system components can be designed to optimize signal-to-noise characteristics.

# Land Use Risk Assessment

Any proposed land use within the boundaries of a current or former defense site reasonably requires an assessment of risk associated with the possible presence of unexploded ordnance (UXO). For the purpose of such a risk assessment, an EM61-MK2 survey was performed over a an active small arms range in Niagara Falls, Canada.

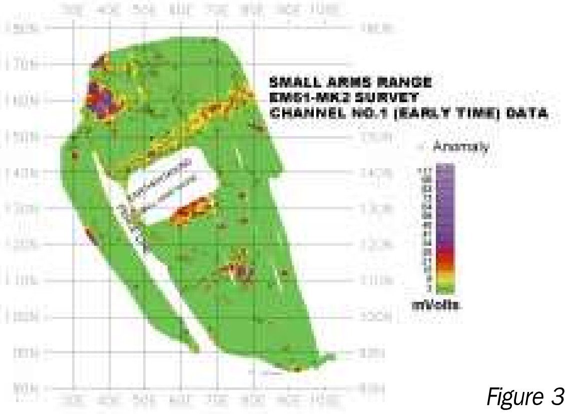

*Figure 3*

A review of the collected data reveals the increased sensitivity of the early time data (*Fig. 3*) relative to the late time data (*Fig. 4*), particularly to the smaller targets encountered at a small arms range. The anomaly "picks" from the early time data are indicated on the late time data for reference.

Further, a NE-SW oriented utility line, clearly delineated at early times, is not evident in the late time data.

A histogram of the calculated apparent time-constant associated with each anomaly is presented in *Figure 5*. With the assumption that any target type will present a unique apparent time-constant, the presence of five or six separate target groups becomes evident. This information, combined with a representative intrusive sampling program, provides valuable assistance to the risk assessment analysis.

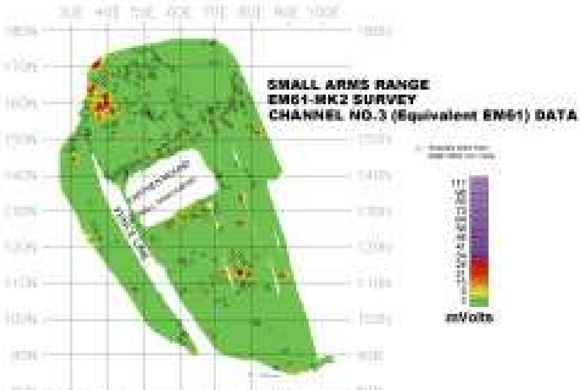

*Figure 4*

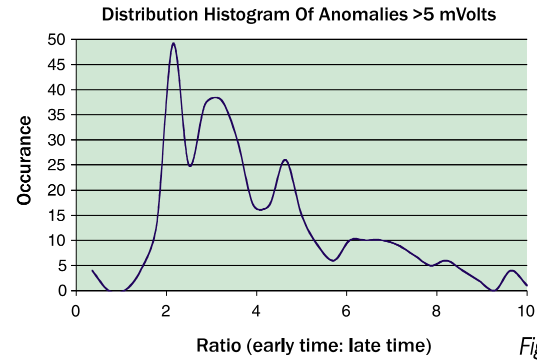

*Figure 5*

## EM61-MK2 Technical Specifications

| | | |
|---|---|---|
| MEASURED QUANTITY | Four channels of secondary response in mV | |
| EM SOURCE | Air-cored coil, 1 x 0.5m size | |
| CURRENT WAVEFORM | Unipolar rectangular current with 25% duty cycle | |
| EM SENSORS | Bottom coil: | Air-cored coil, 1 x 0.5 m in size, coincident with EM source |
| | Top coil: | Air-cored coil, 1 x 0.5 m in size 30 cm above main coil |
| MAXIMUM OUTPUT | 10 000 mV | |
| DYNAMIC RANGE | 18 bits | |
| TIME GATES | Four gates of bottom coil response only, centered at 216, 366, 660 and 1266 µs; or, three gates of bottom coil response at 216, 366 and 660 µs, with one gate of top coil response at 660 µs. | |
| SYSTEM CONTROLLER | ***Allegro*** field computer with 486 AMD processor; 16-line LCD display with 24 characters per line. | |

| | | |
|---|---|---|
| ACQUISITION SPEED | Up to 16 records (4 time gates per record) per second | |
| DATA STORAGE | 24MB solid state memory for up to 1 000 000 records | |
| POWER SUPPLY | 12 V rechargeable battery for 4 h continuous operation | |
| OPERATING WEIGHT & DIMENSIONS | Backpack: | 8 kg; 60 x 30 x 20 cm |
| | Coil Assembly: | 14 kg (23 kg in trailer mode) |
| | Bottom: | 100 x 50 x 5 cm |
| | Top: | 100 x 50 x 2 cm |
| SHIPPING WEIGHT & DIMENSIONS | 38 kg (70 kg with trailer option)<br>112 x 61 x 26 cm (Box 1; harness mode only)<br>54 x 59 x 63 cm (Box 2; with trailer option) | |

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# Appendix E:
# Standard Operating Procedures (On CD-ROM)

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# I. Field Procedures

Procedure I-A-1 Planning Field Sampling Activities
Procedure I-A-5 Site Reconnaissance
Procedure I-A-6 Utility Clearance
Procedure I-A-7 IDW Management
Procedure I-A-9 General Field Operation
Procedure I-A-10 Monitoring/Sampling Location Recording
Procedure I-A-11 Sample Naming
Procedure I-A-12 Monitoring Natural Attenuation

Procedure I-B-1 Soil Sampling
Procedure I-B-2 Geophysical Testing
Procedure I-B-4 Borehole Abandonment

Procedure I-C-1 Monitoring Well and Piezometer Installation
Procedure I-C-2 Monitoring Well Development
Procedure I-C-3 Monitoring Well Sampling
Procedure I-C-4 Groudnwater Sampling from Temporary Wells (Piezometers)
Procedure I-C-5 Low-Flow Groundwater Purging and Sampling
Procedure I-C-6 Monitoring Well and Piezometer Abandonment

Procedure I-D-1 Drum Sampling
Procedure I-D-5 Water Level Measurements
Procedure I-D-7 Field Parameter Measurements
Procedure I-D-8 Headspace Analysis

Procedure I-E Soil and Rock Classification

Procedure I-F Direct Push Sampling Techniques

Procedure I-G-1 Land Surveying

Procedure I-G-2 GPS Surveying

# III. QC Procedures

Procedure III-A Laboratory QC Samples (Water, Soil)

Procedure III-B Field QC Samples (Water, Soil, Sediment, Tissue)

Procedure III-C Field QC Samples (Air)

Procedure III-D Logbooks

Procedure III-E Record Keeping, Sample Labeling, and Chain-of-Custody

Procedure III-F Sample Containers and Preservation

Procedure III-G Sample Handling, Storage, and Shipping

Procedure III-H Performance Evaluation

Procedure III-I Equipment Decontamination

Procedure III-J Equipment Calibration, Operation, and Maintenance

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NAVFAC NW Standard Operating Procedure Number:

I-A-1

Revised February 2015

# PLANNING FIELD SAMPLING ACTIVITIES

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## 1.0 PURPOSE

This section sets forth standard operating procedures (SOPs) for planning and scheduling field sampling activities. This SOP shall also be used to determine the number and type of laboratory and field Quality Control (QC) samples required while working on U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) sites/projects, and to prepare and implement Task Order Field Sampling Plans (FSP). For information on the number and type of QC samples required for the various QC Levels, see SOPs III-A, *Laboratory QC Samples (Water and Soil),* III-B, *Field QC Samples (Water and Soil)*, III-C *Field and Laboratory QC Samples (Air)*.

## 2.0 PROCEDURES

To prepare a field sampling plan, designated personnel must identify the objectives of the sampling program, determine the number of samples to be collected for each matrix (see SOP I-A-2, *Development of Data Quality Objectives*), and select the analyses to be performed on each sample (see SOPs I-A-3, *Selection of Analytes* and I-A-4, *Analytical Methods Selection*). The duration of sampling for each matrix, the preferred sampling method, the method of shipment, and the type and quantity of supplies (such as coolers, coolant and packing material that will be needed for sample storage and transport) must also be determined. Finally, the number and type of decontamination water sources to be used for each phase of sampling must be identified. The methods of determining each of these elements are addressed below.

### 2.1 NUMBER OF SAMPLES

Designated project personnel shall determine the number of samples to be collected from each sample matrix (e.g., soil, water), and specify the type of sample analysis. SOPs I-A-2, *Development of Data Quality Objectives*, I-A-3, *Selection of Analytes*, and I-A-4, *Analytical Methods Selection*, shall be used to determine numbers and locations of samples, as well as appropriate analytical methods. These figures will be used to estimate the costs of sample analysis. They will also help determine the number and types of sample containers required; number of field duplicates, field replicates, equipment rinsates, performance evaluation (PE) samples, matrix spike/matrix spike duplicates (MS/MSD), and trip blanks to be collected, and the analyses to be performed on them for each matrix and analytical method; and the number of days required to perform sampling activities.

Sampling intervals for soil borings shall be selected on the basis of potential sources of contamination, the geologic and hydrologic complexity of the site, and the objectives of the sampling program. Areas of high contamination (for example, contamination in the capillary fringe) or complex geology or hydrogeology may require continuous sampling.

## 2.2 DURATION OF SAMPLING ACTIVITIES

The anticipated number of working days needed to complete field sampling activities shall be determined before fieldwork commences. A schedule should be developed that outlines the approximate number of samples to be collected each day, categorized by sample matrix, method of sample collection, and sample analysis (e.g., 28 soil samples collected using a hand auger and analyzed for organochlorine pesticides and chlorinated herbicides; 15 water samples collected using a bailer—7 analyzed for volatile organics and 8 analyzed for organic lead). This information will be used to determine the number of field equipment rinsate samples that will be collected (if any), the types of analyses to be performed on them, the number of MS/MSDs and field duplicates, equipment needs, and personnel.

## 2.3 NUMBER OF SAMPLES TO BE ANALYZED FOR VOLATILE ORGANICS

Prior to initiation of site sampling activities, designated personnel shall determine the number of samples to be analyzed for volatile organic compounds (VOCs). This information will be used to determine the approximate number of coolers that will contain samples to be analyzed for VOCs, which will in turn, dictate the number of VOC trip blanks needed, as specified in SOP III-B, *Field QC Samples (Water, Soil).*

## 2.4 DECONTAMINATION WATER SOURCES

Prior to initiation of sampling activities, designated personnel shall determine the number and type of decontamination water sources. Decontamination water includes both potable water used for equipment washing, and deionized or distilled water used during the final equipment rinse. The locations of potable water supplies for field decontamination activities shall be identified and designated as the only sources to be used during site sampling activities. Similarly, the source(s) of deionized or distilled water shall be identified and designated as the only source(s) to be used during site sampling activities. The intent of this procedure is to reduce variability in equipment decontamination procedures and to make it possible to easily identify the source of contamination in the event that analysis of field blanks reveals the presence of contaminants of concern.

## 3.0 DOCUMENTATION

The number of samples to be collected, the proposed duration of sampling activities, the number of samples that will be analyzed for VOCs, and the number and type of decontamination water sources that will be used for field activities will be specified in the FSP and QAPP portions of the Work Plan prepared for each NAVFAC NW Task Order. Records of how this information is actually implemented during field activities will be maintained in field logbooks, as specified in SOP III-D, *Logbooks*.

## 4.0 REFERENCES

SOP I-A-2, *Development of Data Quality Objectives*

SOP I-A-3, *Selection of Analytes*

SOP I-A-4, *Analytical Methods Selection*

SOP II-B, *Field QC Samples (Water and Soil)*

SOP III-A, *Laboratory QC Samples (Water and Soil)*

SOP III-B, *Field QC Samples (Water, Soil)*

SOP III-C *Field and Laboratory QC Samples (Air)*

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-A-5

Revised February 2015

# SITE RECONNAISSANCE

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## 1.0 PURPOSE

This standard operating procedure (SOP) defines the activities and documentation requirements for conduct of a site reconnaissance by U.S. Navy Naval Facilities Engineering Command (NAVFAC) NW personnel. Site reconnaissance is an extremely important part of work plan preparation for all project activities and should, therefore, provide site-specific information regarding physical setting, history of land use, sampling locations and rationale, planning logistical considerations, and site safety considerations. In addition, the site reconnaissance effort must provide specific information about any badge and pass requirements for access to facilities that will be inspected and subsequently investigated. The completed site reconnaissance report should provide sufficient information to enable project staff to write project work plans. This reconnaissance shall be conducted in accordance with the U.S. Navy NAVFAC NW Health and Safety Program. It should be noted that in many cases, time constraints (requirements to conduct reconnaissance at a large number of sites in a short time) might not allow all the procedures listed herein to be implemented. In those cases, the reconnaissance team should focus on collecting information concerning site health and safety issues, locations of contaminant sources, acquisition of site maps, and access requirements.

## 2.0 PROCEDURES

Site reconnaissance is essential for preparation of meaningful site-specific work plans. The site reconnaissance team's job is to document and thereby help others to understand the physical setting, history of land use, potential or suggested sampling locations, and rationale, planning, and logistics issues, and site safety considerations. When planning a site investigation (SI) or remedial investigation (RI), personnel should, at a minimum, consider the following factors:

- Physical setting and location of known or suspected sources of contamination
- History of hazardous materials management at the facility
- Suggested sample locations and rationale
- Proposed sampling equipment and procedures
- Data Quality Objectives (DQOs)
- Historical landmarks and culturally significant features/sites
- Site access, health and safety, and security requirements
- Data necessary for preliminary evaluation of exposure pathways

The collection of additional information as available is encouraged. Many of these considerations can be investigated prior to the initiation of the reconnaissance. Information methods for this pre-visit investigation are discussed below.

## 2.1 PRE-RECONNAISSANCE INFORMATION COLLECTION

Prior to conducting the site reconnaissance, all available information on the site should be evaluated. The following should be determined:

- Number of operable units present at the site
- The present and historical land uses for each operable unit
- Previously collected analytical data
- Maps available for the operable units
- The contaminants of concern for each operable unit
- Environmental media that are potentially affected
- Sampling methods that were successful in the past
- Emergency response procedures that are available and locations of the nearest medical facility

Prior to arriving on base, the Project Manager should contact the U.S. Navy Engineer in Charge (Navy EIC). A meeting should be scheduled and the following issues should be discussed:

- The requirements for U.S. Navy NAVFAC NW and subcontractor personnel to gain access to areas of concern
- Pertinent information on site conditions not previously presented to U.S. Navy NAVFAC NW
- Standard procedures for obtaining utility clearances prior to drilling on base
- Availability of site maps depicting the location(s) and physical setting of each operable unit
- Restrictions on physical access to any of the locations
- Other access considerations
- Availability of maps depicting the location(s) of underground utilities and availability of a base engineering staff member to locate utilities prior to the initiation of drilling
- Previous surveys of base locations and locations of existing bench marks, if any
- Operable unit-specific health and safety considerations, and identification of appropriate personal protective equipment

- The presence of health and safety hazards. The necessity for hazard communication orientation and location of medical facilities.

This section describes procedures for recording this information in an orderly fashion and represents the minimum standards for preparing a site reconnaissance report.

## 2.2 PHYSICAL SETTING AND CONTAMINANT SOURCE LOCATIONS

The physical setting of the project site shall be evaluated by the reconnaissance team.

The date, Task Order number, site name, weather conditions, and a brief description of the site including the contaminant source area shall be provided in a field reconnaissance report. Observations of the geologic, hydrologic, topographic, and climatic characteristics of the site should also be included. Site access should be evaluated to assess the need for land clearing prior to the initiation of fieldwork. The availability of utilities (e.g., power, water, etc.) should be evaluated as well as restrictions associated with the site such as limited access, physical impediments (fences, power lines), and the time period required to obtain access. The nature of known or suggested contamination (e.g., surface spill, underground leak, surface impoundment seep), the potential contaminants (e.g., heavy metals, chlorinated solvents, petroleum hydrocarbons, PCBs), and the physical setting (e.g., high relief fractured bedrock, low relief fill material), and proximity to surface water or ground-water wells and all human populations (especially residential and commercial activities) should be included. The potential for sensitive environments to exist near areas proposed for investigation should be assessed. This assessment should be conducted to identify the presence of wetlands or other sensitive areas, which could be impacted by project activities. Photographs documenting all significant physical features should be included in the field reconnaissance report. A brief narrative of the history of site land use from the Navy EIC and other reconnaissance accompanying personnel should be included as well as anecdotal reports. A site sketch should be prepared in the field. The sketch should include a north arrow (scale is not necessary), structures present on the site (e.g., buildings, tanks, sumps, process lines, leach fields), roads, fences, gates, and the location(s) and characteristics of contaminant sources and other potentially contaminated areas. Also essential for work plan development is the depiction of each area of concern at the site on an appropriate base map. These maps are usually available from the base engineering office. If time permits, copies of these maps should be requested prior to arrival at the site. The site sketch and features of interest can then be marked on the base map. These maps will also depict the locations of underground utilities.

## 2.3 HISTORY OF HAZARDOUS MATERIALS MANAGEMENT

The site reconnaissance team shall gather data to supplement existing knowledge of hazardous materials management at the study area. This will include visual observations of site features and characteristics; discussions and interviews with pertinent personnel from the Navy and regulatory agencies (if possible); review of design drawings, hazardous materials manifests, and other records at the facility; and review of historic aerial photographs. All acquired information will be recorded in a field logbook.

## 2.4 SUGGESTED SAMPLE LOCATIONS AND RATIONALE

Suggested locations for sample collection should be shown on the site sketch(s) prepared during the physical inspection. The rationale for choosing a sample location rationale should consider its proximity to known or suspected contaminant source area(s), topography and/or anticipated direction of ground-water movement, proximity to buried or overhead utilities, proximity to heavy traffic areas (e.g., gates, driveways, loading docks), and problems with site access (e.g., fenced areas, non-military property, sites inaccessible to drill rigs). The narrative should include observations (e.g., stained surface soils), state assumptions (e.g., underground tank leak from buried product line), list problems with site access, and note comments from Navy personnel.

## 2.5 PROPOSED SAMPLING EQUIPMENT AND PROCEDURES

The narrative should identify suggested equipment and sampling procedures that will provide the most efficient and reliable sample data. Special consideration should be given to site access issues, sample collection and preservation techniques, and health and safety concerns. Field procedures described in Section I-A through I-I of the Navy IRP Project Procedures Manual shall be reviewed prior to suggesting a particular sampling or test procedure.

## 2.6 DATA QUALITY

The narrative should list suggested analytes that will target the constituents of concern at the desired laboratory detection limit. Evidence of the potential for highly contaminated samples, samples that can be expected to exhibit matrix interferences, etc. should be highlighted and described in the reconnaissance report.

## 2.7 SITE ACCESS, HEALTH AND SAFETY, AND SECURITY REQUIREMENTS

The reconnaissance team must clearly address issues of site access (e.g., special badges or schedules) and coordination requirements. The names, codes, and telephone numbers of Navy personnel to be contacted for additional site information should be included. The person primarily responsible for access is the Navy RPM.

The site reconnaissance report must also address physical constraints en route to all locations of concern (e.g., ferries, boats, tunnels, restricted clearances) at the site location.

The site reconnaissance team shall collect, at a minimum, the following information about health and safety issues:

- Site map and road map(s) showing the project location relative to normal access and emergency routes and facilities
- Lists of previously detected or suspected constituents and the matrix (e.g., soil, air, water) in which they were detected
- Results of any background air monitoring surveys (e.g., HNU, LEL, O2, radionuclides), if available
- Copies of listings from local telephone directories of equipment vendors, specialty subcontractors, and relevant business numbers
- List of Navy or facility emergency contacts and phone numbers and their availability for use by contractors (e.g., fire department, police, hospital, clinics)

- The nature of the work to be performed. A brief synopsis of the anticipated work difficulties or issues that must be considered in the completed work plan

The Health and Safety Plan Manager (HSPM) will use this information to prepare a preliminary, draft site-specific Health and Safety Plan. The HSPM will also provide specific guidance about the costs of health and safety precautions to the RPM, for inclusion in the work plan scope of work and budget.

The narrative should specify Navy requirements for site security (e.g., special security clearances) for contractors.

### 2.8 DATA FOR PRELIMINARY EVALUATION OF EXPOSURE PATHWAYS

The site reconnaissance team shall attempt to collect the following data needed for a preliminary evaluation of exposure pathways.

- Land use within 1/4 to 1/2 mile of the site
- Population density and characteristics (i.e., schools, nursing homes, single family housing, etc.)
- Utilization of ground water in area and general locations of wells within 1/4 to 1/2 mile
- Locations and uses of surface water bodies within 1/4 to 1/2 mile
- Identification of potentially sensitive environments such as wetlands, endangered species habitats, etc.
- Climatic data

Although it may not be possible to acquire all of these data, much of it is readily available from sources such as USGS topographic maps, geologic maps, and by talking with Navy EIC.

### 2.9 SITE RECONNAISSANCE REPORT

A Site Reconnaissance Report shall be prepared in a timely fashion. It shall contain (1) pertinent information concerning the site visit (e.g., date, Task Order number, site name, weather conditions); (2) details of the data acquired; (3) a brief narrative of the history of the site land use and hazardous materials management; (4) a discussion about preliminary sample locations and rationale, site access, health and safety, and exposure pathways; (5) sketch map and photographs of the site; and (6) types of information not researched or obtained and along with the rationale for not acquiring the information.

## 3.0 DOCUMENTATION

Copies of Site Reconnaissance Reports shall be maintained in the project files. The original notes will be recorded in a field notebook for each Task Order. Upon completion of the project, this notebook will be maintained in project files.

## 4.0 REFERENCES

USEPA. 1987. A Compendium of Superfund Field Operation Methods. U.S. Environmental Protection Agency/540/P-87/001.

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

I-A-6

Revised February 2015

# UTILITY CLEARANCE

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features (e.g., vault or tank) at locations where planned site activities involve the physical disturbance of subsurface materials. The definition of subsurface disturbance varies by base. Each base may have specific required procedures. These procedures are made available to the contractor through the Naval Technical Representative (NTR), or other government point of contact. The SOP applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities. The primary purpose of the SOP is to minimize the potential for damaging underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

## 2.0 PROCEDURES

The following steps shall be followed at all sites where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, personnel must always exercise caution while conducting any subsurface exploratory work.

### 2.1 PREPARE PRELIMINARY SITE PLAN

A preliminary, scaled site plan depicting the proposed exploratory locations shall be prepared as part of the work plan. This plan should include as many of the cultural and natural features as practical.

### 2.2 REVIEW BACKGROUND INFORMATION

A search of existing plan files to review the as-built plans is necessary to identify the known location of utilities at the site. Copies of as-built plans shall be copied and maintained for project use. If necessary, the locations of utilities identified shall be plotted onto a preliminary, scaled site plan. Personnel reviewing these files shall inform the Project Manager (PM) if utilities lie within close proximity to a proposed exploration or excavation location. The PM will determine if it is necessary to relocate proposed sampling or excavation locations.

For removal or remedial actions, the utility location information gathered during investigation (e.g., remedial investigation or remedial site evaluation) work shall be included in the project design documents. In this manner, information regarding utility locations collected during implementation of a Task Order can be shared with the Remedial Action Contract (RAC) Contractor during implementation of a particular Delivery Order (DO).

It may be necessary to conduct interviews with onsite and facility personnel familiar with the site in order to obtain information regarding the known and suspected locations of underground utilities. The local 1-800-“Before-U-Dig” service must be contacted a minimum of two business days prior to intrusive work. Other appropriate utility or locating companies should be contacted. The dimensions, orientation, and depth of utilities other than those identified on the as-built plans should be penciled in at their approximate locations on the preliminary plans. The type of utility, the personnel who provided the information, and the date the information was provided should be entered into the field log.

## 2.3 SITE VISIT - LOCATE UTILITIES - TONING

Prior to the initiation of field activities, a qualified staff member shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depressions. All areas where subsurface exploration is proposed shall be accurately located or surveyed and clearly marked with stakes, pins, flags, paint, or other suitable devices.

Local private utility contractors, familiar with individual base operations and procedures should be subcontracted to identify utilities not located by the “Before U Dig” service. The private locator may be utilized earlier in the project to conduct map research if they are familiar with the base operations. The locator should utilize appropriate sensing equipment to attempt to locate any utilities that may not have appeared on the as-built plans. This may involve the use of surface geophysical methods (SOP I-B-2, *Geophysical Testing Procedures*). At a minimum, a utility locator, metal detector, and/or magnetometer should be utilized; however, it is important to consider the possibility that non-metallic utilities or tanks may be present at the site. If non-metallic cultural features are likely to be present at the site, other appropriate surface geophysical methods, such as Ground Penetrating Radar, should be used. Proposed exploration areas shall be cleared of all utilities in the immediate area where subsurface exploration is proposed. All anomalous areas should be clearly toned.

Any anomalous areas detected and toned that are in close proximity to the exploration or excavation areas shall be reported to the Field Manager. The Field Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate proposed exploration or excavation areas. If this is required, the field manager or a similarly qualified individual shall relocate them and clearly mark them using the methods described above. The markings at the prior location shall be completely removed. In some instances, such as in areas extremely congested with subsurface utilities, it is strongly recommended to dig by hand to determine the location of the utilities.

## 2.4 PREPARE SITE PLAN

Prior to the initiation of some field activities, notably remedial action projects, a final site plan shall be drafted which indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Copies of this site plan shall be provided to the Field Manager, the PM and the subcontractor who is to conduct the subsurface exploration/excavation work. The site plan should be reviewed with the Navy Remedial Project Manager (RPM) to verify its accuracy prior to initiating subsurface sampling activities.

## 3.0 DOCUMENTATION

An approved field logbook detailing the pertinent activities conducted during the utility locating procedure shall be kept. The logbook will describe any changes and modifications made to the original exploration plan. Details of the appropriate procedures for maintaining a logbook are documented in SOP III-D, *Logbooks*.

## 4.0 REFERENCES

SOP I-B-2, *Geophysical Testing Procedures*

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

None.

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# IDW MANAGEMENT

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities of the U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) and their subcontractors with regard to management of investigation-derived waste (IDW). The purpose of this procedure provides guidance for the minimization, handling, labeling, temporary storage, and inventory of IDW generated during site investigations and remediation projects conducted under the direction of NAVFAC NW. **Each base may have specific required procedures**. These procedures are made available to the contractor through the NAVFAC Naval Technical Representative (NTR) or other government point of contact. This SOP is also applicable to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste and other regulated wastes generated during implementation of site investigations and removal or remedial actions. The information presented will be used to prepare and implement Work Plans (WP), Field Sampling Plans (FSP), and Waste Management Plans (WMPs) for IDW-related field activities.

## 2.0 PROCEDURES

The procedures for IDW management in the field are described below in Sections 2.1 to 2.5. The implementation of these procedures requires Remedial Project Managers (RPMs), Field Managers, their designates and subcontractors to perform the following tasks:

- Minimize generation of IDW,
- Segregate IDW,
- Properly handle IDW containers,
- Properly label IDW containers,
- Apply good management practices in storing IDW drums and containers,
- Prepare IDW drum inventories,
- Update and Report changes to IDW drum inventories,
- Perform inspections of IDW containers and storage areas, as required,
- Prepare IDW containers for proper off-site transportation and disposition, as required.

## 2.1 IDW MINIMIZATION

Field Managers and their designates shall minimize the generation of onsite IDW to reduce the need for special storage or disposal requirements that may result in substantial additional costs and provide little or no reduction in site risks (EPA 1992). The volume of IDW shall be reduced, by applying minimization practices throughout the course of site investigation activities. These minimization strategies include: 1) material substitution; 2) using proper low-volume drilling techniques; 3) using disposable sampling and PPE; 4) using bucket and drum liners; and 5) segregating non-contaminated IDW and trash from contaminated IDW. Waste minimization strategies and types of IDW expected to be generated shall be documented in the appropriate project plans.

### 2.1.1 Material Substitution

Material substitution consists of selecting materials that degrade readily or have reduced potential for chemical impacts to the site and the environment. An example of this practice is the use of biodegradable detergents (e.g., Alconox® or non-phosphate detergents) for decontamination of non-consumable PPE and sampling equipment. In addition, field equipment decontamination can be conducted using isopropyl alcohol rather than hexane or other solvents (for most analytes of concern), to reduce the potential onsite chemical impacts of the decontamination solvent. Decontamination solvents shall be selected carefully so that solvents, and their known decomposition products, do not result in generation of RCRA hazardous waste.

### 2.1.2 Drilling Methods

Drilling methods that minimize potential IDW generation should be given priority. Sonic, Hollow stem auger and air rotary methods should be selected, where feasible, over mud rotary methods. Mud rotary drilling produces waste drilling mud, while hollow stem and air rotary drilling methods produce relatively low volumes of soil waste. Sonic drilling produces the least amount of waste. Small diameter borings and cores shall be used when soil is the only matrix to be sampled at the boring location; the installation of monitoring wells requires the use of larger diameter borings.

Soil, sludge, or sediment removed from borings, containment areas, and shallow test trenches shall not be returned to the source, unless allowed by regulation and included in the approved WP, FSP, or WMP.

### 2.1.3 Decontamination Fluids

The use of disposable sampling equipment, such as plastic bailers, trowels, and drum thieves (which do not require decontamination) minimizes the quantity of decontamination fluids generated. In general, decontamination fluids, and well development and purge water, should not be minimized because the integrity of the associated analytical data may be affected.

### 2.1.4 PPE and Disposable Sampling Equipment

Visibly soiled PPE and disposable sampling equipment shall be segregated from non-visibly soiled PPE and sampling equipment. Where investigation involves potentially hazardous waste or other regulated wastes, visibly soiled PPE and disposable sampling equipment may require decontamination. The Field

Manager shall use best professional judgment to determine if decontamination is appropriate. This determination should be included in the approved WP, FSP, or WMP. If decontamination is performed, PPE and disposable sampling equipment generated in the decontamination process may be double-bagged and disposed of as non-hazardous waste.

### 2.1.5 Liners

Bucket liners can be used in the decontamination process to reduce the volume of solid IDW-generated and reduce costs on larger projects. The plastic bucket liners can be crushed into a smaller volume than the buckets, and only a small number of plastic decontamination buckets are required for the entire project. Larger, heavy-duty, 55-gallon drum liners can be used for heavily contaminated IDW to provide secondary containment, and reduce the costs of disposal and drum recycling. Drum liners may extend the containment life of the drums in severe climates and will reduce the costs of cleaning out the drums prior to recycling.

### 2.1.6 Segregation of non-IDW

All waste materials generated in the support zone are considered non-IDW trash. To minimize the total volume of IDW, all trash shall be separated from IDW, sealed in garbage bags, and properly disposed of offsite as municipal waste.

### 2.1.7 Monitoring Well Construction

Excess cement, sand, and bentonite grout prepared for monitoring well construction shall be kept to a minimum. Well construction shall be observed by Field Managers to ensure that a sufficient, but not excessive, volume of grout is prepared. Some excess grout may be produced. Unused grout that has not come in contact with potentially contaminated soil or ground water shall be considered non-hazardous trash and shall be disposed of offsite by the drilling subcontractor. Surplus materials from monitoring well installation, such as scrap PVC sections, used bentonite buckets, and cement/sand bags that do not come in contact with potentially contaminated soil, shall be considered non-IDW trash and shall be disposed of offsite by the drilling subcontractor.

### 2.1.8 Field Analytical Test Kits

IDW generated from the use of field analytical test kits consists of those parts of the kit that have been used and/or come into contact with potentially contaminated site media, or excess extracting solvents and other reagents. Potentially contaminated solid test kit IDW shall be contained in plastic bags and stored with PPE or disposable sampling equipment IDW from the same source area as soil material used for the analyses. The small volumes of waste solvents, reagents, and water samples used in field test kits should be segregated, and disposed of accordingly (based upon the characteristics of the materials, MSDS sheets, and as described in the WMP). Most other test kit materials should be considered non-IDW trash, and be disposed of as municipal waste.

## 2.2 SEGREGATION OF IDW BY MATRIX AND LOCATION

To facilitate subsequent IDW screening, sampling, classification and/or disposal, IDW shall generally be segregated by matrix and source location at the time it is generated. Each drum of solid IDW shall be completely filled, when possible. For liquid IDW, drums should be left with headspace of approximately 5% by volume to allow for expansion of the liquid and potential volatile contaminants. IDW from each distinct matrix shall be stored in a single drum (e.g., soil, water or PPE shall not be mixed in one drum). In general, IDW from separate sources should not be combined in a single drum.

It is possible that monitoring well development and purge water will contain suspended solids, which will settle to the bottom of the storage drum as sediment. Significant observations on the turbidity or sediment load of the development or purge water shall be included in the logbook and reported in attachments to the quarterly drum inventory report (see SOP III-D, *Logbooks* and Section 2.5). To avoid having mixed matrices in a single drum (i.e., sediment and water), it may be necessary to decant the liquids into a separate drum, after the sediments have settled out. This segregation may be accomplished during subsequent IDW sampling activities or during consolidation in a holding tank prior to disposal. Disposal of liquid IDW into the sanitary sewer shall only occur if approved by the appropriate regulatory agencies, municipal entities, and Naval installation. Appropriate precautions per the approved Health and Safety Plan (HASP) shall be implemented to ensure worker protection during these activities.

Potentially contaminated well construction material shall be placed in separate containers. Soil, sediment, sludge, or liquid IDW shall be segregated from potentially contaminated waste well construction materials. Potentially contaminated well construction materials from different monitoring wells shall not be commingled.

Potentially hazardous PPE and disposable sampling equipment shall be segregated from other IDW. PPE from generally clean field activities, such as water sampling, shall be segregated from visibly soiled PPE, double-bagged and disposed of offsite as municipal waste. Disposable sampling equipment from activities such as soil, sediment, and sludge sampling includes plastic sheeting used as liner material in containment areas around drilling rigs and waste storage areas; disposable sampling equipment; and soiled decontamination equipment. Where investigation involves potentially hazardous waste, visibly soiled PPE and disposable sampling equipment may require decontamination. The Field Manager shall use best professional judgment to determine if decontamination is appropriate. If decontamination is performed, PPE and disposable sampling equipment generated in the decontamination process may be double-bagged and disposed of as non-hazardous waste. PPE and disposable sampling equipment generated on separate days may be commingled.

Decontamination fluids shall be stored in drums separate from other IDW. If practical, decontamination fluids generated from different sources should not be stored in the same drum. If decontamination fluids generated over several days or from different sources are stored in a single container, information regarding dates of generation and sources shall be recorded in the field notebook, on the drum label (Section 2.3.2), and in the drum inventory (Section 2.5).

Liquid and sediment portions of the equipment decontamination fluid in the containment unit used by the drilling or excavation field crew should be separated. The contents of this unit normally consist of turbid decontamination fluid above a layer of predominantly coarse-grained sediment. When the contents of the containment unit are to be stored in IDW containers, the Field Manager shall direct the placement of as much liquid into drums as possible and transfer the remaining solids into separate drums. Observations of the turbidity and sediment load of the liquid IDW should be noted in the field notebook, on the drum label (Section 2.3.2), and in attachments to the drum inventory (see Section 2.5). It is likely that decontamination fluids will contain minor amounts of suspended solids that will settle out of suspension to become sediment at the bottom of IDW storage drums. As noted above, it may be necessary to segregate the drummed water from sediment during subsequent IDW sampling or disposal activities.

## 2.3 DRUM HANDLING AND LABELING

Drum handling consists of those actions necessary to prepare an IDW drum for labeling. Drum labeling consists of those actions required to legibly and permanently identify the contents of an IDW drum. Specific handling, storage, and labeling requirements may differ with the Naval installation or oversight entity. Specific requirements should be determined at the planning stage and documented in the WMP. General requirements are provided in the following sections.

### 2.3.1 Drum Handling

The drums used for containing IDW shall be approved by the United States Department of Transportation (DOT, 49 CFR 172). The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., 1A1 or 1A2). New steel drums are preferred over recycled drums. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. Consideration must be given to scheduling and cost-effectiveness of bulk storage, treatment, and discharge system versus longer-term drum storage.

For long-term IDW storage, the DOT-approved drums with removable lids are recommended. The integrity of the foam or rubber sealing ring located on the underside of some drum lids shall be verified prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, a drum lid with sealing ring that is in good condition must be used. At some facilities, drums containing liquid IDW will be required to be stored in protective overpacks.

To prepare IDW drums for labeling, the outer wall surfaces and drum lids shall be wiped clean of all material that may prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, that material shall be wiped from the drum, and the paper towel or rag used to remove the material shall be segregated with visibly soiled PPE and disposable sampling equipment.

### 2.3.2 Drum Labeling

Proper labeling of IDW drums is essential to the success and cost-effectiveness of subsequent waste screening and disposal activities. Labels shall be permanent and descriptive to facilitate correlation of field analytical data with the contents of individual IDW drums.

#### 2.3.2.1 *Preprinted Labels*

A preprinted drum label as required by the appropriate Naval installation and/or regulatory agency shall be completed. The label will be affixed to the outside of the drum (or overpack if required) with the label easily readable for inspections and inventory. Label requirements may vary based on the site.

The requested information shall be printed legibly on the drum labels in black, indelible ink. Instructions for entering the required drum-specific information for each label field are provided by the Naval installation.

*Painted Labels*

An alternative method for labeling drums, if acceptable for the project, is to paint label information directly on the outer surface of the drum. At a minimum, the information placed on the drum shall include the contract/delivery order number, a drum number, the source identification type and number, the type of IDW, the generation date(s), and the government point of contact and telephone number. The drum surface shall be dry and free of material that could prevent legible labeling. Label information shall be confined to the upper two-thirds of the total drum height. The printing on the drum shall be large enough to be easily legible. Yellow, white, or red paint markers (oil-based enamel paint) that are non-photodegradable are recommended to provide maximum durability and contrast with the drum surface.

#### 2.3.2.2 *Regulatory Marking and Labeling*

Federal and State regulations may require specific labeling for IDW generated (i.e., RCRA, TSCA, NESHAPs). Pre-printed labels shall be used as appropriate and completed in accordance with the specific regulatory requirement. These requirements will be identified in the approved project plans. Once determined to be hazardous, weekly inspections must also be conducted to ensure that labels and markings are in good conditions and to ensure the integrity of containers.

In addition, prior to off-site transportation USDOT requirements for marking and labeling of regulated DOT materials must be complied with. These requirements will be identified in the approved project plans or otherwise coordinated with the Field Manager after the IDW has been characterized and off-site disposition is being planned. Note that personnel (i.e., contractors or subcontractors) who perform USDOT functions must be properly trained in accordance with 49 CFR 172, Subpart G.

### 2.4 DRUM STORAGE

Drum storage procedures shall be implemented to minimize potential human contact with the stored IDW and prevent extreme weathering of the stored drums. Waste accumulation areas will be pre-designated by NAVFAC NW prior to the start of site work. IDW drums should be placed on pallets. Good management practices should be used in storing drums which include: containers shall be in good condition and closed during storage; wastes must be compatible with containers; where liquids are stored, storage areas should have secondary containment; and spill or leaks should be removed as soon as possible. These good management practices are mandatory requirements where RCRA hazardous wastes are stored.

Waste accumulation areas shall be maintained as prescribed by local regulatory entities and the appropriate Naval installation. In general, drums of IDW shall be stored within the Area of Concern (AOC) so that the site can utilize RCRA regulatory flexibility (i.e., administrative requirements, such as 90-day storage, may not be triggered; and LDRs will not be triggered if IDW is placed back in AOC). If IDW is determined to be RCRA hazardous waste, then RCRA storage, transportation and disposal requirements must be met.

Drums shall be stored at identified waste accumulation areas. All IDW drums generated during field activities at a single AOC shall be placed together, in a secure, fenced onsite area to prevent access to the drums by unauthorized personnel. When a secure area is not available, drums shall be placed in an area of the site with the least volume of human traffic. Plastic sheeting (or individual drum covers) and yellow caution tape shall be placed around the stored drums. Drums from projects involving multiple AOCs should remain at the respective source areas where the IDW was generated. IDW should not be transferred offsite for storage elsewhere, except under rare circumstances, such as the lack of a secure storage area onsite.

Proper drum storage practices shall be implemented to minimize damage to the drums from weathering and possible exposure to humans or the environment. When possible, drums shall be stored in dry, shaded areas and covered with impervious plastic sheeting or tarpaulin material. Every effort shall be made to protect the preprinted drum labels from direct exposure to sunlight, which causes ink on the labels to fade. In addition, drums shall be stored in areas that are not prone to flooding. The impervious drum covers shall be appropriately secured to prevent dislodging by the wind. It may be possible to obtain impervious plastic covers designed to fit over individual drums; however, the labeling information shall be repeated on the outside of these opaque covers.

Drums in storage shall be placed with sufficient space between rows of drum pallets and shall not be stacked, such that authorized personnel may access all drums for inspection. Proper placement will also render subsequent IDW screening, sampling, and disposal more efficient. It is recommended that IDW drums be segregated in separate rows/areas by matrix (i.e., soil, liquid or PPE/other).

If repeated visits are made to the project site, the IDW drums shall be inspected to clear encroaching vegetation, check the condition and integrity of each drum, check and replace labels as necessary, and replace or restore protective covers.

## 2.5 DRUM INVENTORY

Accurate preparation of an IDW drum inventory is essential to all subsequent activities associated with IDW drum tracking and disposal. An inventory shall be prepared for each project in which IDW is generated, stored, and disposed of. Naval installations and local regulatory authorities may have specific requirements associated with waste inventory and these requirements should be included in the planning process and documented in the WP, FSP, and WMP.

The drum inventory information shall include 11 elements that identify drum contents and indicate their fate.

### 2.5.1 Navy Activity (Generator)/Site Name

Inventory data shall include the Navy activity and the site name where the IDW was generated (e.g., NASWI, NBK Bangor, etc.).

### 2.5.2 DO Number

Inventory data shall include the contract and delivery order number associated with each drum (e.g., 0089).

### 2.5.3 Drum Number

The drum number assigned to each drum shall be included in the inventory database.

### 2.5.4 Storage Location Prior to Disposal

The storage location of each drum prior to disposal shall be included in the inventory (e.g., Building 394 Battery Disassembly Area, or Adjacent to West end of Building 54).

### 2.5.5 Origin of Contents

The source identification of the contents of each IDW drum shall be specified in the inventory (e.g., soil boring number, monitoring well number, sediment sampling location, or the multiple sources for PPE- or rinse water-generating activities).

### 2.5.6 IDW Type

Inventory data shall include the type of IDW in each drum (e.g., soil, PPE, disposable sampling equipment, sludge, sediment, development water, steam cleaning water, decontamination rinse water).

### 2.5.7 Waste Volume

The amount of waste in each drum shall be specified in the inventory as a percentage of the total drum volume or an estimated percentage-filled level (e.g., 95% maximum for liquid IDW).

### 2.5.8 Recommended Analytical Methods and Test Results Compared with Applicable Regulatory Standards

The recommended EPA analytical methods that adequately characterize IDW contained in each drum will be summarized in a tabular format and attached to the quarterly IDW drum inventory report (see Attachment I-A-7-1). The methodology for sampling and characterizing IDW shall be specified in the appropriate project plans.

### 2.5.9 Recommended or Actual Disposition of IDW Drum Contents

The recommended means of IDW disposal for each drum shall be summarized in a tabular format (e.g., Offsite, Encapsulated Onsite, Treatment/Sewer, Offsite Incinerator) and attached to the quarterly IDW drum inventory report (see Attachment I-A-7-1). Additional narrative discussion of the rationale for the recommended disposal option shall be attached to the quarterly IDW drum inventory report as data become available.

### 2.5.10 Generation Date

Inventory data shall include the date IDW was placed in each drum. If a drum contains IDW-generated over more than one day, the start date for the period shall be specified in dd-month-yy format. This date is not to be confused with an RCRA hazardous waste accumulation date (40 CFR 262). The accumulation start date, if required for RCRA wastes, shall be included on the hazardous waste drum label (Section 2.3.2.2).

### 2.5.11 Expected Disposal Date

The expected date each drum is to be disposed of shall be specified as part of the inventory in month-yy format. This date is for informational purposes only for the Navy, and shall not be considered contractually binding.

### 2.5.12 Actual Disposal Date

The actual drum disposal date occurs at the time of onsite disposal, or acceptance by the offsite treatment or disposal facility. It shall only be entered in the drum inventory database when such a date is available in dd-month-yy format.

In order to provide information for all 11 of the inventory elements of the quarterly inventory report described above, the main source of information will be provided by RPMs, or their designees, and summarized in Attachment I-A-7-1.

The recommended analytical test methods and actual test results (compared to applicable regulatory standards) will be provided to the appropriate Navy groups, by the RPM, or their designees, when such data are available. Testing methods shall be documented in the associated project plans. Recommended disposal options or actual disposition of the IDW drum contents will also be provided by RPMs as data become available. The NAVFAC Northwest RPM will forward all IDW data to the appropriate Navy authority as attachments to the quarterly IDW drum inventory report. This information constitutes the results of preparing and implementing an IDW screening, sampling, classification, and disposal program for each site.

## 3.0 DOCUMENTATION

The RPM or designee is responsible for completing and updating the site-specific IDW drum inventory spreadsheet and submitting it as needed. The RPM is also responsible for submitting backup documentation to the U.S. Navy Program Management Office (PMO) about the analytical methods recommended to adequately characterize the IDW in each drum (Section 2.5.8). In addition, actual site or drum sampling results shall be forwarded to the PMO, along with a comparison to the applicable regulatory standards, for inclusion as attachments to the quarterly IDW drum inventory. As necessary, the backup documentation to the quarterly IDW drum inventory report shall also include the recommended means for IDW disposal for each drum (Section 2.5.9). After disposal, the actual means and/or location of disposal shall be indicated in tabular format with supporting narrative.

Field Managers and designates are responsible for documenting all IDW-related field activities in the field notebook, including most elements of the IDW drum inventory spreadsheet. The correct methods for developing and maintaining a field notebook are presented in SOP III-D, *Logbooks*.

Upon receipt of analytical data from the investigation, the information will be forwarded to the appropriate Naval authority for comparison to regulatory waste criteria. The Navy will designate the IDW and disposal options will be assessed based on the waste designation, approved transport/disposal facilities, and schedule for disposal. Naval installations may have additional requirements for reviewing analytical data, characterizing waste materials, transporting and off-site disposal. The RPM shall coordinate with the Naval installation early in the planning process to ensure that these requirements are properly identified, incorporated into the approved project plans, as available, and implemented in the field.

The disposal of IDW must be approved by the Navy and, in some cases, pertinent regulatory agencies. The disposal must be documented.

## 4.0 REFERENCES

Department of Transportation (DOT), Hazardous Materials Transportation Regulations, 49 CFR Parts 171 – 179.

EPA. 1998. EPA530-F-98-026, Management of Remediation Waste Under RCRA

EPA. 1991. Management of Investigative-Derived Wastes During Site Inspections. U.S. Environmental Protection Agency/540/G-91/009. May.

EPA. 1992. Guide to Management of Investigative-Derived Wastes. Quick Reference Guide. U.S. Environmental Protection Agency: 9345.3-03FS. January.

## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment IA71 | Example Format – Quarterly IDW Drum Inventory Updates |

## Attachment I-A-7-1
## Quarterly IDW Drum Inventory Updates

| Navy Activity / Site Name (Generator Site) | DO Number (0bbb) | Drum Number (xxxx-AA-Dzzz) | Drum Storage Location | Origin of Contents (Source ID #) | IDW Type | Waste Volume (Fill level %) | Waste Generation Date (dd-mm-yy) | Expected Disposal Date (mm-yy) | Actual Disposal Date (dd-mm-yy) |
|---|---|---|---|---|---|---|---|---|---|
| NSC Pearl Harbor/ Landfill | 0068 | 0068-LF-D001 | NSC, Bldg 7 | SB-1 | Soil Cuttings | 100 | 16-Dec-92 | Dec-93 | Na |
| | | 0068-LF-D002 | NA | MW-1 | Purge Water | 75 | 20-Dec-92 | Jul 93 | 26-Jul-93 |
| | | | | MW-2 | | | | | |
| | | | | MW-3 | | | | | |
| | | 0068-LF-D003 | NA | MW-1 | Decon Water | 95 | 20-Dec-92 | Jul-93 | 26-Jul-93 |
| | | | | MW-2 | | | | | |
| | | | | MW-3 | | | | | |
| | | 0068-LF-D004 | NSC, Bldg.16 | SB-1 | PPE | 50 | 16-Dec-92 | Oct-93 | NA |
| | | | | SB-2 | | | | | |
| | | | | SB-3 | | | | | |
| | | | | SB-4 | | | | | |
| | | | | MW-1 | | | | | |
| | | | | MW-2 | | | | | |
| | | | | MW-3 | | | | | |
| NAVSTA Guam/ Drum Storage | 0047 | 0047-DS-001 | Hazmat Storage Area | SB-1 | Soil Cuttings | 100 | 18-Feb-93 | Sep-93 | NA |
| | | | | SB-2 | | | | | |

NA = Not Applicable

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# GENERAL FIELD OPERATION

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## 1.0 PURPOSE

This standard operating procedure (SOP) defines the general field organization and the field structure of sample collection, sample identification, record keeping, field measurements, and data collection. These SOPs are used to ensure the activities used to document sampling and field operations provide standardized background information and identities.

## 2.0 PROCEDURES

### 2.1 MOBILIZATION/DEMOBILIZATION

The SM or designee ensures that all purchase requests have been reviewed and approved by the PM. Then, the SM and PM assemble the project team in order to review the scope of work, disseminate the project plans, and complete the field equipment checklist (provided as Attachment I-A-9-1). After review by the project team, if additional items are required, additional purchase requests are prepared and approved by the PM.

The SM and project team upon arrival at the site inspects all equipment. Packing slips, bills of lading, or other documentation received with the shipment are initialed and returned to the purchasing department and a copy placed into the field file. Quantities, types, and makes of items received are checked against the original purchase requests to validate the shipment. Prior to validation of the shipping receipt, equipment is inspected to ensure all components are present and that the equipment calibrates and is fully functional. Any equipment received that is not fully functional is returned immediately and the vendor contacted to arrange a replacement.

The SM provides copies of the appropriate SOPs to the project team prior to the start of field activities. The most current versions of the SOPs are brought to the field. Any revisions to the SOPs must be approved by the PM and recorded in the field logbook.

It is imperative that rental equipment be cleaned (decontaminated), packaged, and returned immediately following the completion of a task. If any problems occurred on site with any equipment, the problems should be noted in detail in the field logbook and the SM notified. The SM will forward this information to the purchasing department and the vendor.

### 2.2 SHIPPING

If it is possible and /or practical, equipment and supplies should be shipped directly to the field site. If sensitive field equipment is to be shipped to the site, care shall be taken to ensure the equipment is not damaged en route. All original packaging material should be retained for return shipment of the equipment. Additional packing material (e.g., bubble wrap, bubble bags) may be required to provide additional protection for the shipped items. Equipment should always be shipped in its original carrying case. Each piece being shipped must have an address label on the shipping container separate from the shipping air bill.

### 2.3 CHAIN OF COMMAND

Chain of command protocols are implemented by the PM. These protocols should be strictly followed while performing field tasks. All decisions concerning priorities, project team assignments, sampling procedures, equipment management, and task approach are made by the PM, the SM, or an approved appointee. The SM or an approved designee will conduct a daily meeting prior to the start of field activities to discuss individual responsibilities. The meeting will also address potential contaminants that may be encountered, safety items (such as use of heavy equipment or protection against noise), special sampling requirements, and site control(s) to be employed to prevent injuries or exposure.

### 2.4 SAMPLING ORGANIZATION

The SM ensures the sampling design, outlined in project plans, is followed during all phases of the sampling activities at the site. For each sampling activity, field personnel record the information required by the applicable SOPs in their logbooks and on the exhibits provided in the SOPs.

### 2.5 REVIEW

The PM, SM, and, on occasion, the QAO or an approved designee checks field logbooks, daily logs, and all other documents that result from field operations for completeness and accuracy. Any discrepancies on these documents are noted and returned to the originator for correction. The reviewer acknowledges that review comments have been incorporated into the document by signing and dating the applicable reviewed documents.

## 3.0 DOCUMENTATION

Project activities shall be recorded in the field logbooks. The logbooks shall be kept current for the daily activities including documentation of all samples collected and the information relevant to the sample collection. All project required field forms shall be completed within a timely manner upon completion of the field task. All required field forms and specific logbook notations should be detailed in the field sampling plan.

## 4.0 REFERENCES

None.

## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment IA91 | Field Equipment Checklist. |

## Attachment I-A-9-1
## Field Equipment Checklist

General

___ 1. Health and Safety Plan

___ 2. Site base map

___ 3. Hand calculator

___ 4. Brunton compass

___ 5. Personal clothing and equipment

___ 6. Personal Protective Equipment (First Aid kit)

___ 7. Cell or radio telephone

Environmental Monitoring Equipment

___ 1. Shovels

___ 2. Keys to well caps

___ 3. pH meter (with calibrating solutions)

___ 4. pH paper

___ 5. Thermometer

___ 6. Conductivity meter (with calibrating solution)

___ 7. Organic vapor analyzer or photoionization detector with calibration gas

___ 8. H2S, O2, combustible gas indicator

___ 9. Draeger tubes

Shipping Supplies

___ 1. Sample preservatives (nitric, hydrochloric, sulfuric acid/sodium hydroxide)

___ 2. Heavy-duty aluminum foil

___ 3. Coolers

___ 4. Ice packs

___ 5. Large zipper locking plastic bags

___ 6. Heavy-duty garbage bags

___ 7. Duct tape

___ 8. Strapping tape

___ 9. Paper towels

___ 10. Bubble pack, foam pellets, or shredded paper

___ 11. Vermiculite

___ 12. Cooler labels (“This Side Up,” “Hazardous Material,” “Fragile”)

___ 13. Federal Express/DHL labels

### Sampling Equipment

___ 1. Tool box with assorted tools (pipe wrenches, screwdrivers, socket set and driver, open and box end wrenches, hacksaw, hammer, vice grips)

___ 2. Geologic hammer

___ 3. Trowel

___ 4. Stainless steel and/or Teflon spatula

___ 5. Hand auger

___ 6. Engineer's tape

___ 7. Steel tape

___ 8. Electric water level sounder

___ 9. Petroleum Interface Probe

___ 10. Batteries

___ 11. Bailers (Teflon, stainless steel, acrylic, PVC)

___ 12. Slug test water displacement tube

___ 13. Vacuum hand pump

___ 14. Electric vacuum pump

___ 15. Displacement hand pump

___ 16. Mechanical pump (centrifugal, submersible, bladder)

___ 17. Portable generator

___ 18. Gasoline for generator

___ 19. Hose

___ 20. Calibrated buckets

___ 21. Stop watch

___ 22. Orifice plate or equivalent flow meter

___ 23. Data logger and pressure transducers

___ 24. Strip chart recorders

___ 25. Sample bottles

___ 26. 0.45-micron filters (prepackaged in holders)

___ 27. Stainless steel bowls

___ 28. SW scoop

___ 29. Peristaltic pump/tubing

___ 30. Sample tags

___ 31. SOPs, HAZWOPER training certificates, MSDs, FSP, QAPP

### Decontamination Equipment

___ 1. Non-phosphate laboratory-grade detergent

___ 2. Selected high purity, contaminant free solvents

___ 3. Long-handled brushes

___ 4. Drop cloths (plastic sheeting)

___ 5. Trash container

___ 6. Galvanized tubs or equivalent (e.g., baby pools)

___ 7. Tap Water

___ 8. Contaminant free distilled/deionized water

___ 9. Metal/plastic container for storage and disposal of contaminated wash solutions

___ 10. Pressurized sprayers, $H_2O$

___ 11. Pressurized sprayers, solvents

___ 12. Aluminum foil

___ 13. Sample containers

___ 14. Emergency eyewash bottle

___ 15. Documentation Supplies

Documentation Supplies

___ 1. Weatherproof, bound field logbooks with numbered pages

___ 2. Daily Drilling Report forms

___ 3. Field Borehole Log forms

___ 4. Monitoring Well Installation Log forms

___ 5. Well Development Data forms

___ 6. Groundwater Sampling Log forms

___ 7. Aquifer Test Data forms

___ 8. Sample Chain-of-Custody forms

___ 9. Custody seals

___ 10. Communication Record forms

___ 11. Documentation of Change forms

___ 12. Camera and film

___ 13. Paper

___ 14. Permanent/indelible ink pens

___ 15. Felt tip markers (indelible ink)

___ 16. Munsell Soil Color Charts

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NAVFAC NW Standard Operating Procedure Number:

I-A-10

Revised February 2015

# MONITORING/SAMPLING LOCATION RECORDING

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the guidelines for generating the descriptions and information to be recorded for each physical location where monitoring, or sampling is conducted.

## 2.0 PROCEDURES

### 2.1 SAMPLING LOCATION MARKING

Sampling locations are based on criteria presented in the SAP. Whenever possible, each sampling location will be marked by a wooden lathe stake, directly marking the surface with marking paint, or with surveyors flagging. Each should be labeled with the location identifier outlined in the SAP. This should be done during the site visit or as soon as is feasible during field activities. This is to give the utility locators a better idea of the specific area to be cleared. Having the locations marked will also assist the field crew gain a better perspective of the locations to be worked

### 2.2 PHOTOGRAPHIC DOCUMENTATION

Site photographs showing monitoring/sampling locations with respect to structures or the site in general are encouraged. At certain installations, photography must be approved by the Navy. Prior to commencing work, the Navy must be notified to determine if cameras are allowed at the installation. The Note that the Navy will likely inspect your camera and may purge/delete some pictures if they feel there is a security issue. When possible, a menu board included in the photograph can be used to give relative information regarding the project and location.

For each photograph, record the following information in the field logbook:

- Photo number
- Date and time of the photo
- Orientation of the photo (direction facing)
- Subject-a description of what is contained within the photo. Others may be using the photos that are unfamiliar with the site and locations.

A detailed description of field logbook entries can be found in SOP III-D, *Logbooks*.

## 2.3 MONITORING/SAMPLING LOCATION INFORMATION FORM

A Monitoring/Sampling Location Information form must be filled out to establish each new sampling location. This form must be provided to the Navy for inclusion into the NAVFAC NW NIRIS Database. Established locations should not be re-established unless new information (such as survey information) is recorded about a location. A location description may be provided about a sampling location. It should contain detailed information regarding the physical features surrounding the location, including relevant site information (i.e., obvious contamination, measurements to physical features, topographical relief, etc.). This description may be a copy of the field logbook or notes on project plan maps. These descriptions shall be attached to the field form. The PM is responsible for insuring that the project personnel have and use consistent terminology and descriptions as established in the SAP. The reverse of the field form contains a brief discussion of the form and descriptions of the information requested on the front.

## 3.0 DOCUMENTATION

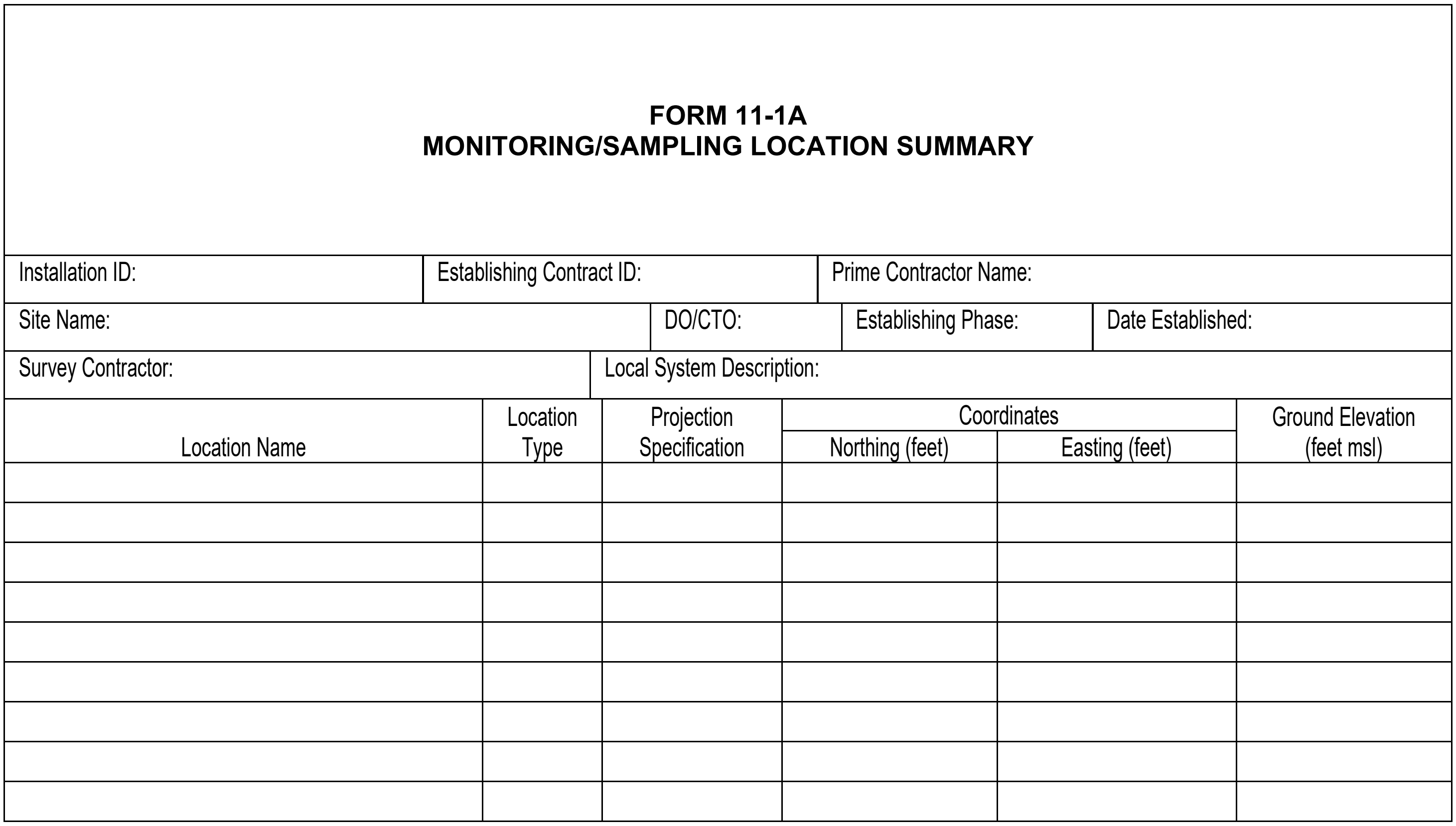
None.

## 4.0 REFERENCES

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

Attachment IA101 Example Monitoring/Sampling Location Information Form



**FORM 11-1A**
**MONITORING/SAMPLING LOCATION SUMMARY**

Installation ID: | Establishing Contract ID: | Prime Contractor Name:
Site Name: | DO/CTO: | Establishing Phase: | Date Established:
Survey Contractor: | Local System Description:

| Location Name | Location Type | Projection Specification | Coordinates | | Ground Elevation (feet msl) |
|---|---|---|---|---|---|
| | | | Northing (feet) | Easting (feet) | |
| | | | | | |
| | | | | | |
| | | | | | |
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| | | | | | |
| | | | | | |
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| Location Types | |
|---|---|
| ACID | Acid Pit |
| ADIT | Adit |
| AGT | Above ground tank |
| AIR | Air (not inside a building - ambient conditions) |
| AMB | Ambient drinking water aquifer monitoring well |
| AOVM | Ambient organic vapor monitor |
| ASBTS | Asbestos-Containing Area |
| BAY | Bay |
| BF | Backfill |
| BH | Borehole/Soil boring |
| BIN | Roll-off bin |
| BIOL | Biological (plant or animal) |
| BLDG | Building (includes building air and building materials) |
| BULK | Bulk sample |
| BURN | Burn pit |
| CB | Concrete boring |
| CENT | Location surveyed at the center of a UST field |
| CLGP | Canal Level Gauging Point |
| CPT | Cone penetrometer |
| CY | Cryopile |
| DCON | Decontamination pad |
| DITCH | Channel/Ditch |
| DP | Direct Push/Geoprobe |
| DRN | Drain |
| DRUM | Drum/Container contents |
| DRW | Drywell |
| DU | Decision Unit |
| DW | Domestic well |
| D_RIG_W | Drill Rig Fluid Container |
| EC | Electrode |
| ECT | Electrode |
| EF | System effluent |
| EVAP | EVAPORATION POND |
| EXCV | Excavation |
| FAGT | Former above ground tank location |
| FL | Fuel line |
| FLOOD | Flood Plain |
| FLOOD_GATE | Flood Control Gate |
| FLOOR | Floor |
| FLOOR_SCRP | Floor scrapings |
| FW | Faucet/Tap/Spigot |
| GAGE | Gaging station (not USGS) |
| GW | Geoprobe well |
| GWTH | Groundwater Test Hold |
| HA | Hand auger |
| HDPCH | Hydropunch |
| HOLE | Hole |
| HP | Holding pond/Lagoon |
| ID | Indoors |
| IMP | Import material |
| IN | System influent |
| IT | Intertidal |
| LAGOON | Lagoon |
| LENTIC | Freshwater, lentic |
| LF | Landfarm |
| LGV | Landfill Gas Vent |
| LH | Leachate (Landfill) |
| LK | Lake/pond/open reservoir |
| LOTIC | Freshwater, lotic |
| LYS | Lysimeter |
| MH | Manhole/Catch basin |
| MS | Sediment e.g., Marine Sediment |
| NQ | Quality Control sample |
| ON | Ocean, open water (not bay) |
| OTHER | Other |
| OUTFALL | Outfall |
| OW | Oil-Water Separator |
| PARK | Plantation/park/forest |
| PC | Paint chip |
| PIPE | Pipeline |
| PUBW | Public drinking water well |
| PUMP_STATN | Pumping station |
| RAIN_STATN | Rainfall station |
| REF | Reference |
| RES | Residential garden/yard |
| RV | River/stream |
| RW | Recovery well |
| SBAG | Soil bag |
| SE | Seep |
| SG | Soil Gas Probe |
| SIDEW | Side Wall |
| SLAG | Slag heap |
| SND_BLST | Sandblast material pile |
| SP | Spring/Seep |
| SPT | Septic tank |
| SR | Sewer System |
| SS | Ground surface |
| STEAM_LN | Steam Line |
| STKP | Stockpile |
| STRM_DRN | Storm drain |
| STRM_MH | Storm drain manhole |
| SUBS | Ground, sub-surface |
| SUBSLAB | Subslab |
| SUBT | Subtidal |
| SUMON | Survey monument |
| SUMP | Sump |
| SV | Soil vapor extraction system |
| SWS | Surface water body - nonspecific |
| SWSD | Surface Water/Sediment |
| SWWP | Wipe |
| SYSTEM | Treatment system air or water |
| T | Trench |
| TAA | Temporary accumulation area |
| TAIL | Mine tailings pile |
| TK | Tank |
| TMPM | Temperature Monitoring Point |
| TP | Test Pit |
| TRANS | Transformer |
| TUNNEL | Steam tunnel sampling location |
| TWP | Temporary well point |
| UGA | Geophysical anomaly |
| UNK | Unknown |
| USGS | USGS gauging station |
| UST | Underground storage tank |
| UXO | UXO |
| UXO_G | UXO grid |
| UXO_P | UXO point |
| VAULT | Vault |
| VPB | Vertical profile boring |
| WALL | Wall |
| WEEP | Weep hole |
| WF | Waste water treatment facility |
| WL | Well |
| WLAM | Alluvial Monitoring Well |
| WLBM | Bedrock Monitoring Well |
| WLE | Extraction well |
| WLEA | Alluvial Extraction Well |
| WLEB | Bedrock Extraction Well |
| WLHM | Hybrid Monitoring Well |
| WLI | Injection well |
| WLIA | Alluvial Injection Well |
| WLIM | Interface Monitoring Well |
| WLL | Leaching Well |
| WLM | Monitoring well |
| WLS | Sparge well |
| WLSG | Soil gas probe/Well |
| WRP | Waste rock pile |
| WSFI | Water system facility intake |
| WT | Wetlands |
| WW | Waste water |

Recorder: ____________________ Date: __________

Checker: ____________________ Date: __________

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NAVFAC NW Standard Operating Procedure Number:

I-A-11

Revised February 2015

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# SAMPLE NAMING

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the naming convention to be used for samples collected, analyzed, and reported for the U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) projects. Unique sample identifiers are used to facilitate tracking by laboratory and project personnel and for purposes of storing, sorting, and querying data in the NAVFAC NW NIRIS database.

## 2.0 PROCEDURES

The contractor is responsible for assigning a unique sample ID to every individual sample collected. The contractor may use his or her own designations as long as the sample ID does not already exist in the NIRIS database. The contractor must also clearly identify which samples are field duplicates. This applies to both historical and planned sampling events. The used sampling identification scheme shall be identified and outlined in the field sampling plan.

## 3.0 DOCUMENTATION

All sample collection information must be recorded within the field logbook. Each sample collected will be clearly associated with the sample location (installation, site, and well or sample point location), matrix type, sample type (i.e. environmental, field duplicate, equipment rinsate), collection date and time, sampling method, and sampling depth (if appropriate). Only data codes and location IDs associated with NIRIS and NAVFAC NW's electronic deliverables SOP (NAVFAC NW 2015) shall be used.

Any sample submitted for analysis shall be documented using a completed chain-of-custody (COC) form that must accompany the shipment and a copy retained for the project records.

Samples submitted to an EPA laboratory shall also include a completed EPA analysis request form. The COC/analytical request form must be used to track all sample IDs.

## 4.0 REFERENCES

NAVFAC NW. 2015. Navy Environmental Data Transfer, Version 5.0.

## 5.0 ATTACHMENTS

None.

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# MONITORING NATURAL ATTENUATION

## 1.1 PURPOSE

The purpose of this SOP is to provide general guidance for field parameter selection in support of Monitored Natural Attenuation to U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and contractors.

This SOP assumes that thorough site characterization has been performed, the potential efficacy of Monitored Natural Attenuation (MNA) as a remedial alternative has been established and a monitoring plan has been developed (USEPA 1999). The processes entailed in arriving at this point are beyond the scope of this SOP.

Detailed information regarding site characterization for potential use of MNA can be found in several sources (Navy 1998, AFCEE 2000, USEPA 1999). Information regarding planning project sampling and scheduling sample collection can be found in SOP 1-A-01, *Planning Field Sampling Activities.*

## 1.2 PROCEDURES

Monitored Natural Attenuation is the use of naturally occurring contaminant degrading and dispersing processes combined with environmental monitoring to remediate contaminated groundwater and soil (Navy 1998). These processes include biodegradation; dispersion; dilution; sorption; volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants. (USEPA 1999). An important factor affecting the success of MNA is the control of the contaminant source, i.e. no new contamination is being introduced into the site. MNA can be an efficient remediation alternative when the rate of contaminant attenuation is higher than the rate of contaminant transport (Navy 1998).

MNA may include monitoring constituents of concern and their daughter products, geochemical parameters, metabolic byproducts of bioremediation and general water quality parameters (AFCEE 2000). Constituents of concern will vary according to the site, but typically include chlorinated solvents, petroleum hydrocarbons, or other organic compounds. Research findings also support the natural attenuation of hexavalent chromium in ground water and soil (USEPA 1995). Sites with chlorinated solvent contamination will likely require a much more diverse suite of analytical parameters than fuel hydrocarbons (AFCEE 2000).

Testing and Analysis of samples in support of MNA can be laboratory or field based, and will usually be conducted temporally over quarterly, semi-annual or annual intervals. Typical groupings of MNA constituents are discussed in more detail in sections 1.3 through 1.6. Actual procedures for collecting and monitoring individual constituents can be found in the Standard Operating Procedure: NAVFAC NW Field Procedures Manual sections I-B through I-D.

A list of analyses that may be included in a Natural Attenuation Monitoring Plan is provided in Table 1.0 (USEPA 1998). Table 1.0 provides additional parameter details, field methods and analysis references, and typical applications for the various parameters.

## 1.3 CONSTITUENTS OF CONCERN AND DAUGHTER PRODUCTS

Monitoring the efficiency of natural attenuation includes the evaluation of the concentrations of contaminants and daughter products in space and time. A daughter product is a compound that results directly from the biodegradation of another. For example cis-1,2-dichloroethene (cis-1,2-DCE) is commonly a daughter product of trichloroethene (TCE) (Navy 1998). The natural attenuation of petroleum hydrocarbons typically includes the loss of light range compounds such as benzene, toluene, ethylbenzene and, and xylenes (BTEX) via biodegradation. Hexavalent chromium [CR(VI)] can be transformed to the less toxic trivalent form [CR(III)] by natural reductants. (USEPA 1995).

Contaminant concentration and migration evaluation is critical in the estimation of natural attenuation rates compared to transport rates. Increased levels of daughter products are an indication that degradation of contaminants are occurring via bioremediation. Testing for daughter products and contaminants of concern is typically laboratory based (see Table 1.0)

## 1.4 GEOCHEMICAL PARAMETERS

The transfer of electrons from organic compounds or reduced inorganic compounds to electron acceptors yields energy used by microorganisms. The actual chemical processes and electron donors and acceptors will vary depending on site conditions.

Electron Acceptors are compounds capable of accepting electrons during oxidation-reduction reactions. Oxygen, nitrate, Fe(III), Mn(IV), sulfate, carbon dioxide and in some cases chlorinated aliphatic hydrocarbons may function as electron acceptors (Navy 1998).

Electron donors supply electrons during oxidation-reduction reactions and include organic compounds from sources such as fuel hydrocarbons, municipal waste leachates and natural organic carbon (dissolved or particulate). Reduced inorganic compounds such as sulfide can also act as electron donors (Navy 1998).

Testing for Geochemical parameters will typically include both field and laboratory based methods. Field based methods are preferable for some parameters where rapid changes in concentrations due to oxidation are likely. When field based methods are employed, some percentage of split samples should be collected for laboratory verification and comparison, typically 10-20 %. Refer to Table 1.0 for further method details.

## 1.5 METABOLIC BYPRODUCTS

Metabolic byproducts are the result of microbially mediated degradation processes. Changes in the concentrations of volatile fatty acids, Fe(II), chloride, carbon dioxide, methane, ethane, ethene, and hydrogen can indicate that these processes are occurring (Navy 1998). Monitoring typically addresses testing or analysis of metabolic byproducts to show a relative increase of these parameters along with changes in contaminant and daughter product ratios. Testing for metabolic byproducts may also include a mixture of laboratory and field based test methods (see Table 1.0)

## 1.6 GENERAL WATER QUALITY PARAMETERS

Physical characteristics of groundwater, such as pH, temperature, conductivity and alkalinity will affect the type and rate of bioremediation that may occur in a particular system. Changes in alkalinity, and lowered ORP are also indicators that bioremediation may be occurring. With the exception of alkalinity, these parameters, along with dissolved oxygen, change quickly once samples are collected and should ideally be measured and recorded in the field (AFCEE 2000).

## 2.0 DOCUMENTATION

Complete laboratory deliverables based on the SAP or QAPP specifications are required for laboratory based methods.

Record all field observations and analyses in a field logbook as defined in SOP III-D, *Logbooks*. If required by the SAP, also complete Form 11-3: Field Measurement Data.

## 3.0 REFERENCES

United States Department of the Navy, 1998. *Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Ground Water at Naval and Marine Corps Facilities.*

United States Environmental Protection Agency, 1998. *Technical Protocol for Evaluating Attenuation of Chlorinated Solvents in Groundwater.* EPA/600/R-98/128

United States Environmental Protection Agency, 1999. *Federal Register Notice - 62-FR 64588-64589 Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites; Office of Solid Waste Emergency Response Directive 9200.4-17P; Final*.

GROUND WATER ISSUE; NATURAL ATTENUATION OF HEXAVALENT CHROMIUM IN GROUND WATER AND SOILS (Document No. EPA/540/S-94/505) Ground Water Currents, July 1995, Issue No. 12

Air Force Center for Environmental Excellence, 2000. *Designing Monitoring Programs to Effectively Evaluate the Performance of Natural Attenuation. US Air Force Center for Environmental Excellence, San Antonio, Texas.*

SOP I-A-1, *Planning Field Sampling Activities*

SOP III-D, *Logbooks*

STANDARD OPERATING PROCEDURE: NAVFAC NW FIELD PROCEDURES MANUAL Sections 1-B through I-I.

## Table I-A-12: Analyses for Assessing Natural Attenuation

Analyses other than those listed in this table may be required for regulatory compliance

| **Analysis** | **Method/Reference** | **Comments** | **Data Use** | **Field or Laboratory** |
|---|---|---|---|---|
| Aromatic and chlorinated hydrocarbons (BTEX, trimethylbenzene isomers, chlorinated compounds) and MTBE | SW-846 Method 8021B (sites with petroleum hydrocarbons only) SW-846 Method 8260B (sites with chlorinated solvents or mixed solvents/petroleum hydrocarbons) | Analysis may be extended to higher-molecular –weight alkyl benzenes. | Method of analysis for BTEX, MTBE, and chlorinated solvents/byproducts, which are the primary target analytes for monitoring natural attenuation; method can be extended to higher molecular weight alkylbenzenes; trimethylbenzenes are used to monitor plume dilution if degradation is primarily anoxic. | Laboratory |
| Hexavalent Chromium [Cr(VI)] | SW-846 Method 7196A | | Target analyte for monitoring natural attenuation. | Laboratory |
| Total Chromium | SW-846 Methods 6010B/6020 | Cr(III) estimated as the difference between Total Cr and Cr(VI) | Changes in the ratio of Cr(VI) and Cr(III) may indicate reduction of Cr(VI) to Cr(III). | Laboratory |
| Oxygen ($O_2$) | Dissolved oxygen meter calibrated in the field according to the supplier's specifications | Refer to American Society for Testing and Materials (ASTM) Method A4500 for a comparable laboratory procedure. | Concentrations generally <0.5 mg/L generally indicate an anoxic pathway. | Field |
| Nitrate ($NO^-_3$) | Ion chromatography (IC) method E300 | Can be done in the field, but analysis by a fixed-base laboratory is recommended. | Substrate for microbial respiration if oxygen is depleted. | Laboratory |
| Soluble Manganese [Mn(II)] | Colorimetric Hach ® Company Method 8149 | Filter if turbidity interferes with analysis. | May indicate an anoxic degradation process due to depletion of oxygen and nitrate. Cr(III) may be oxidized to Cr(VI) in the presence of MnO2. | Field |
| Ferrous Iron [Fe(II)] | Colorimetric Hach ® Company Method 8146 | Filter if turbidity interferes with analysis. | May indicate an anoxic degradation process due to depletion of oxygen nitrate and manganese. Electron donor for reduction of Cr(VI)to less toxic trivalent chromium Cr(III), which can be precipitated as an insoluble hydroxide phase. | Field |
| Sulfate ($SO_4^{2-}$) | IC method E300 | Do not use the field method if this method is used. | Substrate for anoxic microbial respiration. | Laboratory |
| Sulfate ($SO_4^{2-}$) | Hach ® Company Method 8051 | Colorimetric, do not use the fixed-base laboratory method if this method is used | Substrate for anoxic microbial respiration. | Field |
| Hydrogen Sulfide ($H_2S$) | Color Disk Methylene Blue Method | Hach ® Catalog Number 2238-01 | The presence of $H_2S$ suggests biodegradation via sulfate reduction. | Field |
| Methane ($CH_4$), ethane[a/], and ethene[a/] | Kampbell et al. (1989 or SW-846 Method 3810 Modified. | Method published by researchers at the USEPA. | The presence of $CH_4$ suggests biodegradation via methanogenesis. Ethane and ethene data are used where chlorinated solvents are | Laboratory |

# SOIL SAMPLING

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## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline the methods by which U.S. Naval Facilities Engineering Command (NAVFAC NW) personnel and contractors should perform soil sampling.

This procedure describes the protocols for collecting a surface or subsurface soil sample. The procedure will provide descriptions of equipment, field procedures, and documentation necessary to collect representative surface and subsurface soil samples.

## 2.0 PROCEDURE

## 2.1 SURFACE SOIL PROCEDURES

### 2.1.1 Surface Soil Sampling Equipment

Equipment and materials used to collect surface soil samples include:

- Stainless steel spoon, trowel, knife, spatula
- Stainless steel bowl
- Personal protective equipment (PPE) as required by the Health and Safety Plan (HASP)
- Decontamination equipment
- Paper towels
- Laboratory supplied sample jars
- Cooler and blue ice or ice
- Stakes for marking sampling location
- Field forms such as chain of custody, sample collection log, air monitoring log, other necessary health and safety documentation
- Field logbook

### 2.1.2 Surface Soil Sample Collection

The following steps describe the procedures used to collect surface soil samples:

1. Decontaminate sampling equipment.
2. Clear and remove vegetation and any surface debris such as rocks using a decontaminated trowel.
3. Don a clean pair of latex or nitrile or surgical gloves and the appropriate level of protection as specified in the HASP.
4. Collect the surface soil sample from the top 6 inches of soil (or the depth specified in the SAP) using a decontaminated trowel.
5. Special separate collection procedures must be followed if the sample will be analyzed for volatile organic compounds (VOCs). The choice of sampling method/device, container type, and preservation method may be influenced by many factors, including but not limited to the following:
    - Project required detection levels.
    - Expected physical and chemical properties of the soils.
    - Whether samples will be preserved in the field vs. in the laboratory.
    - Holding times for different preservation methods.
    - Elapsed time between sample collection and laboratory delivery.
    - Available shipping methods (may be limited for methanol preserved samples).
    - Any applicable State requirements.

    Detailed sample collection and preservation guidance is provided in Appendix A of SW846 Method 5035A. Additional state guidance is provided in “Collecting and Preparing Soil Samples for VOC Analysis” Implementation Memorandum #5, Washington State Department of Ecology (June 2004). These collection procedures should be used for all Navy Activities in the State of Washington. For Navy Activities in the State of Alaska that include soil sampling in petroleum contaminated sites, the procedures in “Underground Storage Tank Procedures Manual, Guidance for Treatment of Petroleum Contaminated Soil and Water and Standard Sampling Procedures” State of Alaska Department of Environmental Conservation (November, 2002) should be followed.
6. Homogenize the remainder of the sample in a decontaminated stainless steel bowl and fill the remainder of the pre-labeled lab jars for sample analysis.
7. Fill hole with topsoil and replace the vegetative mat over the disturbed area.
8. Record observations in the field logbook
9. Record the sampling location on a site map.

10. Decontaminate sampling device for collection of next sample.

## 2.2 SUBSURFACE SOIL PROCEDURES

Before conducting subsurface soil sampling, you may need a permit or other form of approval from regulatory agencies overseeing your site before you begin any drilling operations. This is especially true if you are working in a wetland or other sensitive area or are installing wells. Always check with utility companies to verify the locations of underground materials before beginning drilling operations.

Subsurface soil samples can be collected during drilling operations using one of several different sampling devices. Subsurface soil samples can also be collected using an alternate method such as a direct-push sampling device (e.g. Geoprobe™). Procedures for collecting subsurface soil samples will be described in this section.

### 2.2.1 Subsurface Soil Sampling Equipment

Equipment and materials used during the collection of subsurface soil samples include:

- Drill rig, hollow-stem auger, mud rotary, or direct-push sampling device
- Sampling device (split-barrel sampler, split-spoon sampler, modified California sampler, thin-wall tub sampler, Shelby tube continuous core sampler)
- Stainless steel spoons, trowels, putty knife
- Stainless steel bowl(s)
- Measuring tape
- Laboratory supplied sample jars
- Cooler and blue ice or ice
- Decontamination equipment
- Paper towels
- PPE as required by the HASP
- Field forms such as chain of custody, sample collection log, air monitoring log, other necessary health and safety documentation
- Field logbook

### 2.2.2 Collection of Subsurface Soil Samples During Drilling Operations

The following procedures should be followed when collecting a subsurface soil sample during drilling operations:

1. Decontaminate all equipment including drill rig and all associated equipment, sampling devices, and stainless steel spoons and trowels.

2. Inspect, clean, and put on appropriate PPE.
3. Advance boring using selected drilling method.
4. Retrieve sample using selected sampling device. If performing the Standard Penetration Test (ASTM D1586), record the number of blows per 6 inches.
5. Observe the soil and measure and record (1) the amount of soil recovered in the sampler, (2) the presence of any free product, (3) any unusual odors, and (4) any stratigraphic changes. Begin to form a description before disturbing the soil.
6. All sample jars should be pre-labeled with appropriate information including date, sample ID, and analyses.
7. Collect a sample using a decontaminated stainless steel spoon or trowel. Special collection procedures must be followed if the sample will be analyzed for volatile organic compounds (VOCs). Refer to section 2.1.2, step 5 for details. Next, place the remaining soil in a stainless steel bowl and collect a homogeneous sample to be analyzed for other parameters. After the laboratory samples are collected, fill a separate sample jar or plastic bag to be used for soil classification. If there is a change in the stratigraphy, set aside some soil from each and place into jars to be used for the soil classification. If the amount of soil is not sufficient, collect another sample immediately below the prior sample interval and homogenize the two samples prior to filling laboratory sample jars.
8. If collecting samples using Shelby Tubes (ASTM D1587), seal the ends, being careful not to disturb the sample.
9. Fill in a detailed description of the soil(s) (ASTM D2488) in the field logbook.
10. Discard any unused soil. See the SOP I-A-7, *Investigation-Derived Waste Management*, for proper storage and disposal procedures.
11. Decontaminate sampling device for collection of next sample.

### 2.2.3 Procedures for Subsurface Soil Sample Collection Using Direct-Push Technology

There are several different types of direct-push technology. Some direct-push sampling devices may not be able to collect a soil sample from greater than 20 feet below ground surface.

The following procedures should be followed when collecting a subsurface soil using direct-push technology.

1. Decontaminate all equipment including sampling devices, and stainless steel spoons and trowels.
2. Inspect, clean, and put on appropriate PPE. Change latex/nitrile gloves for the collection of each sample.
3. Instruct subcontractor to set up truck-mounted equipment at a sampling location.

4. The subcontractor will advance the sample probe and extract a sample from the required depth using a decontaminated sample collection device. The sample probe will be attached to the bottom of a stainless steel rod. The rod will be pushed below ground surface with a hydraulic level attached to the truck. The predetermined depth will be reached by connecting rods together. Immediately before the sample depth is reached, the contractor will connect a handle to the rods and turn it to open the sampling depth. The device will be driven through the desired sample interval and extracted.

5. The soil will be collected in a Teflon sleeve, or other non-reactive sleeve inside the sampling device. After sample retrieval, the sleeve will be sliced open to allow access to the soil. Collect a sample using a decontaminated stainless steel spoon or trowel. Special collection procedures must be followed if the sample will be analyzed for volatile organic compounds (VOCs). Refer to section 2.1.2, step 5 for details. Next, place remaining soil in a stainless steel bowl and collect a homogenous sample to be analyzed for other parameters. After the laboratory samples are collected, fill a separate sample jar or plastic bag to be used for soil classification. If there is a change in the stratigraphy, set aside some soil from each and place into jars to be used for the soil classification. If recovery is not sufficient, collect another sample immediately below the prior sample interval and homogenize the two samples prior to filling laboratory sample jars.

6. Log the description of the soil sample in the field logbook.

7. Decontaminate the stainless steel sample rods and sampling device between each sampling location.

## 2.3 COMPOSITING SOIL SAMPLES

All samples to be composited or split should be homogenized after all aliquots have been combined. DO NOT HOMOGENIZE (MIX OR STIR) SAMPLES FOR VOLATILE COMPOUND ANALYSIS.

If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite the samples as follows:

1. As each sample is collected, place the soil in a decontaminated stainless steel bowl.

2. After all samples from each hole or area are collected in the bowl, stir the sample thoroughly with a decontaminated stainless steel trowel or spatula.

3. For organics analyses, a sheet of aluminum foil may be used instead of a stainless steel bowl.

## 2.4 SPLITTING SAMPLES

Fill the sample containers for the same analyses one after another in a consistent manner (i.e., fill the first lab’s container, then fill the second lab’s container; then go on to the next analysis and fill the first lab’s container and then the second lab’s container).

## 2.5 QA/QC

Quality assurance/quality control (QA/QC) samples are designed to help identify potential sources of sample contamination. Different types of QA/QC samples include field blanks, rinse blanks, trip blanks, and duplicate samples. The frequency of collection and types of QA/QC samples required are indicated in the site-specific sampling plan. All QA/QC samples are labeled with QA/QC identification and sent to the laboratory with the other samples for analysis.

## 3.0 DOCUMENTATION

Documentation of observations and data acquired in the field will provide information on the proper acquisition of samples and provide a permanent record. These observations and data will be recorded with black ink in a bound weatherproof field logbook with consecutively numbered pages. Notes will be recorded daily when in the field. The soil sampling information in the field logbook will include the following as a minimum:

- Project number/name
- Date
- Weather
- Personnel on site (samplers' names, other field crew, observing personnel)
- Boring location
- Start/end time of boring
- Sample ID and depth
- Time sample is collected
- Laboratory sample ID and analytical parameters
- Air monitoring readings taken during drilling or sample collection
- Decontamination procedures
- Presence of free product or unusual observations
- Depth water was first encountered
- Depth rock was encountered
- Borehole abandonment procedures
- Sample description and standard penetration test results may be included in the field logbook, but should also be included on the boring log.

The following information should be included in the field logbook for the completion of a boring log:

- Boring location information including project number/name, location, subcontractor, date, drilling method, type of sampling device, equipment used for standard penetration test, and name of person logging information.

- For each sampling interval, the following should be noted: sampling interval number, time sample was collected, soil description, depth, amount of recovery, and information from standard penetration test. Note any changes in stratigraphy and thickness of each layer in the sample. Note the depth water was first encountered and the depth rock was encountered.

- Also, note the presence of free product, any odors, and air monitoring readings taken during drilling or sample collection, and any other observations that may be used for site characterization in the future.

- After logging is completed, note the total number of samples collected, which ones were sent for laboratory analysis, the laboratory sample IDs, and the parameters requested.

- Note any unusual changes in drilling pressure or drill rig behavior, voids, and unusual conditions encountered during drilling.

- It is important to be as thorough as possible when filling out the boring log. The log may be used to aid in future work at the site, many years down the road, and a complete log will prevent guesswork and the possibility of resampling.

## 4.0 REFERENCES

ASTM Method D1586-84, Standard Method for Penetration Test and Split-Barrel Sampling of Soils

ASTM Method D1587-83, Standard Practice for Thin Walled Sampling of Soils

ASTM Method D2488, Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)

ASTM D420-87, Standard Guide for Investigating and Sampling Soil and Rock

ASTM Method D1452, Standard Practice for Soil Investigation and Sampling by Auger Borings

ASTM Method D2487, Standard Test Method for Classification of Soils for Engineering Purposes

ASTM D4220-89, Standard Practice for Preserving and Transporting Soil Samples

SOP I-A-7, *Investigation-Derived Waste Management*

U.S. Army Corps of Engineers (USACE). *Work Plan for CERCLA Remedial Investigation/Feasibility Study*. Appendix J, SOP 025 - Soil Sampling

EPA. 1996. Test Methods for Evaluating Solid Waste, Physical Chemical Methods. (SW-846), Third edition. December. Method 5035A, Appendix A (July 2002).

Washington State Department of Ecology, *Collecting and Preparing Soil Samples for VOC Analysis*. Implementation Memorandum #5, June, 2004.

State of Alaska Department of Environmental Conservation (ADEC), *Underground Storage Tank Procedures Manual, Guidance for Treatment of Petroleum Contaminated Soil and Water and Standard Sampling Procedures*, November, 2002.

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

I-B-2

Revised February 2015

# GEOPHYSICAL TESTING PROCEDURES

## 1.0 PURPOSE

This section sets forth the standard operating procedure (SOP) for acquiring surface geophysical data to facilitate the collection of geologic, hydrogeologic, and geotechnical data related to hazardous waste site characterization.

## 2.0 PROCEDURES

### 2.1 METHOD SUMMARY

A wide variety of surface based geophysical methods exist that may apply to contamination delineation, geologic, hydrogeologic, or other site characterization/ investigation requirements. In general, geophysical exploration methods provide for a non-invasive mapping of subsurface features through the measurement of the physical properties of the subsurface. Typically, an active signal (e.g., acoustic or electrical) propagates into the earth and the interaction of the signal with the subsurface materials is measured at the surface. Interpretation of the data provides for a map or image of the subsurface. For example, the electrical conductivity of soils governs the propagation of an electrical signal through the subsurface. The geologic/hydrologic/waste characteristics are then inferred from an interpretation of the data or correlated with borehole data.

For a geophysical survey to be successful, the method of choice must be capable of resolving a particular physical characteristic that relates to the goals of the investigation. For example, if a zone of contaminated groundwater is being investigated by an electrical method, the electrical conductivity of the contaminated portion of the aquifer should be sufficiently different from the uncontaminated portion to allow for identification of the 'plume.' If the target (i.e., the high conductivity plume in this example) does not contrast sufficiently with the uncontaminated portion, then the geophysical survey will not be successful. Often, preliminary calculations or a trial survey can be performed to evaluate a particular method. Multiple geophysical methods may need to be used to accomplish the project objectives. It is frequently worth the additional cost to bring several potentially applicable instruments to a site, rather than try to anticipate ahead of time which instrument will provide the best results.

For purposes of this SOP, the geophysical methods discussed herein are classified as follows:

- Seismic methods. These include seismic refraction and seismic reflection methods and are typically applied to investigate depths to the water table or geologic layers (stratigraphic horizons or depth to bedrock).
- Electrical Methods. A wide variety of these exist. Included are Direct Current (DC) Resistivity, Complex Resistivity/Induced Polarization, Low-Frequency Electromagnetic (EM) Induction (i.e.,

loop-loop methods), VLF (Very Low Frequency EM), GPR (Ground Penetrating Radar), and metal detection equipment. These respond to variations in the electrical properties of a site, specifically the electrical conductivity and (for GPR) the dielectric/permittivity constant. Applications include general geologic/hydrologic mapping, identification of solute 'plumes,' and the detection of conductive metallic debris/objects.

- Potential Field Methods. Some methods do not require an active signal source and instead measure naturally occurring potential fields of the earth. These include measurements of the earth's magnetic or gravitational fields. Magnetic methods are often used to detect the response of the earth's magnetic field to metallic objects and can be very effective in locating buried metallic materials. Gravity methods respond to subtle density variations and are typically used to map the depth/thickness of alluvial basins or to detect cavities within consolidated sediments (e.g., karst sinkholes).

While a number of geophysical methods may be applied at hazardous waste sites, the scope of this procedure is limited to the following commonly applied methods:

| | |
|---|---|
| Seismic: | Refraction |
| Electrical: | DC Resistivity |
| | EM Induction (loop-loop) |
| | GPR |
| | Metal Detection |
| | Induced Polarization (IP) |
| | SP Profiling |
| Potential Field: | Magnetics |

Often, geophysical contractors specialize in a particular survey method and it is necessary to pre-qualify the contractor for the particular method proposed. The following references may be useful to provide additional information:

Journals: Geophysics (Society of Exploration Geophysics); Geophysical Exploration European Association of Exploration Geophysicists; occasionally - Groundwater, Groundwater Monitoring Review (National Water Well Association).

Reynolds, J.M, 2011. An Introduction to Applied and Environmental Geophysics, Wiley

Gibson, P.J., George, D. M. 2013. Environmental Applications of Geophysical Surveying Techniques: 2nd Edition, Nova Science Pub Inc.

Telford, W.M., L.P. Geldart, R.E. Sheriff, D.A. Keys. 1978. Applied Geophysics, Cambridge University Press.

Dobrin, M.B. 1976. Introduction to Geophysical Prospecting, McGraw-Hill.

Sheriff, R.E. 1973, 1990. Encyclopedic Dictionary of Exploration Geophysics, Society of Exploration Geophysics.

## 2.2 METHOD LIMITATIONS/INTERFERENCES AND POTENTIAL PROBLEMS

Each of the geophysical methods discussed herein are typically designed and implemented on a site-specific basis. Care must be exercised to ensure that a particular method is applicable and that an identifiable target is likely to exist. A determination must be made that the exploration target can be resolved versus the background signal/site conditions and that cultural or other 'noise' problems will not interfere. 'Cultural Noise' is defined as near-surface or surficial features (e.g., power lines or traffic vibrations) that can potentially mask or overwhelm the signal produced by the subsurface target. The geophysicist shall make a rough field sketch of all visible cultural features that may affect later interpretation of the results and submit that sketch with the final report.

All of the survey methods require field instrumentation and electronics that may be affected by extreme climatic variations. The equipment should be checked regularly (daily, at a minimum) to ensure internal calibration. The manufacturers' guidelines and specifications should be reviewed prior to any field application and proof of instrument calibration must be available.

### 2.2.1 Method Limitations and Potential Problems

#### *2.2.1.1 Seismic Refraction Surveys*

Care should be exercised in avoiding the following potential problems:

- Poorly emplaced geophones, for example in loose soil
- Poor couplings of induced signal with ground
- Intermittent electrical shorts in geophone cable (never drag geophone cables)
- Wet geophone connections (marsh phones should be used in wet conditions)
- Vibration due to wind and traffic-induced noise
- Improper gain/filter settings
- Insufficient signal strength: typically hammer seismic methods do not provide a sufficient seismic source for most applications.
- Topographic irregularities: an accurate topographic survey is often required prior to field operations.

#### *2.2.1.2 DC Resistivity*

Measurement of electrical resistivity represents a bulk average of subsurface material resistivity. In some instances, the resistivity of the target material may not contrast sufficiently with 'background' material to be observed with this method, especially as the target material gets thinner and/or deeper. If highly conductive soils/rocks are present at shallow depths, electrical current may not penetrate to depths beyond this layer. An electrical current always follows the path of least resistance.

The DC resistivity method has the following limitations or potential problems that may occur during a survey:

- Poorly coupled electrodes (insufficient grounding)
- Unshielded wires causing intermittent shorts
- Background electrical noise such as natural currents (S.P. or telluric effects)
- Electromagnetic coupling with power lines, causing the introduction of induced electrical currents into the receiver wire
- Grounded fence lines, power lines interfering with the survey
- Inadequate signal power (increase current levels to produce sufficient signal to noise ratios)
- Very low resistivity layer at the surface preventing the electrical field from penetrating deeper layers
- Very high resistivity layer at the surface (e.g. dry sandy gravel) preventing the electrical field from penetrating the surface layer

#### *2.2.1.3 EM Method*

A variety of EM methods may be applied; however, in practice the Geonics EM-31 and EM-34 Loop-Loop instruments are usually used in hazardous waste surveys. The EM methods are similar to DC methods in application and are sensitive to conductive materials, except for the basic distinction that they are not electrically grounded. Complications may arise in the EM method in developed sites because aboveground, metallic objects or electrical fields may interfere. Power lines, automobiles, train tracks, water tanks, and other objects may completely dominate data results and render the method useless. A comparison of the contoured data with the site sketch made by the geophysicist will help in the interpretation of any anomalous results.

#### *2.2.1.4 Ground Penetrating Radar (GPR) Methods*

Ground penetrating radar (GPR) methods are seldom useful where highly conductive conditions or clay is present at shallow depth. The high-frequency signal propagates as a function of both electrical conductivity and dielectric constant (permittivity). The selection of transmission frequency is important because high frequencies are rapidly attenuated and the signal may not penetrate. Often, a choice of frequencies is available and it is suggested that site-specific field tests be performed over known, observable targets to determine whether GPR is appropriate for use.

A number of potential problems may occur:

- Improperly adjusted/configured equipment (e.g., antenna gain, filter slopes or gain thresholds)
- Insufficient signal and/or poor transmission qualities of the materials found at a site (e.g., clay, saline water conditions) and

- The influence of reflected signals outside of the immediate zone of investigation upon the radar record (e.g., fences, power poles, buildings)

#### *2.2.1.5 Metal Detection*

Metal objects that are not targets of the survey, including those worn or carried by the operator, may interfere with measurements.

#### *2.2.1.6 Magnetic Methods*

The signal measured by a magnetometer varies with time and is subject to variations induced by solar storms. Instruments include total field and the vertical magnetic gradient. Vertical gradient magnetometer or gradiometer data enhance the response to shallow sources. Instruments that can accomplish both measurements are preferred. Specific problems that may occur include:

- Metal objects that are not survey targets, such as metallic objects at or near the ground surface interfering with measurements;
- Only ferrous metal objects are detectable;
- Metallic objects worn or carried by the operator;
- Lack of base station control to measure background field fluctuations; and
- Failure to maintain a constant sensor height with respect to ground elevation.

## 2.3 SURVEY DESIGN/PRE-FIELD PREPARATION

### 2.3.1 Survey Design

Prior to performing a field investigation, it is often possible to estimate the effectiveness of a surface geophysical survey by using data interpretation software relevant to the survey or by other calculation methods. A sensitivity analysis is usually performed to determine if a geophysical target possesses sufficient contrast with background conditions to be detected using surface geophysics. For example, measuring electromagnetic resistance with an EM-31 and a 50-foot line spacing, may miss an individually buried drum that would have been detected using a 20-foot line spacing. In some instances, available site data or prior geophysical investigations may be available to obtain estimates of the geophysical characteristics of the site. The perceived failure of geophysical methods frequently relates to taking too few data points, using a sub-optimal combination of instruments for the particular soil or rock conditions, and processing the data improperly.

### 2.3.2 Field Preparation

- Verify that the required geophysical equipment is pre-calibrated and operational
- Establish grid locations or set-up traverses for location of sampling stations. Survey the station locations and record on a scaled site plan
- Test and calibrate geophysical equipment

## 2.4 FIELD PROCEDURES

The following procedures apply to geophysical surveys conducted at a hazardous waste site. Procedures may vary since equipment capabilities and methodologies are rapidly evolving. In general, make sure that field locations are surveyed, and recorded accurately and that the equipment is functional and calibrated. Typically, a control or base station location will be established to check the equipment response over the duration of the field investigation. In addition, make sure a high signal-to-noise (S/N) ratio can be maintained to obtain a geophysical response representative of the target/zone of interest.

### 2.4.1 Seismic Refraction Methods

Seismic refraction techniques are used to determine the structure of a site based upon the travel time or velocity of seismic waves within subsurface layers. Interpretation of the travel-time variation along a traverse of geophones can yield information regarding the thickness and depth of buried strata. Seismic methods are often used to determine depths to specific horizons of contrasting seismic velocities such as bedrock, clay layers, or other lithologic contrasts, and the groundwater surface (under unconfined conditions).

**Procedures:**

- Check the seismic signal and noise conditions on the instrument to verify the proper functioning of geophones and cables and to check the instrument settings. In urban areas, it may be necessary to schedule the field survey at night to avoid vibrations induced by car and truck traffic.
- When hard copies of seismic records are not produced by the seismic field equipment, the arrival time selected from the electronic display should be immediately plotted on a time/distance graph in the field. A hard copy of the data should be produced and kept in the record file. Problems with improper picks are often discovered by early inspection of these plots.
- Background or offsite data may be required for correlation to site conditions. Correlation of the seismic data with electrical method results, if obtained, or with borehole or outcrop data, may be a useful means of assigning thickness or seismic velocities.
- If possible, boring logs or other data should be analyzed to determine if low velocity (inverse layers) or thin beds might be present that might not be detected otherwise.
- The seismic system should be run at a known standard base station for periodic check of instrument operation.
- Properly store the data in digital form for subsequent processing and data evaluation. In general, use of the generalized reciprocal method is preferred for data processing.

### 2.4.2 Electrical Methods

#### *2.4.2.1 DC Resistivity*

The resistivity method provides a measurement of the bulk electrical resistivity of subsurface materials. Application of the method requires that a known electrical current be induced into the ground through a pair of surface electrodes. The resulting potential field (voltage) is measured between a second pair of surface electrodes. Evaluation of the subsurface electrical properties is performed on the basis of the current, voltage, and electrode position (array configuration).

Given the length of the wire cables, their connections to the electrodes and the coupling of the electrodes with the ground, there are a number of potential problems for obtaining reliable data (e.g., poor electrical contact, short and open circuits). These conditions can be minimized by careful observation of instrument readings and trends.

**Procedures:**

Apparent resisttivities should be calculated and plotted during field acquisition as a means of quality control. If vertical electrical sounding (VES) is performed, the data plots (curves) should be smooth, and discontinuous jumps in the data should not occur. Profiling data should also show a general trend in the data from one station to the next. However, abrupt changes may occur in both sounding and profiling data due to "noise" from near-surface inhomogeneities or electrode contact problems.

The resistivity instrument can be calibrated using standard resistors or by using the internal calibration circuits often contained within the equipment. Calibration is particularly important if the data are to be compared to resistivity measurements from other instruments or other parameters, such as specific conductance of water samples.

### *2.4.2.2 EM Methods*

Electromagnetic methods (EM) provide a means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Electrical conductivity (the inverse of electrical resistivity) is a function of the type of soil, porosity, permeability, and the conductivity of fluids in the pore spaces. The EM method can be used to map natural subsurface conditions and conductive contaminant plumes. Additionally, trench boundaries, buried conductive wastes such as steel drums, metallic utility lines and steel underground storage tanks may potentially be located using EM techniques.

Documentation of factory calibration that meets the requirements of the manufacturer needs to accompany each instrument. In addition, a secondary standard area should be established at the field site by the geophysicist to be used for periodic recalibration. This will provide a reference base station, to check "drift" in the instrument's performance and to permit correlation between instruments.

While precision can be easily checked by comparing subsequent measurements with the instrument at a standard site, accuracy is much more difficult to establish and maintain.

EM instruments are often used to obtain relative measurements. For these applications, maintenance of absolute accuracy is not critical; however, the precision of the instrument can be important. For example, in the initial mapping of the spatial extent of a contaminant plume, a moderate level of precision is necessary. If the same site is to be resurveyed annually to detect small changes in plume migration and movement, a very high level of precision is necessary.

If the objective of the survey is to obtain quantitative results from the EM data, for correlation to other measurable parameters (e.g., specific conditions), proper steps should be taken to assure good instrument calibration. This is particularly important when performing surveys in areas of low conductivity, where measurement errors can be significant.

The dynamic range of EM instruments varies from 1 to 1,000 millimhos/meter (mmho/m). At the lower conductivities, near 1 mmho/m and less, it is difficult to induce sufficient current in the ground and thus difficult to produce a detectable response, hence readings may become unreliable. At conductivity values greater than about 100 mmho/m, the received signal is no longer linearly proportional to subsurface conductivities, and corrections must be applied to the data, if it is to be used for quantitative purposes.

**Procedures**

- Maintain or verify calibration records from the equipment supplier or manufacturer. The EM system should be regularly calibrated.
- Prior to conducting a survey, select a temporary site on location for daily calibration checks. Calibration checks shall be made twice daily, before and after conducting daily survey operations. Readings shall repeat to +/-5 percent. Originals of all calibration records shall remain onsite during field activities, and copies shall be submitted to the records file. The original calibration records shall be transferred to the project files upon completion of the fieldwork. Calibration checks should be made outside the influence of power lines, buried utilities and metal objects, fences, etc. on a relatively flat surface.
- When there is local or distant thunderstorm activity, the field operating party shall check instrument stability. Electromagnetic radiation from thunderstorms can generate noise in the EM system. Operations may have to be postponed during rainstorms and resumed when these have ceased.
- Technical judgment shall be exercised such that conductivity readings recorded in the field are reasonable with respect to existing site conditions.
- Instrument sensitivity settings should be recorded in the field notebook as readings are taken. The notebook should be submitted to the records file.

### *2.4.2.3 Ground Penetrating Radar*

Ground Penetrating Radar (GPR) uses high frequency radio waves to acquire subsurface information. Energy is radiated downward into the subsurface through a small antenna, which is moved slowly across the surface of the ground. Energy is reflected back to the receiving antenna, where variations in the return signal are continuously recorded. This data produces a continuous cross-sectional image or profile of shallow subsurface conditions. These responses are caused by radar wave reflections from interfaces of materials having different electrical properties. Such reflections are often associated with natural hydrogeologic conditions such as bedding, cementation, moisture content, clay content, voids, fractures, and intrusions, as well as manmade objects. The radar method has been used at numerous hazardous waste sites to evaluate natural soil and rock conditions, as well as to detect buried wastes and buried metallic objects.

The radar system measures two-way travel time from the transmitter antenna to a reflecting surface and back to the receiver antenna. Calibration of the radar system and data requires a two-step process:

- First, the total time window (range) set by the operator must be accurately determined.
- Second, the electromagnetic velocity (travel time) of the local soil-rock condition must be determined.

After completing these two steps, the radar data may then be calibrated for depths of particular features.

The time window (range) that has been picked for the survey is calibrated by use of a pulse generator in the field. This generator is used to produce a series of time marks on the graphic display, measured in nanoseconds. These pulses are counted to determine the total time range of the radar. A calibration curve can be made up for each radar system.

In order to precisely relate travel time to actual depth units, the velocity (or two-way travel time per unit distance) must be determined for the particular soil or rock found at the site.

Various levels of accuracy in determining travel time can be used. These may range from first order estimates to precisely measured onsite values.

Using the depth of a known target (trenches, road cuts or buried pipes/road culverts can provide a radar target of known depth), a radar record taken over the known target, and a time scale provided by the pulse generator will provide a basic calibration record. From these data, a two-way travel time can be accurately determined at the given target location. Because this approach may give accurate calibration at the specific site, it must be assumed that conditions in other areas to be surveyed are the same as in the calibration areas. If they are not, errors will occur in determining depths.

If significant changes in soil type or moisture content occur with depth, travel time will not be the same throughout the vertical radar profile, and the vertical radar depth scale may be non-linear. Such a condition is common, and occurs whenever an unsaturated zone exists over a saturated zone.

**Procedures**

- The time scale of the GPR unit shall be checked regularly for accuracy. This can be done either on or off the site by placing the GPR unit at a known distance from the ground, a wall, etc., and measuring the two-way travel time to that reflecting surface in the air. The velocity of electromagnetic waves in air is 1 foot per nanosecond ($3 \times 10^8$ m/sec.). The following equation shall be used:

  $$t = 2d/c$$

  where

  t = two-way travel time from antenna to the surface, (nanoseconds)

  d = distance of antenna to the surface, (feet)

c = velocity of light in air, (1 foot/nanosecond)

- Prior to conducting a survey, a GPR traverse should be conducted over a buried object of known depth (if available). From the two-way travel time and the measured burial depth of the object, the average electromagnetic wave velocity in soil can be calculated from the following equation:

$$V = 2d/t$$

The average dielectric constant of the soil is then calculated using:

$$Er = c^2/v^2$$

where

Er = average relative dielectric constant of soil (unitless)

c = velocity of light in air (1 foot/nanosecond)

v = average electromagnetic wave velocity of the soil (feet/nanosecond)

Note: The equation above assumes a soil with a relative magnetic permeability of 1. Technical judgment shall be exercised such that soil velocity and relative dielectric constant values are reasonable with respect to existing site conditions.

- A short GPR traverse shall be repeated twice daily over a known feature prior to, and after conducting daily operations. Technical judgment shall be exercised to ensure that variations between repeat readings are due to changing soil conditions rather than the electronics.

### *2.4.2.4 Magnetometers*

Magnetometers are designed to provide measurements of the earth's magnetic field. In hazardous waste site investigations, magnetometers are invaluable for detecting buried drums and for delineating the boundaries of areas containing ferrous metallic debris.

**Procedures**

- Check the proposed date of the magnetic survey for solar flares to ensure that anticipated background conditions do not occlude data collection (National Oceanographic and Atmospheric Administration (NOAA) http://www.sec.noaa.gov/SWN/index.html).

- Obtain a daily background reading in the immediate vicinity of the site to be surveyed. This reading should be outside the influence of all sources of cultural magnetic fields (e.g., power lines, pipeline, etc.). Technical judgment should be exercised such that the background reading is reasonable with regard to published data for the total magnetic field intensity at the site latitude and longitude. This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field.

- Sequential readings should be taken twice daily, before and after normal magnetic surveying operations. These readings (within 10 seconds of each other) shall be taken at any location onsite, distant from cultural magnetic fields, and recorded in the field notebook. Two or three sequential readings should be sufficient. In the absence of magnetic storms (sudden and violent variations in the earth's magnetic field), the readings should compare within 0.1 to a few tenths of a gamma. Variations during magnetic storms may approach 1 gamma.

- Base station readings should be taken so that the efforts of diurnal variation in the earth's magnetic field may be removed from the data. Magnetic storms can be detected if the base station sampling frequency is high enough. It may be prudent to suspend operations during a magnetic storm and resume them when the storm has passed. Identification of such periods of rapid synoptic variation may be documented at a permanent base station set up onsite where continuous readings are automatically recorded every 10 to 15 minutes. Alternatively, readings may be manually recorded at a base station during the survey every 45 to 60 minutes.
- Use of automatic recording magnetometers requires recording in a field notebook the magnetometer readings for the first and last station of each traverse. The data recorded in the field notebook should be compared at the end of the day with data from the automatic recording device. Data recorded in the field notebook should be within 1 gamma of the values derived from the recording device. It is recommended that the data be transferred onto hard copies from the recording device on a daily basis.

Total field measurements may be corrected for these time variations by employing a reference base station magnetometer; changes in the earth's field are removed by subtracting fixed base station readings from the moving survey data. Gradiometers do not require the use of a base station, as they inherently eliminate time variation in the data.

#### *2.4.2.5 SP Profiling*

This method is different from other electrical techniques in that no artificial current source is used to inject a signal into the ground; only the naturally occurring voltage potentials are measured between surface stakes. These natural voltages are produced by chemical oxidation reactions between groundwater and different soil and mineral types.

SP equipment consists of a digital, high-impedance voltmeter; two porous pot electrodes; and cables. SP equipment should have a resolution of at least ±2 mv and accuracy within ±10 mv.

**Procedures**

- Calibrate equipment per manufacturer’s specifications. At a minimum, equipment should be calibrated twice daily, once prior to beginning operations and once at the end of daily operations. Record calibration results in the field log.
- Each SP station shall be identified with a unique number and located on a site layout drawing. Profiling results shall be recorded for each station using a field data form that includes the time of each measurement. The form shall be annotated to show any natural or cultural features near or between the SP stations.

- A base station shall be established for the purpose of measuring instrument drift during the SP profiling activities. The instrument shall be taken to the base station routinely during the day and readings obtained from one location at the base station. Base station readings should be obtained at the beginning and end of each day and at interim intervals not exceeding 4 hours in duration.

- Data reduction consists of adjusting measurements obtained for instrument drift. Base station readings are plotted as a separate curve from profiling station measurements. The drift is interpolated (straight line) between base station readings as a function of time and the appropriate drift correction is subtracted from each profiling station measurement. Reduced data are used for interpretation.

- Data interpretation is accomplished by plotting reduced data (either for linear cross-sections of the study area or as surface contours over the study area surface). Anomalies are identified from these plots and inferences regarding their sources are developed.

### 2.4.3 Post-Operations

Geophysical personnel working at a site should follow standard hazardous waste site protocols. In many cases, the geophysical survey may precede services that may result in personnel contact with hazardous waste/materials. Standard hazardous waste site decontamination procedures should be followed by geophysical personnel at all sites.

## 2.5 DATA REDUCTION/DATA INTERPRETATION

Geophysical surveys typically require significant data reduction and processing. The exact methodology depends upon the purpose, scope, and type of survey.

Data interpretation and presentation reports should note the following:

- Equipment used
- Field sketch map that shows any site conditions visible at the ground surface that may affect the geophysical results
- Site base map showing survey location or transects
- Dates and times of survey
- Survey location data
- Data reduction technique
- Data processing steps
- Technical basis for data processing
- Interpretation results
- Theoretical assumptions for the interpretation

- Data format (digital format, ASCII, SEG B., etc.)

## 2.6 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance procedures apply to all of the geophysical instrumentation and their use during data acquisition.

- All data transmittals will be documented on standard forms supplied by the geophysical subcontractor. Copies of these forms will be maintained with the field files on site.
- All geophysical instrumentation shall be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.
- Battery voltage levels for all instruments shall be monitored each day throughout the survey. Battery packs should be charged or replaced when voltage levels fall below the recommended level specified by geophysical equipment manufacturers.

## 3.0 DOCUMENTATION

The Field Manager (FM) is responsible for documenting all field activities in the field logbook as defined in SOP III-D. The FM should also oversee all subcontractor activities and make sure that their documentation is complete. The specific procedures used in the field shall be documented in the site characterization report or similar deliverable.

## 4.0 REFERENCES

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## 8.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-B-4

Revised February 2015

# BOREHOLE ABANDONMENT

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## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline the methods by which all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and/or their contractors should perform borehole abandonment. The procedure provides descriptions of equipment, field procedures, and necessary documentation.

## 2.0 PROCEDURE

The procedures used in boring abandonment should ideally accomplish two objectives: (1) protect aquifers from cross-contamination by sealing the borehole, and (2) restore the strata in the borehole to nearly original conditions by selective placement of fill material. Be advised that regulators in all states may not approve objective 2.

Field staffs are required to be familiar with applicable state regulations concerning borehole abandonment. The work plan should be consulted for project-specific requirements. The following sections discuss various types of abandonment procedures.

### 2.1 EQUIPMENT

Equipment and materials used during borehole abandonment include:

- Drill rig (trailer-mounted mixer and grout pump)
- Wheelbarrow or drum
- Filter pack material
- Bentonite powder to make appropriately weighted slurry
- Bentonite pellets (seal) or chips
- Portland cement, Type II
- Water from an approved source
- Weighted tape measure
- Tremie pipe (small-diameter, rigid PVC pipe)
- Weatherproof bound field logbook with numbered pages

- Indelible/permanent marking pens
- Appropriate health and safety equipment
- Appropriate equipment for managing investigation-derived waste

## 2.2 CLOSING BOREHOLES

The following procedures should be used for the closure of boreholes located more than 15 feet from an existing or planned well:

1. Pull, drill out, or thoroughly pierce any temporary casing.
2. Use tremie pipe to place grout from the bottom of the hole to within 3 feet of the ground surface.
3. Allow grout to settle for 24 hours.
4. Fill the remainder of the hole with concrete.
5. Mound and smooth the surface of the concrete and inscribe it with “ABD” (for abandoned), any assigned well or boring designation, and the date the hole was abandoned.
6. Include all boring logs, samples, completion records, and abandonment procedures in the records of work on the site.
7. File any required documentation with state regulatory authority.

## 2.3 CLOSING BOREHOLES WITHIN 15 FEET OF A MONITORING WELL

If the hole is within 15 feet of a monitoring well in the same aquifer, or if a replacement well is to be installed within 15 feet of the abandoned borehole, the following procedure should be followed. This procedure must be pre-approved by regulators in some states.

1. Pull, drill out, or thoroughly pierce any temporary casing.
2. Use tremie pipe to backfill the hole with filter pack material opposite sand strata and bentonite or grout opposite substantial (2 feet or thicker) clay and silt strata. Where the filter pack material approaches the ground surface, 2 feet of bentonite should be placed above the filter pack material, and a 3-foot concrete plug placed to the surface. Otherwise, backfill materials should be placed from the bottom of the hole to within 3 feet of the ground surface.
3. Allow these materials to settle for 24 hours.
4. Fill the remainder of the hole with concrete.
5. Mound and smooth the surface of the concrete and inscribe it with “ABD” (for abandoned), any assigned well or boring designation, and the date the hole was abandoned.
6. Include all boring logs, samples, completion records, and abandonment procedures in the records of work on the site.

7. File any required documentation with state regulatory authority.

## 2.4 SHALLOW BORINGS NOT PENETRATING WATER TABLE

Shallow borings made for the collection of subsurface soil samples should be abandoned by backfilling the hole with cuttings from the hole, if and only if the boring does not penetrate the water table. Clean sand should be used to make up any volume not filled by the cuttings.

Some states DO NOT permit the backfilling of any borehole with cuttings in any instance and require that borings be sealed with grout.

## 2.5 SHALLOW BORINGS PENETRATING THE WATER TABLE

Shallow borings that were made for the collection of subsurface soil samples and that penetrate the water table should be abandoned by grouting the hole from the bottom to the surface as described in Section 2.2.

## 2.6 DEEP STRATIGRAPHIC BORINGS

Deep stratigraphic borings are normally located in areas that, by virtue of the historical record, are presumed relatively uncontaminated. Therefore, these borings are usually more than 100 feet from any sampling well locations. Any boring located within 15 feet of a proposed well location, or located directly upgradient or downgradient (on anticipated flow line) of a proposed well location, should be abandoned by placing clean sand in the aquifer intervals and bentonite or grout in aquitard intervals as described above (if allowed by state regulations). If the boring is over 15 feet from or not upgradient of a proposed well location, the boring will be completely filled with grout.

## 2.7 GROUT

Grout used in construction will be composed as follows:

- 20 parts by weight of cement (Portland cement, Type II or V)
- 0.4 to 1 part, by weight, of bentonite (maximum) (2 to 5 percent)
- 8 gallons (maximum) approved water per 94-pound bag of cement

Local regulations may state the requirements for grout. For instance, the New Jersey regulations list sterilized clay slurry weighing not less than 14 pounds per gallon, cement grout, neat cement, or concrete.

Additives or borehole cuttings should not be mixed with the grout. Bentonite should be added after the required amount of cement is mixed with the water.

All grout material should be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout should be recirculated through the grout pump prior to placement.

A trailer-mounted mixer with grout pump and attached hose can be used in place of a mud rotary-equipped drill rig. For shallow borings 1 to 3 feet below ground surface, the grout may be mixed in a wheelbarrow or drum and poured or shoveled into the borehole.

Grout should be placed using a commercially available grout pump and a rigid tremie pipe. Grouting should be accomplished in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This should be accomplished by placing a tremie pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the topmost section, until grout flows from the boring at ground surface.

After 24 hours, the abandoned drilling site should be checked for grout settlement. On that day, any settlement depression should be filled with grout and rechecked 24 hours later. This process should be repeated until firm grout remains at the ground surface.

## 3.0 DOCUMENTATION

The following information should be logged in the field logbook:

General requirements

- Date
- Time
- Boring location
- Personnel/subcontractor on site
- Visitors

Specific to abandonment

- Start/end times
- Depth of boring
- Materials used to seal each stratum
- Detailed description of procedure
- Date/time of return visit(s)
- Activities performed on return visit(s)

All entries in the field logbook must be printed in black ink and legible.

## 4.0 REFERENCES

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

I-C-1

Revised March 2015

# MONITORING WELL AND PIEZOMETER INSTALLATION

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## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline the methods by which all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and their contractors will conduct monitoring well and piezometer installation. This procedure establishes the protocols and necessary equipment for installation of groundwater monitoring wells and piezometers.

## 2.0 PROCEDURES

### 2.1 EQUIPMENT

The following is an equipment list:

- Drill rig capable of installing wells to the desired depth in the expected formation material and conditions
- Well casing and well screen
- Bentonite pellets
- Filter pack sand
- Bentonite Grout or Portland Type I or II cement and powdered bentonite for grouting
- Protective well casing with locking cap
- High-pressure steamer/cleaner
- Long-handled bristle brushes
- Wash/rinse tubs
- Appropriate decontamination supplies as specified in the SOP for decontamination procedures
- Location map
- Plastic bags (re-sealable)
- Self-adhesive labels
- Weighted tape measure

- Water level probe
- Deionized water
- Logbook
- Boring log sheets
- Well construction form
- Plastic sheeting
- Drums for containment of cuttings and decontamination and/or development water (if necessary)

## 2.2 DECONTAMINATION

Before drilling or well installation begins, all drilling and well installation material should be decontaminated according to the protocols in SOP III-I, *Equipment decontamination*. Drilling equipment should be decontaminated between well locations.

## 2.3 INSTRUMENT CALIBRATION

Before going into the field, the sampler should verify that field instruments are operating properly. Calibration times and readings should be recorded in a notebook to be kept by the field sampler. Specific instructions for calibrating the instruments are provided in the respective SOPs.

## 2.4 DRILLING AND WELL INSTALLATION PROCEDURES

### 2.4.1 Drilling Technique

If soil sampling is required by project plans, all soil samples should be collected according to the subsurface soil sampling procedures. The hole should be logged according to the methods specified in the project plans.

Boreholes should be advanced via conventional continuous-flight hollow-stem auger, sonic, air rotary, or mud rotary drilling methods and a drill rig capable of completing the monitor well(s) to the depth(s) specified in the project plans. Before drilling begins, well locations should be numbered and staked. The necessary permits and utility clearances shall be obtained in accordance with permits and utility clearance procedures. The permits and clearances will conform to specific Naval installation procedures or SOP 1-A-6 for utility location procedures.

During the drilling operation, the cuttings from the boring shall be placed into 55-gallon drums or roll-off container as specified in the project plans. Disposal of cuttings should be in accordance with the project plans and follow the specific Naval installation procedures or SOP l-A-7 for investigation-derived waste (IDW) management procedures.

### 2.4.2 Well Bore Drilling Operations

The procedure for well bore drilling is as follows:

- Set up drilling rig at previously staked and borehole location cleared for utilities.

- Record location, date, time, and other pertinent information in the field logbook.
- Drill hole of appropriate size using the project specified drilling method.
- Collect split-spoon samples at the predetermined intervals, if appropriate, for sample description and/or chemical analysis as specified in the project plans.
- Complete the borehole to the depth specified in the project plans.
- Document any difficult drilling conditions and ensures taken in response to such conditions (such as the addition of clean water to control heave).

### 2.4.3 Well Design Specifications

The general specifications for wells are as follows:

Boring Diameter. The boring should be of sufficient diameter to permit at least 2 inches of annular space between the boring wall and all sides of the centered riser and screen. The boring diameter should be of sufficient size to allow for the accurate placement of the screen, riser, filter pack, seal, and grout.

Well Casing. The well riser should consist of new, flush-threaded, PVC or stainless steel. The well diameter and thickness should be specified in the project plans. The risers should extend approximately 2 feet above the ground surface, except in the case of flush-mount surface casings. The tops of all well casings should be fitted with plugs or caps in locking monuments and locking caps in non-locking monuments.

Well Screens. The screen length for each well should be specified in the project plans. Well screens should consist of new threaded pipe with factory-machine slots or wrapped screen with an inside diameter equal to or greater than that of the well casing. The slot size should be indicated in the project plans and designed to be compatible with aquifer and sand pack material. The schedule thickness of PVC screen should be the same as that of the well casing. All screen bottoms should be fitted with a cap or plug of the same composition as the screen and should be within 0.5 foot of the open part of the screen. Traps may be used.

### 2.4.4 Well Installation Procedure

The following procedure should be initiated within 12 hours of well bore completion for uncased holes or partially cased holes and within 48 hours for fully cased holes. Once installation has begun, if no unusual conditions are encountered, there should be no breaks in the installation procedure until the well has been completed and the drill casing has been removed.

The procedure for monitoring well installation is as described below.

1. Decontaminate all well materials according to the SOP for decontamination procedures. After decontamination, all personnel who handle the casing should put on a clean pair of rubber or surgical gloves.
2. Measure each section of casing and screen to nearest 0.10 foot.

3. Assemble screen and casing as it is lowered into the open boring or drill casing (augers, when auger drilling is used) the hollow-stem augers.

4. Lower screen and casing to about 6 inches above the bottom of the boring.

5. Record the level of top of casing and calculate the screened interval. Adjust screen interval by raising assembly to desired interval, if necessary, and add selected filter sand to raise the bottom of the boring.

6. Begin adding filter pack sand around the annulus of the screen and casing a few feet at a time while withdrawing the drill casing or augers. Repeated depth soundings should be taken to monitor the level of the sand.

7. Allow sufficient time for the filter sand to settle through the water column outside the casing before measuring the sand level.

8. Extend the filter pack sand to at least 2 to 5 feet above the top of the well screen.

9. After placing the sand filter pack, install a seal at least 3 to 5 feet thick of bentonite pellets or chips. Add the bentonite pellets or chips slowly through the drill casing to avoid bridging. The thickness of the completed bentonite seal should be measured before the pellets have been allowed to swell. The completed bentonite seal should be allowed to hydrate before proceeding with the grouting operations.

10. Grout the remaining annulus from the top of the bentonite seal to near the ground surface as measured after the drill casing has been removed. The grout should be tremied into the borehole until the annulus is completely filled. The base of the tremie pipe should be placed approximately 5 feet above the bentonite seal. Bentonite chips or pellets may be used to backfill the well borehole.

11. After the grout sets for 24 hours it should be checked for settlement. If necessary, additional grout should be added to top off the annulus. This procedure may not be an option in high traffic or unsecured areas.

12. The steel monument, concrete pad and bollards, if required, should be installed according to the specifications in this SOP. The protective casing and posts should be painted a highly visible color.

13. Optional: Personnel should affix to the outer steel protective casing of each well a permanent, noncorrosive tag that clearly identifies the well number, the client’s name, or the adjusted top of casing elevation. In some states, a state well identification number must be affixed to the monument.

### 2.4.5 Well Installation Specifications

Filter Pack. The annular space around the well screen should be backfilled with clean, washed silica sand sized to perform as a filter between the formation material and the well screen. The filter pack should extend a minimum 3 feet above the screen and may be tremied into place. The final depth to the top of the filter pack should be measured directly with the use of a weighted tape measure or rod and not by volumetric calculation methods. The grain size of the filter pack should be shown on the well construction log. The filter pack must be selected based on the grain size distribution of the native formation, and should be specified in the project plans.

Bentonite Seal and Grout. A minimum 2-foot-thick bentonite pellet/chip seal should be placed in the annulus above the filter pack. The thickness of the seal may vary slightly based on site conditions. The thickness of the seal should be measured immediately after placement, without allowance for swelling. Bentonite Grout or cement grout should then be placed from the top of the bentonite seal to the ground surface. Bentonite grout is preferred because of potential investigation derived waste issues if too much cement grout is prepared and due to heat generated from cement grout. Bentonite grout shall be "high solids" and prepared in accordance with the manufacturer's instructions. Cement grout should consist of a mixture of Portland cement (ASTM C150) and clean water, with a ratio of no more than 7 gallons of clean water per bag of cement (1 cubic foot or 94 pounds). Additionally, 3 percent by weight of bentonite powder should be added if permitted by state regulations. The grout should be prepared in a rigid aboveground container by first thoroughly mixing the cement with water, and then mixing in the bentonite powder. Grout mixtures should be placed, by pumping through a tremie pipe. The lower end of the tremie pipe should be kept within 5 feet of the top of the bentonite seal. Grout should be pumped through the tremie pipe until undiluted grout flows from the annular space at the ground surface. The tremie pipe should then be removed and more grout added to compensate for settling. After 24 hours, the drilling contractor should check the site for grout settlement and add more grout to fill any depression. This should be repeated until firm grout remains at the surface.

Protection of Well. Personnel should at all times during the progress of the work take precautions to prevent tampering with the wells or the entry of foreign material into them. Upon completion of a well, a suitable cap should be installed to prevent foreign material from entering the well. The wells should be enclosed in a protective steel casing. Steel casings should be, at a minimum, 6 inches in diameter and should be provided with locking caps and locks. All locks used at a site should be keyed alike. If the well is to be a stickup (i.e., an aboveground monument), as specified in the project plans, a 1/4-inch drainage hole should be drilled in the protective steel casing, centered approximately 1/8-inch above the internal mortar collar for drainage. The well designation should be painted on the protective casing with a brush or paint pen. Painting should be done prior to well development. If specified in the project plans, a concrete pad should be constructed around the protective casing at the final ground level elevation and sloping away from the well. The concrete pad should measure at least 2 by 2 feet, with a thickness of 6 to 8 inches. Three 3-inch-diameter or larger steel posts should be equally spaced around the well and embedded in separate concrete-filled holes just outside the concrete pad. The protective steel posts should extend approximately 1 foot above the well riser. Any well that is to be temporarily removed from service or left incomplete due to a delay in construction should be capped with a watertight cap and equipped with a "vandal-proof" cover, satisfying applicable state or local regulations or recommendations.

## 3.0 DOCUMENTATION

Observations and data acquired in the field during the drilling and installation of wells should be recorded to establish a permanent record. A boring log should be completed for each well bore.

Additional documentation of well construction in the field logbook will include the following:

- Top of Casing surveyed elevation to 0.01 feet relative to known benchmarks, control points, and coordinate systems as defined in the Survey Specifications of NAVFAC NW SOPs V5.0 (or more current)
- Date
- Time
- Personnel
- Weather
- Subcontractors
- Health and safety monitoring equipment and readings
- Description of well location and triangulation measurements from landmarks, or GPS readings.
- Quantity and composition of grout, seals, and filter pack actually used during construction
- Screen slot size (in inches), slot configuration, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer
- Coupling/joint design and composition
- Protective casing composition and nominal inside diameter
- Start and completion dates
- Discussion of all procedures and any problems encountered during drilling and well construction

In addition, the well installation details should be shown in a diagram drawn in the field logbook. Each well diagram should consist of the following (denoted in order of decreasing depth from the ground surface):

- Reference elevation for all depth measurements
- Project and site names
- Well number
- Date(s) of installation

- Depth at which the hole diameter changes (if appropriate)
- Depth of the static water level and date of measurement(s)
- Total depth of completed well
- Depth of any grouting or sealing
- Nominal hole diameter(s)
- Depth and type of well casing
- Description (to include length, internal diameter, slot size, and well screen material
- Any sealing off of water-bearing strata
- Static water level upon completion of the well and after development
- Drilling date(s)
- Other construction details of monitoring well including grain size of well filter pack material and location of all seals and casing joints

All entries in the field logbook should be printed in black ink and legible.

## 4.0 REFERENCES

SOP I-A-7, *IDW Management*

SOP III-I, *Equipment Decontamination*

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-C-2

Revised March 2015

# MONITORING WELL DEVELOPMENT

---

## 1.0 PURPOSE

This section describes the standard operating procedures (SOP) for monitoring well development to be used by all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and their contractors.

## 2.0 PROCEDURE

### 2.1 INTRODUCTION

Well development procedures are crucial in preparing a well for sampling. Development enhances the flow of groundwater from the formation into the well and grades the well filter pack to reduce the movement of fine (clay and silt) particles into the well. The reduction in groundwater sample turbidity achieved by development improves the representation of chemical analyses performed on groundwater samples.

The goal of well development is to restore the area adjacent to a well to its natural condition by correcting damage to the formation during the drilling process. Well development should accomplish the following tasks:

- Remove any filter cake or any drilling fluid within the borehole that affects formation permeability.
- Grade the well filter pack to reduce the intrusion of fine formation particles.

Well development should not be performed sooner than 24 hours after the completion of well installation to allow the annular seal to fully set up.

### 2.2 FACTORS AFFECTING MONITORING WELL DEVELOPMENT

#### 2.2.1 Type of Geologic Materials

Different types of geologic materials are developed more effectively by using certain development methods. Where permeability is greater, water moves more easily into and out of the formation and development is accomplished more quickly. Highly stratified deposits are effectively developed by methods that concentrate on distinct portions of the formation. If development is performed unevenly, a ground-water sample will likely be more representative of the permeable zones. In uniform deposits, development methods that apply powerful surging forces over the entire screened interval will produce satisfactory results.

### 2.2.2 Design and Completion of the Well

Because the filter pack reduces the amount of energy reaching the borehole wall, it must be as thin as possible if the development procedures are to be effective in removing fine particulate material from the interface between the filter pack and natural formation. Conversely, the filter pack must be thick enough to ensure a good distribution of the filter-pack material during emplacement and allow effective grading during development. Generally, filter pack material must be at least 2 inches thick. Variances from state agencies may be required for filter pack materials of less than 2 inches thick.

The screen slot size must be appropriate for the geologic material and filter pack material in order for development to be effective. If the slot size is too large, the filter pack and native material will enter the well, causing settlement of overlying materials and sediment accumulation in the casing. If the slot size is too small, full development may not be possible and the well yield will be below the potential of the formation. Additionally, incomplete development coupled with a narrow slot size can lead to blockage of the screen openings.

### 2.2.3 Drilling Method

The drilling method influences development procedure. Typical problems associated with specific drilling methods include the following:

- If a mud rotary method is used, a mudcake builds up on the borehole wall and must be removed during the development process.

- If drilling fluid additives have been used, the development process must attempt to remove all fluids that have infiltrated into the native formation.

- If driven casing or hollow-stem auger methods have been used, the interface between the casing or auger flights and the natural formation may have been smeared with fine particulate matter that must be removed during the development process.

- If an air rotary method has been used in rock formations, fine particulate matter is likely to build up on the borehole walls and may plug pore spaces, bedding planes, and other permeable zones. These openings must be restored during the development process.

## 2.3 PREPARATION

In preparing for monitoring well development, development logs for any other monitoring wells in the vicinity should be reviewed to determine the general permeability of the water-bearing formation, the associated likely groundwater yield from the well and the appropriate development method.

Depth to groundwater and information from the well construction log should be used in calculating of the required quantity of water to be removed. The distance between the equilibrated water level and the bottom of screen is the saturated section. The saturated section (feet) multiplied by the unit well volume per foot (gallons/linear foot) equals the gallons required to remove one total well volume of water. The unit well volume is the sum of the casing volume and the filter-pack pore volume, both of which depend upon casing and borehole diameter and the porosity of the filter pack material. Well volume for wells can be calculated using Table I-C-2-1 and Table I-C-2-2.

**Table I-C-2-1***
**Casing Volume**

| Casing Diameter (inches) | Volume (gallon/linear foot) |
|---|---|
| 2 | 0.16 |
| 4 | 0.65 |
| 6 | 1.47 |

**Table I-C-2-2***
**Filter Pack Pore Volume**

| Casing Diameter (inches) | Borehole Diameter (inches) | Volume[a] (gallon/linear foot) |
|---|---|---|
| 2 | 6 | 0.52 |
| 2 | 8 | 0.98 |
| 4 | 10 | 1.37 |
| 4 | 12 | 2.09 |
| 6 | 12 | 1.76 |

* The above two volumes must be added together to obtain one unit well volume.

[a] Assumes a porosity of 40% for filter pack.

## 2.4 DECONTAMINATION

The purpose of decontamination of development equipment is to prevent cross-contamination between monitoring wells. A steam-cleaner, if available, should be used to decontaminate development equipment. The equipment should be cleaned away from the monitoring well in such a fashion that decontamination effluent can be containerized.

A triple rinse decontamination procedure is acceptable for equipment such as bailers if access to a steam cleaner is not possible. See SOP III-I, *Equipment Decontamination*.

## 2.5 WELL DEVELOPMENT MONITORING

Throughout the well development process, a development record should be maintained in the field logbook. A well development field form presented in Attachment 1 (or similar) may be filled out in addition to the field logbook. The record should include the following information:

General

- Well name/number and location

- Date, time, and weather conditions
- Names of personnel involved

Development volume

- Initial and final water level
- Casing total depth and diameter
- Borehole diameter
- Casing volume, filter pack pore volume, total well volume
- Volume of water to be evacuated
- Method and rate of removal
- Appearance of water before and after development

Monitoring data for each sample point

- Date, time, elapsed time
- Cumulative gallons removed, removal method, removal rate
- Temperature, pH, specific conductance, turbidity, dissolved oxygen, and redox potential

Part of the well development procedure should consist of acquisition and analysis of general water quality parameters at periodic intervals, considering the total quantity of water to be removed and the removal rate. Depending on site conditions, the parameters specific conductance, pH, temperature, dissolved oxygen, turbidity, and redox potential may be measured. At a minimum the temperature, pH and turbidity should be monitored. Parameter measurements should be collected on a periodic basis during development. At a minimum, these parameters should be measured after removal of each well volume. The cumulative water volume of removed, the clock time, and the time elapsed during development should be recorded and a flow rate should be calculated. Development should continue until turbidity stabilizes at or below 10 nephelometric units or at least three well volumes have been removed. If three successive parameter measurements show stable values (values within 10% of each other) and turbidity is low, well development may cease. If stabilization has not been attained, if turbidity remains high, or if the well does not readily yield water, development should continue for a reasonable time as determined in the project plans or by the Project Manager.

The discussion of well development in special situations such as low yield formations is described in Section 2.7.

## 2.6 METHODS OF MONITORING WELL DEVELOPMENT

The methods available for the development of monitoring wells have been inherited from production well practices. Methods include (1) mechanical surging with a heavy, non-disposable bailer (stainless steel or PVC) surge block or swab, and (2) surge pumping. Development methods using air or jetting of water into the well are discouraged because of the potential for affecting water quality. In some circumstances, air or water jet development may be necessary and should be conducted under the supervision of a qualified hydrogeologist.

All development water must be containerized and appropriately labeled, unless it is permissible to discharge onsite. Development should generally utilize mechanical surging or surge pumping, followed by bailing or groundwater removal with a pump. More detailed descriptions of appropriate development methods are presented below.

### 2.6.1 Mechanical Surging and Bailing

For mechanical surging and bailing, a heavy bailer, surge block or swab is operated either manually or by a drill rig. The bailer, surge block, or swab should be of sufficient weight to free-fall through the water in the well and create a vigorous outward surge. The equipment lifting the tool must be strong enough to extract it rapidly. A bailer is then used to remove fine-grained sediment and groundwater from the well.

Methodologies:

1. Properly decontaminate all equipment entering well.
2. Record the static water level and the total well depth.
3. Lower the bailer, surge block or swab to top of the screened interval.
4. Operate in a pumping action with a typical stroke of approximately 3 feet.
5. Gradually work the surging downward through the screened interval during each cycle.
6. Surge for several minutes per cycle.
7. Remove surge block and attach bailer in its place.
8. Bail to remove fines loosened by surging until water appears clear.
9. Repeat the cycle of surging and bailing until turbidity is reduced and stabilization of water quality parameters occurs.
10. The surging should initially be gentle and the energy of the action should gradually increase during the development process.

The advantages (+) and disadvantages (–) of this method are listed below:

+ It reverses the direction of flow, reduces bridging between large particles; the inflow then moves the fine material into the well for withdrawal.

+ It affects the entire screened interval.

+ It effectively removes fines from the formation and the filter pack.

– It may cause upward movement of water in the filter pack that could disrupt the seal.

- Potential exists for damaging a screen with a tight-fitting surge block or with long surge strokes.

### 2.6.2 Surge Pumping

Methodologies:

1. Properly decontaminate all equipment entering well.
2. Record the static water level and the total well depth.
3. Lower a submersible pump or airlift pump without a check valve to a depth within 1 to 2 feet of the bottom of the screened section.
4. Start pumping and increase discharge rate causing rapid drawdown of water in the well.
5. Periodically stop and start pump, allowing the water in the drop pipe to fall back into the well and surge the formation (backwashing), thus loosening particulates.
6. The pump intake should be moved up the screened interval in increments appropriate to the total screen length.
7. At each pump position, the well should be pumped, over-pumped, and backwashed alternately until satisfactory development has been attained as demonstrated by reduction in turbidity and stabilization of water quality parameters.

The advantages (+) and disadvantages (–) of this method are listed below:

+ Reversing the direction of flow reduces bridging between large particles, and the inflow then moves the fine material into the well for withdrawal.
+ It effectively removes fines from the formation and filter pack.
- The pump position or suction line must be changed to cover the entire screen length.
- Submersible pumps suitable to perform these operations may not be available for small diameter (2 inches or less) monitoring wells.
- It is not possible to remove sediment from the well unless particle size is small enough to move through pump.

For additional information on well development, consult the references included in Section 4.0 of this SOP.

## 2.7 SPECIAL SITUATIONS

### 2.7.1 Development of Low Yield Wells

Development procedures for monitoring wells in low-yield (<0.25 gpm) water-bearing zones are somewhat limited. Due to the low hydraulic conductivity of the materials, surging of water in and out of the well casing is difficult. Also, when the well is pumped, the entry rate of water is inadequate to remove fines from the well bore and the gravel pack. Additionally, the process may be lengthy because the well can be easily pumped dry and the water level will be very slow to recover.

The procedures for mechanical surging and bailing should be followed for low yield wells. During surging and bailing, wells in low yield formations should be drawn down to total depth twice if possible. Development can be terminated, however, if the well does not exhibit 80% recovery after 2 hours have passed.

## 3.0 DOCUMENTATION

Well development information should be documented in field logbooks in accordance with SOP III-D, *Logbooks* using indelible ink. In addition, well development monitoring forms (Attachment I-C-2-1 or similar) may be filled out in addition to the field logbook documentation. Copies of this information should be sent to the Project Manager and to the project files.

## 4.0 REFERENCES

Driscoll, F.G. 1987. Ground Water and Wells. Published by Johnson Division, St. Paul, Minnesota.

USEPA. 1992. RCRA, Ground Water Monitoring Technical Enforcement Guidance Document. U.S. Environmental Protection Agency/530/R-93/001. November.

U.S. EPA Environmental Response Team. 1988. Response Engineering and Analytical Contract Standard Operating Procedures. U.S. EPA, Research Triangle Park, NC.

SOP III-I, *Equipment Decontamination*

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

Attachment I-C-2-1 Well Development Record

## Attachment 1-C-2-1
## Well Development Record

## WELL DEVELOPMENT LOG

| | | |
|---|---|---|
| PROJECT | | WELL NO. |
| JOB NO. | SITE | PREPARED BY |

METHOD
OVERPUMPAGE __________
BAILER __________

SURGE
BLOCK __________
AIR LIFT __________
OTHER __________

INITIAL WATER LEVEL __________
FINAL WATER LEVEL __________

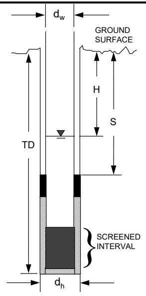
REMARKS:

CAPACITY OF CASING
(GALLONS/LINEAR FOOT)

2” = 0.16
4” = 0.65
6” = 1.47

VOLUME BETWEEN CASING AND HOLE
(GALLONS/LINEAR FOOT)
(ASSUMING 40% POROSITY)
2” CASING AND 6” HOLE - 0.52
2” CASING AND 8” HOLE - 0.98
4” CASING AND 10” HOLE = 1.37
4” CASING AND 12” HOLE - 2.09

Hole Diameter $d_h$ =_____
Well Casing:
Inside Diameter $d_wID$ =_____
Outside Diameter $d_wOD$ =_____
Depth to Water: H =_____
Depth to Base of Seal: S =_____
Depth to Base of Well: TD =_____
Estimated Filter Pack Porosity: P =_____



WELL VOLUME CALCULATION :

$$\text{CASING VOLUME} = V_c = \Pi\left(\frac{d_wID}{2}\right)^2(\text{TD - H}) = 3.14\left(\frac{\_\_\_\_}{2}\right)^2(\_\_\_\_ - \_\_\_\_) = \_\_\_\_\_\_$$

$$\text{FILTER PACK PORE VOLUME} = V_f = \Pi\left[\left(\frac{d_h}{2}\right)^2 - \left(\frac{d_wOD}{2}\right)^2\right](\text{TD} - (\text{S or H}\,*)(\text{P}) = \_\_\_\_\_\_$$

$$(*\text{ if S > H, use S; if S < H, use H})$$

$$= 3.14\left[\left(\frac{\_\_\_\_}{2}\right)^2 - \left(\frac{\_\_\_\_}{2}\right)^2\right](\_\_\_\_ - \_\_\_\_)(\_\_\_\_) = \_\_\_\_\_\_$$

$$\text{TOTAL WELL VOLUME} = \text{VT} = \text{Vc} + \text{Vf} = \_\_\_\_ + \_\_\_\_ = \_\_\_\_\_\_\ \text{ft.}^3 \times 7.48 = \_\_\_\_\_\_\ \text{gal.}$$

| DEVELOPMENT LOG: | | | | | CUMULATIVE WATER REMOVED | WATER QUALITY | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | TIME BEGIN/END | METHOD | ELAPSED TIME | FLOW RATE (gpm) | GALLONS | pH | TEMP | CONDUC-TIVITY | D.O.* | REDOX | TURBID-ITY | |
| | | | | | | | | | | | | |

* = Dissolved Oxygen

NAVFAC NW Standard Operating Procedure Number:

I-C-3

Revised March 2015

# MONITORING WELL SAMPLING

---

## 1.0 PURPOSE

This standard operating procedure (SOP) describes the conventional monitoring well sampling procedures to be used by all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and contractors. Low-flow sampling procedures are provided in SOP I-C-5, *Low-Flow Groundwater Purging and Sampling*.

## 2.0 PROCEDURE

### 2.1 PURPOSE

This procedure establishes the method for the sampling of groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples with as little alteration of water chemistry as possible.

### 2.2 PREPARATION

#### 2.2.1 Site Background Information

A thorough understanding of the purposes of the sampling event should be established prior to commencing field activities. A review of available data obtained from the site and pertinent to the groundwater sampling should also be conducted. Copies of well logs or summary tables regarding well construction information should be available on-site if possible.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that may be encountered during sampling, such as excessive turbidity and low well yield. These records should indicate where dedicated pumps are placed in the water column.

#### 2.2.2 Groundwater Sample Analysis Selection

The requisite field and laboratory analyses should be established prior to performing groundwater sampling by the project plans. The types and numbers of quality assurance/quality control (QA/QC) samples to be collected (refer to SOP III-B, *Field QC Samples*) should be specified in the QA plan developed for the site.

### 2.3 GROUNDWATER SAMPLING PROCEDURES

Groundwater sampling procedures for each well site should include: (1) measurement of depth to groundwater and total depth, (2) assessment of the presence or absence and thickness of an immiscible phase (if required by the project plan), (3) purging of static water within the well and well bore, (4) assessment of purge parameter stabilization, (3) purging of static water within the well and well bore, and (5) obtaining a groundwater sample. Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a general rule, at least 24 hours should separate well development and well sampling events.

### 2.3.1 Measurement of Static Water Level Elevation

The depth to water and the total depth of the well should be measured to the nearest 0.01 foot to provide groundwater elevation data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). Delete extra space depending upon individual project requirements, synoptic water level collection may be required prior to groundwater sampling activities. Each well should be marked with a permanent, easily identified reference point for water level measurements. The establishment of the location and elevation of the reference point should be made by a professional surveyor as defined in the Survey Specifications of the NAVFAC NW SOP V5.0 (or more current).

An electronic water level meter or tape and paste apparatus accurate to 0.01 foot should be used to measure the water level surface and depth of the well. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an electronic interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

### 2.3.2 Decontamination of Equipment

Each piece of non-dedicated equipment should be decontaminated prior to entering the well. Decontamination should also be conducted prior to the start of sampling at a site, even if the equipment has been known to be decontaminated subsequent to its last usage. This precaution is taken to minimize the potential for cross-contamination. Additionally, each piece of equipment used at the site should be decontaminated prior to leaving the site. Dedicated sampling equipment need only be decontaminated prior to installation within the well. Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without onsite decontamination.

Further details are presented in SOP III-I, *Equipment Decontamination*.

### 2.3.3 Detection of Immiscible Phase Layers

Unless specified in the project plans, groundwater samples should not be collected from wells with detectable amounts of LNAPL and DNAPL.

### 2.3.4 Purging Equipment and Use

To help minimize the potential for cross-contamination, well sampling should proceed from the least contaminated well to the most contaminated well. This order may be changed in the field if conditions warrant, particularly if dedicated sampling equipment is used. The water present in a well prior to sampling may not be representative of *in situ* groundwater quality and should be removed prior to sampling. All groundwater removed from potentially contaminated wells should be handled in accordance with the investigation-derived waste (IDW) handling procedures described in SOP I-A-7, *IDW*

*Management*. In order to obtain representative groundwater samples, three well casing volumes should be removed. Table I-C-3-1 presents the casings volumes per linear foot of water.

**Table I-C-3-1**
**Casing Volumes**

| Casing Diameter (inches) | Volume (gallon/linear foot) |
|---|---|
| 2 | 0.16 |
| 4 | 0.65 |
| 6 | 1.47 |

Purging should be accomplished by removing groundwater using bailing or pumping methods. Disposable bailers or tubing should be used when possible. If decontamination of a bailer or tubing is required by the project, Teflon® bailers or tubing is recommended. The goal of purging is to ensure that fresh water from the formation is present in the well casing at time of sampling. During purging, the pump intake should be placed in the middle of the calculated saturated screened interval. During the well purging procedure, water levels measurements should be collected to assess the hydraulic effects of purging.

Water quality parameters should be collected and recorded on a regular basis during purging. Field parameters to be collected may include temperature, pH, specific conductance, salinity, dissolved oxygen, Redox potential, and turbidity. Field personnel should refer to the project plan for specific parameters of measurement requirements. At least seven readings should be taken during the purging process. These parameters are measured to demonstrate that the natural character of the formation waters has been restored. Purging should be considered complete when three consecutive field parameter measurements stabilize within 10%. Turbidity may be considered stable if values are less than 10 nephelometric turbidity units (NTUs). The criterion for temperature may not be applicable if a submersible pump is used during purging due to the heating of the water by the pump motor. All information obtained during the purging and sampling process should be entered into the field logbook. The data may be logged on a groundwater sampling log (Figure I-C-3-1 or equivalent) in addition to the field logbook.

In special situations where LNAPL has been detected in the monitoring well and a groundwater sample is determined to be necessary by the project manager, a stilling tube should be inserted into the well prior to well purging. The stilling tube should be composed of a material that meets the performance guidelines for sampling devices. The stilling tube should be inserted into the well to a depth that allows groundwater from the screened interval to be purged and sampled, but that is below the upper portion of the screened interval where the LNAPL is entering the well screen.

The goal is to sample the aqueous phase (groundwater) while preventing the LNAPL from entering the sampling device. To achieve this goal, the stilling tube must be inserted into the well in a manner that prevents the LNAPL from entering the stilling tube. One method of doing this is to cover the end of the stilling tube with a membrane or material that will be ruptured by the weight of the pump. A piece of aluminum foil can be placed over the end of the stilling tube. The stilling tube is lowered slowly into the well to the appropriate depth and then attached firmly to the top of the well casing. When the pump is inserted, the weight of the pump breaks the foil covering the end of the tube, and the well can be purged and sampled from below the LNAPL layer. The membrane or material that is used to cover the end of the stilling tube must be fastened firmly so that it remains attached to the stilling tube when ruptured. Moreover, the membrane or material must retain its integrity after it is ruptured. Pieces of the membrane or material must not fall off of the stilling tube into the well. Although aluminum foil is mentioned in this discussion as an example of a material that can be used to cover the end of the tube, a more chemically inert material may be required, based on the site-specific situation. Stilling tubes should be thoroughly decontaminated prior to each use. Groundwater removed during purging should be collected and stored onsite until its disposition is determined based upon laboratory analytical results. Storage should be in secured containers such as DOT-approved drums. Containers of purge water should be labeled with NAVFAC NW approved labels or paint pens.

### 2.3.5 Monitor Well Sampling Methodologies

#### *2.3.5.1 Sampling Light, Non-Aqueous Phase Liquids (LNAPL)*

LNAPL, if present, must be collected prior to any purging activities. The sampling device should generally consist of a dedicated or disposable bailer equipped with a bottom-discharging device. The bailer should be lowered slowly until contact is made with the surface of the LNAPL, and lowered to a depth less than that of the immiscible fluid/water interface depth as determined by measurement with the interface probe. The bailer should then be allowed to fill with the LNAPL and retrieved.

When sampling LNAPLs, bailers should never be dropped into a well and should be removed from the well in a manner that causes as little agitation of the sample as possible. For example, the bailer should not be removed in a jerky fashion or be allowed to continually bang against the well casing as it is raised. When using bailers to collect LNAPL samples for inorganic analyses, the bailer should be composed of fluorocarbon resin. Bailers used to collect LNAPL samples for organic analyses should be constructed of stainless steel. The cable used to raise and lower the bailer should be composed of an inert material (e.g., stainless steel) or coated with an inert material (e.g., PTFE).

#### *2.3.5.2 Sampling Dense, Non-Aqueous Phase Liquids (DNAPL)*

DNAPL should be collected prior to any purging activities. The best method for collecting DNAPL is to use a double check valve, stainless steel bailer, or a Kemmerer (discrete interval) sampler. The sample should be collected by slow, controlled lowering of the bailer to the bottom of the well, activation of the closing device, and retrieval.

#### *2.3.5.3 Groundwater Sampling Methodology*

The well should be sampled when groundwater within it is representative of aquifer conditions and after it has recovered sufficiently to provide enough volume for the selected analyses. A period of no more than 2 hours should elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. Water level should be measured and recorded prior to sampling to demonstrate the degree of recovery of the well. Sampling equipment should never be dropped into the well, because this could cause aeration of the water upon impact. Additionally, the sampling methodology utilized should allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers.

### 2.3.6 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs, are chemically unstable, and therefore samples must be preserved. The U.S. Environmental Protection Agency document entitled *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846),* includes a discussion of appropriate sample preservation procedures. In addition, SW-846 specifies the sample containers that should be used for each constituent or common set of parameters. In general, check with specific laboratory requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field team may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Samples should be transferred in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the Quality Assurance Project Plan.

When sampling for VOCs, water samples should be collected in vials or containers specifically designed to prevent loss of VOCs from the sample. Analytical Laboratories shall provide vials, preferably by the laboratory that will perform the analysis. Groundwater from the sampling device should be collected in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment should not touch the interior of the vial. The vial should be filled above the top of the vial to form a positive meniscus with no overflow. No headspace should be present in the sample container once the container has been capped. To check for headspace, invert the vial, and then tap the side of the vial to dislodge any air bubbles. Sometimes, it is not possible to collect a sample without air bubbles, particularly water that is aerated. In these cases, the investigator should note the problem to account for possible error. Field logs and laboratory analysis reports should note any headspace in the sample container(s) at the time of receipt by the laboratory, as well as at the time the sample was first transferred to the sample container at the wellhead.

#### *2.3.6.1 Special Handling Considerations*

Samples requiring analysis for organics should not be filtered. Samples should not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container.

Groundwater samples to be analyzed for metals should be obtained sequentially. One sample should be obtained directly from the pump and be unfiltered. The second sample should be filtered through a 0.45-micron membrane in-line filter, transferred to a container, preserved with nitric acid to a pH less than 2, and analyzed for dissolved metals. Allow at least 500 ml of effluent to flow through the filter prior to sampling. Any difference in concentration between the total and dissolved fractions may be attributed to the original metallic ion content of the particles and adsorption of ions onto the particles.

#### *2.3.6.2 Field Sampling Preservation*

Samples should be preserved immediately upon collection. Ideally, sample jars contain preservatives of known concentration and volume during the initial filling of the jar to a predetermined final sample volume. For example, metals require storage in aqueous media at pH of 2 or less. Typically, 0.5 ml of 1:1 nitric acid added to 500 ml of groundwater will produce a pH less than 2.0. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. It should be noted that introduction of preservatives will dilute samples, and may require normalization of results. Guidance for the preservation of environmental samples can be found in the EPA "Handbook for Sampling and Sample Preservation of Water and Wastewater:" (EPA 1982). Additional guidance can be found in other EPA documents (EPA 1992, EPA 1995.)

#### *2.3.6.3 Field Sampling Log*

A groundwater sampling log should be documented in the field logbook and contain the following information:

- Identification of well
- Well depth
- Static water level depth
- Presence of immiscible layers
- Purge volume and pumping rate
- Time that the well was purged
- Sample ID
- Well evacuation procedure/equipment
- Date and time of collection
- Parameters requested for analysis
- Field analysis data, including purge parameter measurements
- Field observations during sampling event
- Name of collector

## 3.0 DOCUMENTATION

Information collected during groundwater sampling should be documented in the field logbook in accordance with SOP III-D, *Logbooks* in indelible ink. In addition, groundwater sample purge logs (Figure I-C-3-1 or equivalent) may be completed. Copies of this information should be sent to the Project Manager and to the project files.

## 4.0 REFERENCES

EPA. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029. September 1982.

NJDEP. 1986. Field Sampling Procedures Manual. New Jersey Department of Environmental Protection.

SOP I-A-7, *IDW Management*

SOP I-C-5, *Low-Flow Groundwater Purging and Sampling*

SOP III-I, *Equipment Decontamination*

SOP III-B, *Field QC Samples*

SOP III-D, *Field Logbooks*

USEPA. 1986. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document.

USEPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Enforcement Guidance Document.

USEPA. 1995 and as revised. Test Methods for Evaluating Solid Waste–Physical/Chemical Methods (SW-846). January 1995.

USEPA. 1994a and as revised. Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic Analysis.

USEPA. 1994b and as revised. Contract Laboratory Program (CLP) Statement of Work (SOW) for Inorganics Analysis.

U.S. EPA Environmental Response Team. 1988. Response Engineering and Analytical Contract Standard Operating Procedures. U.S. EPA, Research Triangle Park, NC.

## 5.0 ATTACHMENTS

None.

Revised March 2015

## Figure 1-C-3-1
## Groundwater Sampling Log

Project Number: ____________________ Date: ____________________

Location: ____________________ Time: ____________________

Well Number: ____________________ Climatic Conditions: ____________________

| | | |
|---|---|---|
| Initial Measurements: | Static Water Level: | ____________ |
| | Total Depth: | ____________ |
| Well Purging: | Length of Saturated Zone: | ____________linear feet |
| | Volume of Water to be Evacuated: | ____________gals./linear ft. x |
| | Linear feet of Saturation x Casing Volumes* = | ____________gallons |
| | Method of Removal: | ____________ |
| | Pumping Rate: | ____________ gallons/minute |

Well Purge Data:

| DATE/ TIME | GALLONS REMOVED | pH | SP. COND. | D.O. | REDOX | TURBIDITY |
|---|---|---|---|---|---|---|
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Sample Withdrawal Method: ____________________

| | | |
|---|---|---|
| Appearance of Sample: | Color | ____________ |
| | Turbidity | ____________ |
| | Sediment | ____________ |
| | Other | ____________ |

Laboratory Analysis Parameters and Preservatives: ____________________

Number and Types of Sample Containers Used: ____________________

Sample Identification Number(s): ____________________

Decontamination Procedures:____________________

Notes: ____________________

Sampled by:____________________
Samples delivered to:____________________
Date/Time:____________________
Transporters: ____________________

* Capacity of casing (gallons/linear foot): 2”-0.16, 4”-0.65, 6”-1.47, 8”-2.61, 10”-4.08, 12”-5.87

# GROUNDWATER SAMPLING FROM TEMPORARY WELLS (PIEZOMETERS)

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities of the U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and/or their contractors pertaining to the collection of groundwater samples from temporary wells (also known as piezometers).

## 2.0 PROCEDURES

Before starting fieldwork, review the sampling procedures checklist shown in

Attachment I-C-4-1.

### 2.1 EQUIPMENT

**The following items are required for sampling groundwater from temporary wells:**

- Well keys
- Bolt cutters and extra locks
- Water level indicator
- Assorted tools, such as a knife and screwdriver
- Polyvinyl chloride (PVC), Teflon, or stainless steel reusable or disposable bailer (bottom filling for sampling and purging); submersible pump or other appropriate pump
- Generator or 12-volt battery, if electric pump is to be used
- Clean nylon line or wire line (for deep wells) for lowering bailer into well
- Thermometer, pH meter (with automatic temperature compensation), and conductivity meter, or meter containing a combination of these three
- Conductivity and pH buffer calibration solutions for the meters
- Plastic squeeze bottles filled with deionized water and other decontamination chemicals as required for analyses being performed

- Polyethylene or glass container (for field parameter measurements)
- Paper towels or other chemically clean wipes such as Kimwipes
- Calculator
- Weatherproof, bound field logbook with numbered pages
- Permanent/indelible black ink pens
- Waterproof and permanent marker
- 55-gallon drum, holding tank, or 5-gallon buckets for storing purged water (if necessary)
- Plastic sheeting (for placing around well)
- Appropriate decontamination equipment as specified in SOP III-I, *Equipment Decontamination.*
- Sample jars, labels, and chain-of-custody forms. Sample bottles with preservatives added will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.

### 2.2 EQUIPMENT DECONTAMINATION

If not using disposable, non-reusable sampling equipment, before any purging or sampling begins, decontaminate all bailers and other purging or sampling equipment following the procedures specified in the SOP III-I, *Equipment Decontamination*, for sampling equipment decontamination.

### 2.3 INSTRUMENT CALIBRATION

Before going into the field, verify that field instruments are operating properly. The pH and conductivity meters require calibration prior to use every day. Record calibration times and readings in the field log book. Specific instructions for calibrating the instruments are given in the manufacturer’s manual; additional information may also be available in SOP I-D-7, *Field Parameter Measurement.*

### 2.4 WELL VOLUME CALCULATIONS

Use the appropriate equation to calculate the volume of water inside a well of any diameter:

Volume of water in casing (gal) = 12 x water column (ft.) x $\pi$ (pi) x (well radius in inches)$^2$ x 0.0043

Volume of water in annulus (gal) = 12 x water column (ft.) x $\pi$ (pi) x [(borehole radius in inches)$^2$ - (well radius in inches)$^2$ ] x 0.0043

Multiply the volume of one well casing volume by 3 to obtain the minimum volume of water to be purged.

## 2.5 WELL PURGING

The purpose of well purging is to remove stagnant water from the well so that a sample of water representative of the aquifer (or portion of aquifer) can be obtained. Unless the project plans state otherwise, before a sample is taken, purge the well a minimum of three well casing volumes. Ensure that water parameters (pH, conductivity) have stabilized or the well is bailed dry. Purge the well on the same day that samples are taken. Handle purged well water according to the protocols outlined in the SOP I-A-7 for investigation-derived waste management.

Before well purging begins, perform the following procedures:

1. Note the conditions of the area around the well. Place plastic sheeting around the well.
2. Open the well.
3. Note the condition of the well cap and casing.
4. Measure the depth of the static water level to the nearest 0.01-foot and the top of PVC well casing at the northernmost point or some other pre-marked point.
5. Measure the total well depth from the same point used to measure the water level.
6. Calculate the volume of water in the well casing in gallons, based on feet of water and casing diameter.
7. Obtain an initial sample from the bailer for field measurements of temperature, conductivity, and pH, and for observation of water quality.
8. Remove three volumes of water from the casing with a bailer or pump (refer to Attachment I-C-4-3 and Attachment I-C-4-4). Techniques for low-flow groundwater sampling can be referenced in SOP I-C-5, Low-Flow Groundwater Purging and Sampling. Measure temperature, conductivity, and pH for each well volume removed to determine water parameter stability. For low-flow sampling, measure temperature, conductivity, and pH every 5 minutes (for 20 to 30 minutes) until the water parameters have stabilized.
9. When evacuating a well using a pump, place the pump intake as follows:
    - At the bottom of the screened interval, for low-recovery wells (wells that can be pumped dry)
    - At two-thirds of the way down the screen length for low-flow sampling
    - At the top of the water column for high-recovery wells (little drawdown with pumping)

10. If the well is bailed or pumped dry during evacuation, assume that all stagnant water has been removed and the well is ready to be sampled. If recovery is very slow, obtain samples as soon as sufficient water is available in the well.

## 2.6 SAMPLE COLLECTION

Collect samples for chemical analysis within 8 hours after purging is completed. For low-recovery wells, collect the sample immediately after a sufficient volume is available. The following sampling procedure is to be used at each well:

1. Assemble sampling equipment. Use either new nylon rope for each well for each sampling event or decontaminated stainless steel cable on a reel. Do not use any type of adhesive tape to secure the rope or twine knot. The adhesive may contain chemical constituents that could contaminate the water that is being sampled.
2. Complete the identification labels for sample containers for each well.
3. Use a new pair of disposable gloves at each sample collection location.
4. Lower bailer slowly and gently into contact with the water in the well. If additional volume of water is required to fill all the sample containers, the bailer will be lowered to the same depth in the well each time.
5. Retrieve bailer smoothly and drain water slowly into the sample containers. Attachment I-C-4-5 provides instructions for filtering the samples that require dissolved metals analysis.
6. Fill individual sample containers. The first samples to be collected should be for the analysis of volatile organic compounds (VOCs).
7. Fill VOC sample vials completely so the water forms a convex meniscus at the top, then cap so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles that would indicate airspace. If air bubbles are observed in the sample, discard the sample vial and repeat the procedure.
8. Record time of sampling.
9. Replace and lock well cap.
10. Document field activities, including the chain-of-custody documentation, in accordance with SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures.*

The well sampling order depends on expected levels of contamination in each well, if known, determined prior to sampling. Sampling should progress from the least contaminated to the most contaminated well.

## 2.7 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND SAMPLES

Field QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. The frequency of QA/QC sample collection and the types of QA/QC samples required are described in the project plans. All QA/QC samples are labeled with identification numbers and sent to the analytical laboratory "blind" with the other samples. Refer to the SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures.*

## 3.0 DOCUMENTATION

The following information for groundwater sampling is included in the field logbook and/or a groundwater sampling data form (Attachment I-C-4-2):

- Date
- Time
- Weather
- Personnel on site
- Site location description
- General observations
- Well designation and well location
- Condition of the well
- Initial static water level and total well depth
- Calculations (e.g., calculation of purged volume)
- Number of well volumes purged
- Volume of water purged before sampling
- Conductivity, temperature, dissolved oxygen, turbidity and pH during purging
- Decontamination information
- Date and time of sampling
- Person performing sampling
- Number of samples taken
- Sample IDs associated with each well sampled

- Preservation of samples
- Analyses that will be performed by the laboratory
- Record of any QA/QC samples
- Any irregularities or problems that may have a bearing on sampling quality
- Unusual events
- Visitors to the site

All entries in the field logbook must be printed in black ink and legible.

## 4.0 REFERENCES

SOP I-A-7, IDW Management

SOP I-C-5, Low-Flow Groundwater Purging and Sampling

SOP I-D-7, Field Parameter Measurement

SOP III-E, Record Keeping, Sample Labeling and Chain-of-Custody Procedures

SOP III-I, Equipment Decontamination

## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment I-C-4-1 | Groundwater Sampling From a Piezometer, Checklist of Procedures |
| Attachment I-C-4-2 | Groundwater Sampling Data Form |
| Attachment I-C-4-3 | Hand Bailer Sampling Technique |
| Attachment I-C-4-4 | Pump Sampling Technique |
| Attachment I-C-4-5 | Dissolved Metals Sample Collection |

## Attachment I-C-4-1
## Groundwater Sampling From a Piezometer
## Checklist of Procedures

☐ Have access agreements been obtained? Has permission been granted to mobilize on site?

☐ What site facilities are available during the groundwater sampling event?

  ☐ Restrooms

  ☐ Water

  ☐ Telephone

☐ Are the temporary well locations clear of all ground cover (i.e., bushes, brush)?

☐ Are locations identified on a grid map or relative to other site marking?

## Attachment I-C-4-2
## Groundwater Sampling Data Form

Project Number: ______________________ Date: ______________________

Location: ______________________ Time: ______________________

Well Number: ______________________ Climatic Conditions: ______________________

Initial Measurements: Static Water Level: ______________________
Total Depth: ______________________

Well Purging: Length of Saturated Zone: ______________________linear feet
Volume of Water to be Evacuated: ______________________gals./linear ft. x
Linear feet of Saturation x Casing Volumes* = ______________________gallons
Method of Removal: ______________________
Pumping Rate: ______________________ gallons/minute

Well Purge Data:

| DATE/ TIME | GALLONS REMOVED | pH | SP. COND. | D.O. | REDOX | TURBIDITY |
|---|---|---|---|---|---|---|
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Sample Withdrawal Method: ______________________

Appearance of Sample: Color ______________________
Turbidity ______________________
Sediment ______________________
Other ______________________

Laboratory Analysis Parameters and Preservatives: ______________________

Number and Types of Sample Containers Used: ______________________

Sample Identification Number(s): ______________________

Decontamination Procedures:______________________

Notes: ______________________

Sampled by:______________________
Samples delivered to:______________________
Date/Time:______________________
Transporters: ______________________

* Capacity of casing (gallons/linear foot): 2”-0.16, 4”-0.65, 6”-1.47, 8”-2.61, 10”-4.08, 12”-5.87

## Attachment I-C-4-3
## Hand Bailer Sampling Technique

Prior to the start of the field work, review the type of contaminants expected to be encountered and the type of bailer materials being employed to ensure that the materials are compatible with the types of anticipated contaminants and to ensure that the samples will not be cross-contaminated by construction materials (e.g., plastics typically will introduce phthalates into the sample). The types of bailer and material used for construction are specified in the project plans. Preferred materials of construction are polytetrafluorethylene (PTFE) and stainless steel, but other materials may be used if determined to be compatible. Disposable bailers are typically constructed of polyethylene or polyvinyl chloride and may not be compatible with the types of contaminants expected to be encountered. Sampling of the well can begin after the well has been evacuated of the required volume of water. Normally, sampling will be conducted within 2 hours of completion of purging.

1. Cover the area surrounding the well with plastic sheeting so that the bailer cord does not contact the ground surface and transfer potentially contaminated soil particles into the well.

2. Select an appropriate bailer for the size of the well to be sampled. If non-dedicated equipment is used in the sampling process, field staff will decontaminate the equipment according to the SOP for equipment decontamination prior to each use.

3. Use a dedicated length of rope or cord for each purging or sample collection. Typically, a rope made of polyethylene or other nonreactive material, or stainless steel cable on a reel, is used for the bailer cord.

4. Fasten the rope securely to the top of the bailer in such a way as to prevent the loss of the bailer down the well. Ensure that the rope or cord employed is strong enough to prevent breakage when subjected to the weight of the full bailer. Firmly attach the end of the rope that is not attached to the bailer to the well monument or other surface feature to prevent the loss of the bailer and rope down the well.

5. Lower the bailer into the water slowly to avoid aerating the water and losing volatile contaminants. Under no circumstances will a bailer be allowed to fall freely into the water. Lower the bailer into the water opposite the well screen and then retrieve it to the surface.

6. After the bailer is retrieved to the surface, slowly transfer the water into the appropriate sample containers. Fill the sample containers for volatile organics analyses (VOA) first. Fill each VOA vial completely so that the water mounds at the top of each vial, and then place the cap carefully on the vial. Check each vial for headspace bubbles by inverting the vial and tapping it against the hand. If bubbles are present, select a new vial and fill it according to the same procedure until no headspace is indicated.

7. Fill the remaining sample containers by repeated trips into the well with the bailer. Fill sample containers for analyses other than volatile organics to the shoulder of the container to allow for addition of preservatives and for expansion and contraction of the sample.

# Attachment I-C-4-4

## Pump Sampling Technique

1. Insert an electrical water level probe into the well to determine static water level.

2. Where the static water level is above the top of the well screen, install the pump so that the pump intake is not more than 1 foot below the top of the screen.

3. Where the static water level is below the top of the well screen, carefully sound the bottom of the well with the probe. The difference between recorded well depth and measured well depth is probably from accumulated silt. Carefully install the pump so the bottom of the pump is not less than 1 foot above the measured bottom of the well. This prevents the pump from becoming silted into the well, and prevents silt from being pulled into the groundwater sample.

4. For low-flow sampling, place pump two-thirds of the way down screen.

5. Using the adjustment on the pump control box, initialize pumping at a minimum rate and slowly increase the rate until observable drawdown is measured using the water level probe. If permeability or pumping information is available from previous studies, calculate estimated pumping rate before starting field sampling.

6. Maintain an ideal pumping rate, i.e., a rate that does not create a drawdown in the well of over 0.5 foot. However, judgment must be used in balancing ideal conditions against completion of the project. Refer questions to the Site Manager.

7. At the completion of well purging, record time and water level measurements during the recovery of water level to static conditions.

8. Conduct well sampling with the pump at a flow rate not exceeding 0.2 to 0.3 liter per minute. Use a 0.45-micron in-line filter to collect samples for analyses of dissolved inorganics; all other samples should be unfiltered.

9. Pump samples directly into appropriate sample containers and preserve per the SOP III-F for sampling containers, preservation, and maximum holding times.

## Attachment I-C-4-5
## Dissolved Metals Sample Collection

1. Collect a groundwater sample from the well.
2. Prior to containerizing the sample, filter the groundwater using a disposable 0.45-micron filter.
3. Introduce the filtered groundwater into the sample container (with preservative) immediately after filtering, or filter the water directly into the sample container.
4. If the filter becomes clogged or filtering is severely impeded by sediment particles in the filter, replace the filter with an unused (new) filter. Ensure that used filters are not used on samples collected later in the field investigations.

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# LOW-FLOW GROUNDWATER PURGING AND SAMPLING

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the conventional monitoring well sampling procedures to be used by all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and contractors. Conventional monitoring well sampling procedures are provided in SOP I-C-4, *Groundwater Sampling from Temporary Wells (Piezometers)*.

## 2.0 PROCEDURE

### 2.1 PURPOSE

This procedure establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples with as little alteration of water chemistry as possible.

### 2.2 PREPARATION

### 2.2.1 Site Background Information

A thorough understanding of the purposes of the sampling event should be established prior to commencing field activities. A review of available data obtained from the site and pertinent to the water sampling should also be conducted. Copies of well logs or summary tables regarding well construction information should be available on-site if possible.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that may be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column.

It is highly recommended that the field sampling team is familiar with the U.S. EPA recommended protocols for low-flow sampling outlined in the April 1996 Ground Water Issue *Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures* (U.S. EPA 1996).

### 2.2.2 Groundwater Analysis Selection

The requisite field and laboratory analyses should be established prior to performing water sampling. The types and numbers of quality assurance/quality control (QA/QC) samples to be collected (refer to SOP III-B, *Field QC Samples (Water, Soil)*) should be specified in the QA plan developed for the site.

### 2.3 GROUNDWATER SAMPLING PROCEDURES

Groundwater sampling procedures at a site should include: (1) measurement of depth to groundwater and total depth, (2) assessment of the presence or absence of an immiscible phase (if required by the project plan), (3) assessment of purge parameter stabilization, (4) purging of static water within the well and well bore, and (5) obtaining a groundwater sample. Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events.

### 2.3.1 Measurement of Static Water Level Elevation

The depth to water and the total depth of the well should be measured to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). Dependent upon individual project requirements, synoptic water level collection may be required prior to groundwater sampling activities. In the event that synoptic water levels **are not** collected prior to sampling activities, total depth measurements should be collected **after** purging and sampling activities to prevent the suspension of fine-grained sediment that may be present at the bottom of the well. Each well should be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed.

An electronic water level meter accurate to 0.01 foot should be used to measure the water level surface and depth of the well. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

### 2.3.2 Decontamination of Equipment

Each piece of non-dedicated equipment should be decontaminated prior to entering the well. Decontamination should also be conducted prior to the start of sampling at a site, even if the equipment is known to be decontaminated subsequent to its last usage. This precaution is taken to minimize the potential for cross-contamination. In addition, each piece of equipment used at the site should be decontaminated prior to leaving the site. Dedicated sampling equipment need only be decontaminated prior to installation within the well. Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without onsite decontamination.

Further details are presented in SOP III-I, *Equipment Decontamination*.

### 2.3.3 Detection of Immiscible Phase Layers

Unless specified in the project plans, groundwater samples should not be collected from wells with detectable amounts of LNAPL and DNAPL.

### 2.3.4 Purging Equipment and Use

To help minimize the potential for cross-contamination, well sampling should proceed from the least contaminated to the most contaminated. This order may be changed in the field if conditions warrant, particularly if dedicated sampling equipment is used. If decontamination of tubing is required by the project, Teflon® tubing is recommended. All groundwater removed from potentially contaminated wells should be handled in accordance with the investigation-derived waste (IDW) handling procedures described in SOP I-A-7, *IDW Management*.

Purging should be accomplished by removing groundwater from the well at low flow rates using a pump. According to the U.S. EPA (1996), the rate at which groundwater is removed from the well during purging ideally should be between than 0.1 to 0.5 L/min. The pump intake should be placed in the middle of the calculated saturated screened interval. The purge rate should be low enough that substantial drawdown (>0.3 foot) in the well does not occur during purging. If a stabilized drawdown in the well can't be achieved and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. ***Under no circumstances should the well be pumped dry or otherwise over-purged***. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or groundwater sampling log with a recommendation for a different purging and sampling procedure (USEPA, 2012).

Water level measurements should be collected to assess the water level effects of purging. A low purge rate also will reduce the possibility of stripping VOCs from the water, and will reduce the likelihood of mobilizing colloids in the subsurface that are immobile under natural flow conditions.

Water quality parameters should be collected and recorded on a regular basis (every 3-5 minutes) during well evacuation. Field parameters to be collected may include temperature, pH, specific conductance, salinity, dissolved oxygen, Redox potential, and turbidity. At least seven readings should be taken during the purging process unless the field parameters stabilize more quickly. These parameters are measured to demonstrate that the formation water, not stale well casing water, is being evacuated. Purging should be considered complete when the high and low values between three consecutive field parameter measurements stabilize within 10%. Turbidity may be considered stable if values are less than 10 nephelometric turbidity units (NTUs). The criterion for temperature may not be applicable if a submersible pump is used during purging due to the heating of the water by the pump motor. Field personnel should refer to the project-specific Sampling and Analysis Plan (SAP) for specific measurement requirements and well stabilization criteria.

All information obtained during the purging and sampling process should be entered into the field logbook. In addition to the field logbook, the data may be logged on a groundwater sampling log (Figure I-C-5-1 or equivalent). In special situations where LNAPL has been detected in the monitoring well and a groundwater sample is determined to be necessary by the Project Manager, a stilling tube should be inserted into the well prior to well purging. The stilling tube should be composed of a material that meets the performance guidelines for sampling devices. The stilling tube should be inserted into the well to a depth that allows groundwater from the screened interval to be purged and sampled. The bottom of the tube should be set below the upper portion of the screened interval where the LNAPL is entering the well screen. The goal is to sample the aqueous phase (groundwater) while preventing the LNAPL from entering the sampling device. To achieve this goal, the stilling tube must be inserted into the well in a manner that prevents the LNAPL from entering the stilling tube.

One method of doing this is to cover the end of the stilling tube with a membrane or material that will be ruptured by the weight of the pump. A piece of aluminum foil can be placed over the end of the stilling tube. The stilling tube is lowered slowly into the well to the appropriate depth and then attached firmly to the top of the well casing. When the pump is inserted, the weight of the pump breaks the foil covering the end of the tube, and the well can be purged and sampled from below the LNAPL layer. The membrane or material that is used to cover the end of the stilling tube must be fastened firmly so that it remains attached to the stilling tube when ruptured. Moreover, the membrane or material must retain its integrity after it is ruptured. Pieces of the membrane or material must not fall off of the stilling tube into the well. Although aluminum foil is mentioned in this discussion as an example of a material that can be used to cover the end of the tube, a more chemically inert material may be required, based on the site-specific situation. Stilling tubes should be thoroughly decontaminated prior to each use. Groundwater removed during purging should be collected and stored onsite until its disposition is determined based upon laboratory analytical results. Storage should be in secured containers such as DOT-approved drums. Containers of purge water should be labeled with NAVFAC NW approved labels or paint pens.

### 2.3.5 Groundwater Sampling Methodology

The well should be sampled when groundwater within it is representative of aquifer conditions and after it has recovered sufficiently to provide enough volume for the groundwater sampling parameters. A period of no more than 2 hours should elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. The water level should be measured and recorded prior to sampling to demonstrate the degree of recovery of the well. Sampling equipment should never be dropped into the well, because this could cause aeration of the water upon impact. In addition, the sampling methodology utilized should allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers.

### 2.3.6 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs are chemically unstable; therefore, samples must be preserved. The U.S. Environmental Protection Agency document entitled *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846)* (U.S. EPA 1995), includes a discussion of appropriate sample preservation procedures. In addition, SW-846 specifies the sample containers that should be used for each constituent or common set of parameters. In general, check with specific laboratory requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field team may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Samples should be transferred in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the Quality Assurance Project Plan.

When sampling for VOCs, water samples should be collected in vials or containers specifically designed to prevent loss of VOCs from the sample. An analytical laboratory should provide these vials, preferably by the laboratory that will perform the analysis. Groundwater from the sampling device should be collected in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment should not touch the interior of the vial. The vial should be filled above the top of the vial to form a positive meniscus with no overflow. No headspace should be present in the sample container once the container has been capped. The sample can be checked for headspace by inverting the sample bottle and tapping the side of the vial to dislodge air bubbles. Sometimes it is not possible to collect a sample without air bubbles, particularly water that is aerated or naturally carbonated. In these cases, the investigator should note the problem to account for possible error. Field logs and laboratory analysis reports should note any headspace in the sample container(s) at the time of receipt by the laboratory, as well as at the time the sample was first transferred to the sample container at the wellhead.

#### *2.3.6.1 Special Handling Considerations*

Samples requiring analysis for organics should not be filtered. Samples should not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container.

Groundwater samples to be analyzed for total and dissolved metals should be obtained sequentially. The sample to be analyzed for total metals, should be obtained directly from the pump and be unfiltered. The second sample should be filtered through a 0.45-micron membrane in-line filter and transferred to a container to be analyzed for dissolved metals. Allow at least 500 ml of effluent to flow through the filter prior to sampling. Any difference in concentration between the total and dissolved fractions may be attributed to the original metallic ion content of the particles and adsorption of ions onto the particles.

#### *2.3.6.2 Field Sampling Preservation*

Samples should be preserved immediately upon collection. Ideally, sample jars contain preservatives of known concentration and volume during the initial filling of the jar to a predetermined final sample volume. For example, metals require storage in aqueous media at pH of 2 or less. Typically, 0.5 ml of 1:1 nitric acid added to 500 ml of groundwater will produce a pH less than 2.0. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. It should be noted that introduction of preservatives will dilute samples, and may require normalization of results. Guidance for the preservation of environmental samples can be found in the EPA "Handbook for Sampling and Sample Preservation of Water and Wastewater:" (U.S. EPA 1982).

## 3.0 DOCUMENTATION

Information collected during groundwater sampling should be documented in the field logbook in accordance with SOP III-D, *Logbooks*. In addition, groundwater sampling purge logs may be (Figure I-C-5-1 or equivalent) may be filled out in addition to the field logbook. Copies of this information should be sent to the Project Manager and to the project files.

A groundwater sampling log should be documented in the field logbook and contain the following information:

- Identification of well
- Well depth

- Static water level depth
- Presence of immiscible layers
- Purge volume and pumping rate
- Time that the well was purged
- Collection method for immiscible layers
- Sample IDs
- Well evacuation procedure/equipment
- Date and time of collection
- Parameters requested for analysis
- Field analysis data
- Field observations on sampling event
- Name of collector

Revised March 2015

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## Figure 1-C-5-1
## Groundwater Sampling Log

Project Number: ____________________ Date: ____________________

Location: ____________________ Time: ____________________

Well Number: ____________________ Climatic Conditions: ____________________

Initial Measurements: Static Water Level: ____________________
Total Depth: ____________________

Well Purging: Length of Saturated Zone: ____________________linear feet
Volume of Water to be Evacuated: ____________________gals./linear ft. x
Linear feet of Saturation x Casing Volumes* = ____________________gallons
Method of Removal: ____________________
Pumping Rate: ____________________ gallons/minute

Well Purge Data:

| DATE/ TIME | GALLONS REMOVED | pH | SP. COND. | D.O. | REDOX | TURBIDITY |
|---|---|---|---|---|---|---|
| | | | | | | |
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Sample Withdrawal Method: ____________________
Appearance of Sample: Color ____________________
Turbidity ____________________
Sediment ____________________
Other ____________________

Laboratory Analysis Parameters and Preservatives: ____________________

Number and Types of Sample Containers Used: ____________________

Sample ID(s): ____________________

Decontamination Procedures: ____________________

Notes: ____________________

Sampled by: ____________________
Samples delivered to: ____________________
Date/Time: ____________________
Transporters: ____________________

* Capacity of casing (gallons/linear foot): 2”-0.16, 4”-0.65, 6”-1.47, 8”-2.61, 10”-4.08, 12”-5.87

## 4.0 REFERENCES

SOP I-A-7, IDW Management

SOP *-C-4, *Groundwater Sampling from Temporary Wells (Piezometers)*

SOP III-I, Equipment Decontamination

SOP III-B, Field QC Samples

SOP III-D, Logbooks

U.S. EPA. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029. September 1982.

U.S. EPA. 1986. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document.

U.S. EPA. 1996. Ground Water Issue, Low-flow (Minimal Drawdown) Groundwater Sampling Procedures. EPA/540/S-95/504. April 1996

U.S. EPA. 1995 and as revised. Test Methods for Evaluating Solid Waste–Physical/Chemical Methods (SW-846). January 1995.

U.S. EPA. 2012. Standard Operating Procedure Low-Stress (Low Flow) / Minimal Drawdown Ground-Water Sample Collection, USEPA, Region 9, Management and Technical Services Division, April 2012.

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

I-C-6

Revised March 2015

# MONITORING WELL AND PIEZOMETER ABANDONMENT

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## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline the methods by which all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and contractors will conduct monitoring well and piezometer abandonment. This procedure describes the protocols for monitoring well and piezometer abandonment. The procedure provides descriptions of equipment, field procedures, and documentation necessary to properly abandon a monitoring well or piezometer.

## 2.0 PROCEDURES

### 2.1 EQUIPMENT

Equipment and materials used during monitoring well and piezometer abandonment include the following:

- Drill rig or trailer-mounted mixer and grout pump
- Filter pack material
- Pure sodium bentonite with no additives
- Bentonite pellets/chips
- Bentonite grout
- Portland Type II cement
- Water from an approved source
- Weighted tape measure
- Flexible hose
- Tremie pipe (small-diameter, rigid polyvinyl chloride [PVC] pipe)
- Weatherproof bound field logbook with numbered pages
- Appropriate health and safety equipment

## 2.2 METHODOLOGY

The following procedure applies to the abandonment of wells aborted prior to completion and existing wells determined to be ineffective or otherwise in need of closure. Prior to abandoning any developed well, you may need to acquire a permit from the state in which you are working. The permit application may require a detailed design of the well abandonment. Also, prior to abandonment, all obstructions (pumps, lost equipment) must be removed from the well. Some states are adamant about this point and will not allow the closure of a well with lost equipment in it. The state may require the removal of all objects to allow a proper seal during abandonment. Great lengths must be taken to reclaim lost items, such as the use of downhole video cameras to inspect and aid in the recovery of items.

At locations where a well log is not available the following procedure shall be implemented:

1. The casing should be pulled, drilled out, or thoroughly pierced.
2. With the use of a tremie pipe, grout should be placed from the bottom of the hole to within 3 feet of the ground surface.
3. The material should be allowed to settle for 24 hours.
4. The remainder of the hole should be filled with concrete.
5. All boring logs, samples, completion records, and abandonment procedures should be included in the records of work.

At locations where a well completion log is available the following procedure shall be implemented :

1. With the use of a tremie pipe, grout should be placed from the bottom of the hole to within 3 feet of the ground surface.
2. The material should be allowed to settle for 24 hours.
3. The remainder of the hole should be filled with concrete.
4. All boring logs, samples, completion records, and abandonment procedures should be included in the records of work.

Depending on the regulatory body under which you are working, the procedures listed above may differ. All work shall be performed by a licensed well driller in the state work is being performed. The licensed well driller is responsible for documenting the abandonment of the monitoring well with the appropriate state agency.

In Washington, if downhole problems prevent completion of the boring into a monitoring well, the boring should be abandoned in accordance with Washington State Department of Ecology Minimum Standards for Construction and Maintenance of Wells (Washington Administrative Code [WAC] 173-160). If the height of standing water in the hole is less than 25 feet, you should proceed with the abandonment by placing bentonite chips into the boring at a pour rate of 3 minutes or slower per standard sack.

A sounding tape should be run in the boring to measure the fill-up rate and to ensure that bridging does not occur. If bridging occurs, the bridge should be broken up before additional chips are poured. If the height of water in a boring is greater than 25 feet, a grout slurry should be pumped into the hole via a tremie pipe. Abandonment should be deemed complete when the bentonite hole seal has stabilized at 0 foot below ground surface (bgs). Abandoned borings should be inspected for 2 or 3 days after completion to ensure that the grout level has not dropped. If the grout has subsided, additional grout should be added to the hole.

You should always check the regulatory requirements in the area of the site before establishing the SOP for a particular site (e.g. WAC 173-160, 18 AAC 75 / 18 AAC 78).

### 2.3 REPLACEMENT WELLS

Replacement wells (if any) should normally be offset at least 15 feet from any abandoned well in an up-gradient or cross-gradient groundwater flow direction. Site-specific conditions may necessitate variation of this placement.

### 2.4 GROUT

Bentonite grout is preferred for the abandonment of monitoring wells. Cement grout, if used for abandonment, should be composed of the following by weight:

- 20 parts cement (Portland cement, Type II or V)
- 0.4 to 1 part (maximum) (2 to 5 percent) bentonite
- 8 gallons (maximum) approved water per 94-pound bag of cement

Neither additives nor borehole cuttings should be mixed with the grout. Bentonite should be added after the required amount of cement has been mixed with the water.

All grout material should be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout should be recirculated through the grout pump prior to placement.

The mixture can be combined and recirculated through a drill rig equipped for mud rotary drilling or through a mixer and grout pump mounted on a trailer.

Grout should be placed with the use of a commercially available grout pump and a rigid tremie pipe. Casing and grouting should be removed in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This should be accomplished by placing a tremie pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the topmost section, until grout flows from the boring at the ground surface.

After 24 hours, the abandoned drilling site should be checked for grout settlement. On that day, any settlement depression should be filled with grout and rechecked 24 hours later. This process should be repeated until firm grout remains at the ground surface.

Be aware that when the drillers are finished, they will need a large supply of water to rinse out their equipment. This wash water must be containerized as IDW in accordance with SOP I-A-6. Also, any materials (such as the removed protective casing, manhole covers, and concrete collars) shall be disposed of in accordance with naval installation procedures.

## 3.0 DOCUMENTATION

The following information should be recorded in the field logbook.

General information:

- Date
- Time
- Well/piezometer location
- Personnel/subcontractor on site
- Visitors

Information specific to abandonment:

- Start/end times
- Depth of well/piezometer
- Materials used to seal each stratum
- Detailed description of procedure
- Date/time of return visit(s)
- Activities performed on return visit(s)

All entries in the field logbook should be printed in black ink and legible.

Well abandonment information must also be submitted to NIRIS per the instructions detailed in the NAVFAC NW SOPs (V5.0 or more current) under Tabular Electronic Data Submittals, Location NEDD, Location Description page.

## 4.0 REFERENCES

Washington Administrative Code [WAC] 173-160. Washington State Department of Ecology Minimum Standards for Construction and Maintenance of Wells.

Alaska Administrative Code [AAC] 18 AAC 75 and 18 AAC 78. Monitoring well design, construction, installation, maintenance, and decommissioning, Alaska Department of Environmental Conservation (ADEC).

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

I-D-1

Revised March 2015

# DRUM SAMPLING PROCEDURES

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## 1.0 PURPOSE

This document defines the Standard Operating Procedure (SOP) for drum sampling. This SOP lists the equipment and procedures to follow by U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and/or their contractors when preparing to sample drums containing soil and liquid.

## 2.0 PROCEDURES

This section outlines the procedures to be used in drum sampling.

## 2.1 EQUIPMENT

The following equipment will be required to complete the drum sampling activities:

- Crescent wrench for removing drum heads or 3/4" socket and driving if standard size bolt is used
- Non-sparking bung wrench
- Disposable soda lime glass coliwasas for taking liquid grab samples
- Stainless steel mixing bowl or bucket for compositing solid samples, or
- Glass sample jar large enough to contain the liquid for liquid composite samples
- Stainless steel trowels or mixing spoons
- Stainless steel 2-inch diameter hand auger with 2 foot and 4 foot extensions
- Appropriate decontamination equipment as specified in SOP III-I, *Equipment Decontamination*
- Appropriate Health and Safety equipment and personal protective equipment (PPE) as specified in the Health and Safety Plan
- Spray paint or wax pen to mark the drums
- Field book and writing instruments

## 2.2 INSPECTION OF DRUMS

Follow these steps to inspect the drums before opening:

1. Prior to any handling, drums with unknown contents should be visually inspected for any words, symbols, or labels on the drum surface that would indicate the nature of its contents.

2. A careful inspection should also be made for signs of leakage, rusting, corrosion, or bulging.

3. If the drum is of unusual construction or material, such as nickel or stainless steel, it may contain a particularly hazardous or chemically sensitive material.

4. The type of drumhead and type of bungs (if any) should be inspected. If the whole drum lid is removable, it may be designed to contain solid materials. If it has a bung (or bungs) it may be designed to contain a liquid.

5. If the drum has a polyethylene or PVC liner, it may have been designed to contain a corrosive material.

6. The top of the drum and the area around the bungs should be inspected for any signs of crystal formation, staining or unusual materials on the surface.

7. The drum may need to be photographed and numbered during the inspection process.

## 2.3 SPILL CONTROL DURING HANDLING

Spills or leaks may occur during drum movement and handling. Absorbent materials (clay, oil-dry, etc.) should be readily available in sufficient quantity to absorb spilled or leaked material. Where large spills could occur, a containment berm should be constructed around the area. A special pad for drum handling (concrete, HDPE, etc.) with containment berms may be required for certain types of work. Only appropriately trained personnel wearing adequate PPE should perform spill control. A Spill Plan should be part of the Site Health and Safety Plan (HSP).

## 2.4 OPENING DRUMS

Follow these precautions when preparing to open a drum:

1. Use a crescent wrench or equivalent and/or a non-sparking bung wrench to remove bungs and/or the drumhead to gain access to the drum interior. Bungs should be turned slowly to allow the drum to vent gradually prior to removing the bung and/or the drumhead.

2. An appropriately rated fire extinguisher should be on hand ready for use to control incipient fires.

3. OSHA specifies that a "suitable shield" be placed between the employee and the drum being opened to protect the employee in case of accidental explosion.

4. If there appears to be real danger of accidental explosion, the drum should be opened remotely. One of the best ways to do this is to use a bronze spike mounted on the end of a backhoe arm. The backhoe operator looks out through a clear explosion shield. The spike is used to punch a hole through the surface of the drum.

5. A variety of pneumatic and hydraulic remote drum-operating devices may be available. The efficiency of their use must be evaluated on a case-by-case basis.

## 2.5 CONTAINERIZED SOLIDS SAMPLING PROCEDURE

The following procedures are to be followed for obtaining a sample of containerized solids:

1. Inspect, clean, and put on appropriate PPE.
2. Remove the drum lids from all drums that are to be sampled in a set if compositing samples.
3. Utilizing a 2-inch diameter stainless steel hand auger, auger down into the cuttings at the center of the drum. Place auger contents into the stainless steel mixing bowl. Continue augering until the bottom of the drum is encountered, collecting additional grab samples with the auger.
4. This procedure will be repeated, if compositing samples, for each drum to be sampled.
5. Utilizing stainless steel spoons or trowels gently mix the cuttings in the bowl so that the contents are slowly combined, until a uniform, homogeneous color is obtained.
6. Samples for Volatile Organic Compounds will not be mixed in the mixing bowl and will be collected directly into the lab supplied containers assuring that a representative sample is collected.
7. The remaining soil shall then be transferred into the appropriate sample jars.
8. Label and handle the jars according to the procedures outlined in SOPs III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, III-F, *Sample Containers and Preservation*, and III-G, *Sample Handling, Storage, and Shipping Procedures*.
9. Replace drum covers and secure them.

## 2.6 CONTAINERIZED LIQUIDS SAMPLING PROCEDURE

The following procedures are to be followed for obtaining a sample of containerized liquid:

1. Inspect, clean, and put on appropriate PPE.
2. Remove the bungs (or drum lids if no bung is present) from all drums that are to be sampled in a set if compositing samples.
3. Utilizing a 3/4-inch diameter disposable glass coliwasa, a sample of the liquid will be obtained by inserting the coliwasa into the center of the drum.
4. Close the coliwasa, remove it from the drum, and release its contents directly into a glass sample jar of appropriate size for compositing the number of drums in the sample group.
5. After all drums in a set are sampled, transfer the composited sample to the appropriate lab supplied bottle(s).

6. VOC samples will be collected directly into the containers (supplied by the lab) assuring that a representative sample is collected.

7. Label and handle the jars according to the procedures outlined in SOPs III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, III-F, *Sample Containers and Preservation*, and III-G, *Sample Handling, Storage, and Shipping Procedures*.

8. Replace bungs or drum covers and bolt them down tightly.

9. Dispose of the glass coliwasa according to the Protocols specified in the work plan after sampling each set of drums.

## 3.0 DOCUMENTATION

After sampling, record all relevant observations and sampling information in the site field logbook. This is to document that appropriate procedures have been followed and to track the equipment operation. All entries in the field logbook must be written accurately and legibly as outlined in the SOP III-D, *Logbooks*.

## 4.0 REFERENCES

SOP III-D, *Logbooks*

SOP III-I, *Equipment Decontamination*

SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*

SOP III-F, *Sample Containers and Preservation*

SOP III-G, *Sample Handling, Storage, and Shipping Procedures*

## 5.0 ATTACHMENTS

None.

# WATER LEVEL MEASUREMENTS

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## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish standard protocols for all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) field personnel for use in making water level measurements.

## 2.0 PROCEDURE

### 2.1 EQUIPMENT

Equipment and materials used during liquid level and well-depth measurements:

- Electronic water level indicator with cable marked with 0.01-foot increments
- Electronic oil-water interface probe
- Engineers measuring tape with 0.01-foot increments may be used for water and petroleum reactive pastes as an alternative to an oil-water interface probe
- Weighted steel tape with 0.01-foot increments and chalk may be used as an alternative to a water level indicator
- Decontamination equipment
- Weatherproof, bound field logbook with numbered pages (see SOP III-D, *Logbooks*)
- Health and safety equipment appropriate for site conditions
- Keys for locked well covers
- Wire cutters if well has a security tag
- Turkey baster or hand pump in case flush-mount manhole is filled with water
- Bolt cutters for cutting “frozen” or rusted locks. HWD-40 is used to lubricate a rusted lock, but extreme care should be taken to avoid possible contamination to the well and equipment.
- Extra locks to replace cut locks

### 2.2 PRELIMINARY STEPS

Follow these steps prior to disturbing the liquid level in the well:

1. Locate the well and, confirm its label (if marked), and verify its position relative to other site features on the site map. Gain access to the top of the well casing.

2. Locate the permanent reference mark at the top of the well casing. This reference point shall be scribed, notched, or otherwise noted on the top of the casing. If no such marks are present, measure depth relative to the top of the highest point of the well casing and note this fact in the field logbook. Determine from the records and record the elevation of the permanent reference point and record it in the logbook.

3. Record any observations and remarks regarding the characteristics and condition of the well, such as evidence of cracked casing or surface seals, security of the well (locked cap), evidence of tampering, missing well cap, surface water entering the well casing, etc.

## 2.3 OPERATION

Follow these steps when taking depth to liquid level measurements in well suspected to have NAPL present.

1. Sample the air in the wellhead for gross organic vapors if required.

2. If non-aqueous phase liquid (NAPL) contamination is suspected, use an oil-water interface probe to determine the existence and thickness of the NAPL.

3. Open interface probe housing, turn probe on, and test the alarm. Ground the probe, because the slight electric charge from the probe could set off an explosion of highly flammable vapors. Slowly lower the probe into the well until the alarm sounds. A continuous alarm indicates light non-aqueous phase liquid (LNAPL), while an intermittent alarm indicates water. If LNAPL is detected, record depth of the initial (first) alarm. Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing. Determine the depth to liquid relative to the permanent reference point on the well casing. Withdraw cable sufficiently to record the depth from the scale on the interface probe cable.

4. Continue to slowly lower the probe until it passes into the water phase (intermittent alarm). Slowly retract the probe until the NAPL continuous alarm sounds and record that level in the same manner as described above.

5. Record the depth to NAPL and the depth to water readings independently in the logbook. The thickness of the LNAPL can be calculated by subtracting depth to LNAPL reading from depth to water measurement.

6. Continue to slowly lower the interface probe through the water column to check for the presence of dense non-aqueous phase liquid (DNAPL) if suspected.

7. Measure and record the depths of the DNAPL layer (if any) as described above.

8. Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. If there is a discrepancy in depths, clean the probe sensor and recheck the depth measurements.

9. Always lower and raise the interface probe slowly to minimize mixing of media.
10. Always perform a NAPL check in wells installed in areas with suspected NAPL contamination. Always perform a NAPL check if headspace test reveals presence of volatiles. Always perform a NAPL check the first time depth to liquid is measured in a well. If a well has been measured previously, with no NAPLs present, and none of the preceding conditions are met, the NAPL check may be omitted.
11. Decontaminate interface probe as appropriate.

For wells where NAPL is not suspected to be present, an electronic water level indicator or steel tape can be used as described below:

1. Remove the water level indicator probe from the case, turn on the sounder, and test the battery and sensitivity scale by pushing the test button. Adjust the sensitivity scale until you can hear the alarm.
2. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering the probe until the alarm sounds. Very slowly raise and lower the probe until the point is reached where the meter just beeps. Mark the spot by grasping the cable with thumb and forefingers at the top of the casing. Record the depth to water relative to the permanent reference point. If no mark is present, use the highest point on the casing as a reference point. Withdraw the cable and record the depth.
3. Alternately, use a steel tape with an attached weight if the aquifer gradients are lower than 0.05 ft./ft. Due to the possibility of adding unknown contaminants from chalk colorants, only white chalk is permitted as a level indicator.
4. Rub chalk onto the end (first 1 foot) of the steel tape and slowly lower the chalked end into the well until the weighted end is below the water surface. (A small splash can be heard when the weighted end hits the water surface.)
5. Mark the spot on the tape by grasping the tape with the thumb and forefingers at the top of the casing as described in the subsection (2) above. Record this spot on the tape in the logbook as the "HOLD". Ensure not to retract the tape from the well until after the depth measurement (HOLD) is recorded.
6. Remove the steel tape from the well. The chalk will be wet or absent where the tape was below the water surface. Locate, read, and record this length in the logbook as the "CUT". Subtract the "CUT" length from the "HOLD" length and record the difference in the logbook. This is the depth to water table.
7. Decontaminate water level indicator or steel tape as appropriate

## 2.4 PRECAUTIONS

- Depending on the device used, correction factors may be required for some measurements. For example, if the water level indicator has been shortened during its repair.

- Check instrument batteries prior to each use.
- Exercise care not to break the seals at the top of the electric water level indicator probe.
- It is important to note that when measuring total well depth (bottom of casing), using an interface probe or water level indicator, the increments of measure are ticked off from the alarm sensor on the probe. On some meters there is a portion of the probe that sticks out beyond the alarm sensor. This needs to be accounted for when reading the bottom of casing measurement (i.e., added onto the reading). A potential problem arises if it is unknown whether this has been done on previous readings or not.

## 3.0 DOCUMENTATION

This section describes the documentation necessary for depth to liquid and well-depth measurements. All information shall be recorded in the field logbook using indelible ink in accordance with SOP III-D, *Logbooks*. At a minimum, the following information must be recorded:

- Date
- Time
- Weather
- Field personnel
- Well location and label
- Well condition
- Monitoring equipment type and readings
- Depth to Liquid measurements obtained
- Any other observations

All entries in the field logbook must be printed in black ink and legible. The actual readings measured should be recorded directly in the logbook. If calculations are necessary to determine the depth to liquid or liquid elevation, they should be performed using direct readings documented in the logbook.

Water level measurements must also be submitted electronically using the appropriate Naval Electronic Data Deliverable (NEDD) format for loading into NIRIS as defined in the NAVFAC NW SOPs (V5.0 or more current).

## 4.0 REFERENCES

SOP III-D, *Logbooks*

Thornhill, Jerry T. 1989. “Accuracy of Depth to Groundwater Measurements.” In *EPA Superfund Groundwater Issue.* EPA/504/4-89/002.

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-D-7

Revised March 2015

# FIELD PARAMETER MEASUREMENTS

## 1.0 PURPOSE

This standard operating procedure (SOP) provides instructions for the calibration, use, and checking of instruments and equipment for field measurements.

## 2.0 PROCEDURES

### 2.1 WATER QUALITY MEASUREMENTS

All field water quality meters shall be calibrated daily following the manufacturers' specifications. Calibration shall be performed prior to using the instrument for collecting parameters. In addition, the meter's calibration should be checked at mid-day and the end of the day to determine if measurements have drifted from the original calibration numbers. These checks are not intended to be a recalibration of the instrument. All calibration and measurement data shall be recorded in the project logbook. Fluids used for calibration shall be changed at regular intervals to ensure its integrity. Since different fluids have different shelf lives and tolerances, manufacturers' specifications should be checked as appropriate.

Most multi-probe water quality meters utilize a flow-through cell. If the unit being used does not have a flow-through cell, a large enough vessel (i.e. polypropylene beaker) in which the probes will be submerged shall be used. The water to be measured will be pumped continuously through the beaker from the bottom, overflowing the top. The flow-through cells will usually allow for quicker stabilization of dissolved oxygen and oxidation-reduction potential readings.

Water shall be allowed to flow continuously through the cell or beaker with water quality measurements being collected at regular intervals, every three to five minutes, until stabilization of the parameters has occurred. A minimum number of seven sets of readings should be collected or as otherwise outlined in the field sampling plan. Stabilization is considered to have occurred when three consecutive readings meet the following guidelines:

| | |
|---|---|
| pH | + 0.2 Scientific Units |
| Specific Conductance | + 3 % mS/cm |
| Turbidity | + 10% or < 10 NTUs |
| Dissolved Oxygen | + 10% mg/cm |
| Salinity | + 10% |
| Oxidation-Reduction Potential | + 10 mV |
| Temperature | + 10% °C |

In addition to recording the above listed parameters the following information shall also be documented: date, time of measurement, flow rates, purge volumes, total volume purged, and other relative information (i.e. odors, sheen, comments on turbidity, water color)

## 2.2 ORGANIC VAPORS

Various organic vapor monitors have differing requirements for equipment warm-up and operation. Ensure that all organic vapor monitors are calibrated and operated according to the manufacturer's specification.

For measuring vapors present in soils, expose the monitor to a sample of soil by collecting a sample in sealable plastic baggy and placing the probe tip into the closed bag. In cold weather, the soil may need to be warmed prior to testing.

For measuring breathing zone vapors, hold the probe tip in the area of the breathing zone while field activities are being conducted. Take representative measurements from each different work or sampling area.

For monitoring well head space, place the probe tip just inside of the monitoring well casing immediately after removing the cap.

All readings including calibration information shall be recorded in the field logbook.

## 3.0 DOCUMENTATION

Record all observations and analysis in the field logbook as defined in SOP III-D, *Logbooks*. If required by the SAP, also complete the Field Measurement Data Form.

Field measurements must also be submitted electronically using the appropriate Naval Electronic Data Deliverable (NEDD) format for loading into NIRIS as defined in the NAVFAC NW SOPs (V5.0 or more current).

## 4.0 REFERENCES

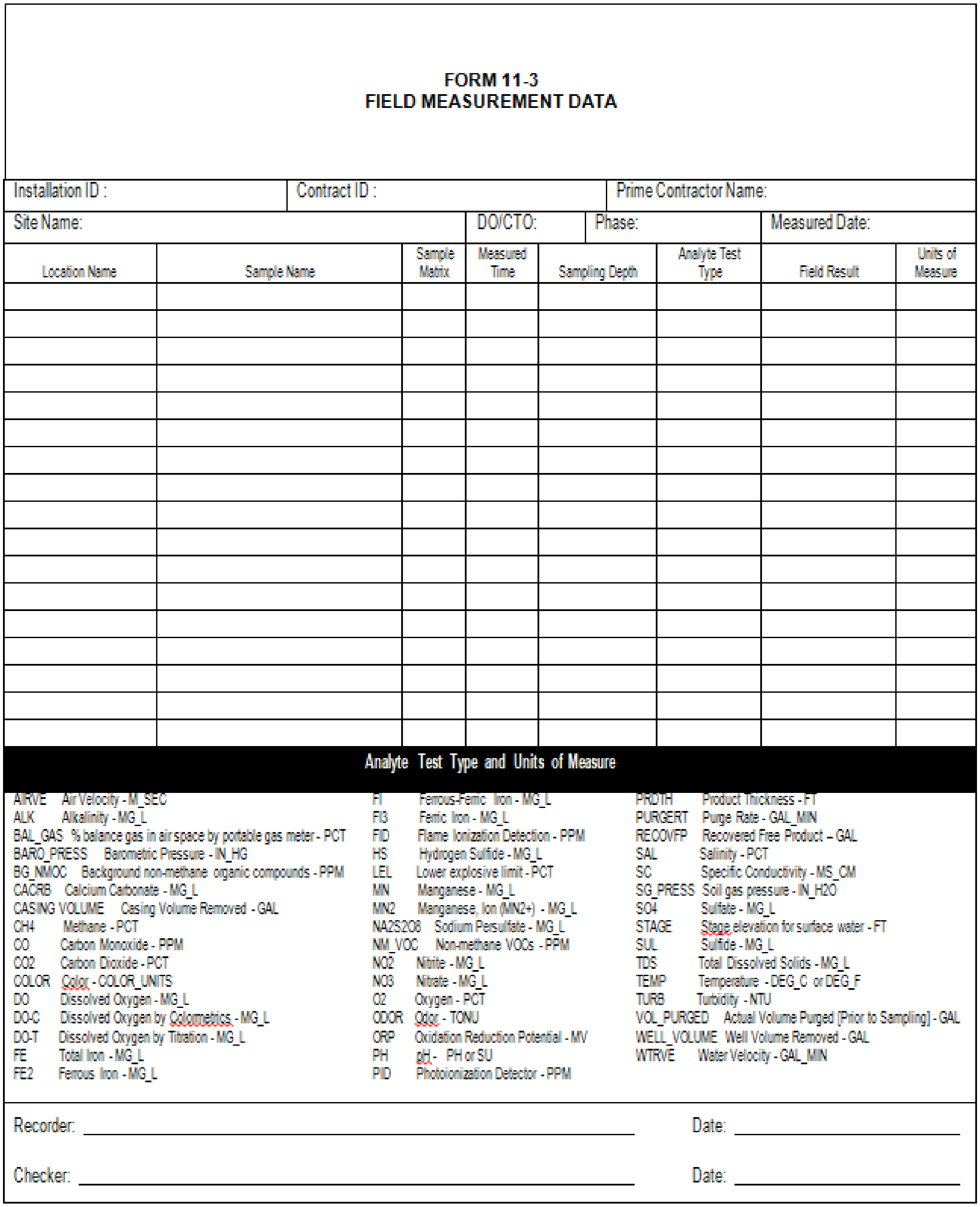
ASTM International. 2003. D6771-02 Standard Practice for Low-flow Purging and Sampling Wells and Devices Used for Groundwater Quality Investigations

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment I-D-7-1 | Example Field Measurement Data form |

Revised March 2015



## FORM 11-3
## FIELD MEASUREMENT DATA

| | | |
|---|---|---|
| Installation ID : | Contract ID : | Prime Contractor Name: |

| | | | |
|---|---|---|---|
| Site Name: | DO/CTO: | Phase: | Measured Date: |

| Location Name | Sample Name | Sample Matrix | Measured Time | Sampling Depth | Analyte Test Type | Field Result | Units of Measure |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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### Analyte Test Type and Units of Measure

AIRVE Air Velocity - M_SEC
ALK Alkalinity - MG_L
BAL_GAS % balance gas in air space by portable gas meter - PCT
BARO_PRESS Barometric Pressure - IN_HG
BG_NMOC Background non-methane organic compounds - PPM
CACRB Calcium Carbonate - MG_L
CASING VOLUME Casing Volume Removed - GAL
CH4 Methane - PCT
CO Carbon Monoxide - PPM
CO2 Carbon Dioxide - PCT
COLOR Color - COLOR_UNITS
DO Dissolved Oxygen - MG_L
DO-C Dissolved Oxygen by Colometrics - MG_L
DO-T Dissolved Oxygen by Titration - MG_L
FE Total Iron - MG_L
FE2 Ferrous Iron - MG_L
FI Ferrous-Ferric Iron - MG_L
FI3 Ferric Iron - MG_L
FID Flame Ionization Detection - PPM
HS Hydrogen Sulfide - MG_L
LEL Lower explosive limit - PCT
MN Manganese - MG_L
MN2 Manganese, Ion (MN2+) - MG_L
NA2S2O8 Sodium Persulfate - MG_L
NM_VOC Non-methane VOCs - PPM
NO2 Nitrite - MG_L
NO3 Nitrate - MG_L
O2 Oxygen - PCT
ODOR Odor - TONU
ORP Oxidation Reduction Potential - MV
PH pH - PH or SU
PID Photoionization Detector - PPM
PRDTH Product Thickness - FT
PURGERT Purge Rate - GAL_MIN
RECOVFP Recovered Free Product – GAL
SAL Salinity - PCT
SC Specific Conductivity - MS_CM
SG_PRESS Soil gas pressure - IN_H2O
SO4 Sulfate - MG_L
STAGE Stage elevation for surface water - FT
SUL Sulfide - MG_L
TDS Total Dissolved Solids - MG_L
TEMP Temperature - DEG_C or DEG_F
TURB Turbidity - NTU
VOL_PURGED Actual Volume Purged [Prior to Sampling] - GAL
WELL_VOLUME Well Volume Removed - GAL
WTRVE Water Velocity - GAL_MIN

Recorder: ______________________________ Date: ______________

Checker: ______________________________ Date: ______________

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NAVFAC NW Standard Operating Procedure Number:

I-D-8

Revised March 2015

# HEADSPACE ANALYSIS

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## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for performing headspace analysis of soil samples. The SOP will provide descriptions of equipment and procedures for field screening of soil samples. This procedure provides real-time data for soil removal operations, where decisions regarding the extent of soil drilling, excavation, trenching, and disposal must be determined on site. Using this method, the number of soil samples that are to be submitted to a commercial laboratory may be reduced.

## 2.0 PROCEDURES

### 2.1 EQUIPMENT

The following equipment is required for headspace analysis:

- Clean glass sample containers
- Zip-lock plastic bags
- Paper towels
- Aluminum foil
- Organic vapor analyzer equipped with a photoionization detector (PID)
- Waterproof/permanent marking pens
- Field notebook
- Equipment Calibration Log
- Appropriate PPE and Health and Safety Plan

### 2.2 COLLECTION METHOD

Follow the procedures below for the proper collection of headspace analysis:

1. Collect soil sample using a split-spoon sampler, hand auger, or other apparatus, which will yield a soil core or intact sample.
2. Transfer approximately 100 cubic centimeters of sample to a sealable plastic bag or fill the glass container half full. If a glass container is used, cover the mouth of the container with aluminum foil then screw the lid back on the container.

3. Agitate the sample in the bag or container in order to break up the soil matrix and maximize the surface area of soil that is in contact with the headspace. Allow the sample to equilibrate with the headspace for 15 to 30 minutes. Attempt to keep the samples between 50ºF and 80ºF.
4. Insert the instrument probe inside the bag or container. If the headspace sample is in a glass container, analyze by removing the lid and inserting the instrument probe through the foil liner. Care must be taken in the selection of appropriate foil, foil placement over the mouth of the container, and removal of the lid so as not to compromise the integrity of the seal. If the seal has been compromised, this will be recorded appropriately or collect a new sample if possible.
5. Read the concentration of the organic vapors after a pre-determined equilibration period has elapsed (approximately 10 to 20 seconds) or after the instrument read-out has stabilized.
6. Record the organic vapor concentration and the gross physical characteristics of the sample (e.g., dry, wet, sandy, discolored).

### 2.3 ORGANIC VAPOR ANALYZER SELECTION

The selection of the appropriate organic vapor analyzer equipped with either a photo ionization detector (PID) or a flame ionization detector (FID) shall be based on the contaminants of concern and/or ambient conditions at the respective site. The lamp selected for the PID, where applicable, will be based on the relative ionization potentials of the expected volatile contaminants.

### 2.4 CALIBRATION

The instrument(s) selected for use in accordance with data quality objectives and site requirements shall be calibrated according to the manufacturer’s recommendations and specifications. Calibration information shall be recorded on the equipment calibration log and in the field notebook, see Documentation, Section 3.0.

## 3.0 DOCUMENTATION

All procedures and field conditions shall be recorded in the field logbook. The record shall include a description of the material being screened as well as site conditions such as humidity and the equilibration time and temperature.

The following records will be made in the field logbook:

- Date
- Time
- Personnel
- Weather
- Deviation from this SOP
- Readings collected

- Containers used
- Equipment used
- Calibration performed
- Matrix description

All entries in the field logbook must be printed in black ink and legible.

## 4.0 REFERENCES

None.

## 5.0 ATTACHMENTS

None.

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# SOIL AND ROCK CLASSIFICATION

## 1.0 PURPOSE

This section sets forth standard operating procedures (SOPs) for soil and rock classification to be used by U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and their contractors.

## 2.0 PROCEDURES

### 2.1 SOIL CLASSIFICATION

The basic purpose of the classification of soils is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system for the NAVFAC NW. The Unified Soil Classification System (USCS) was developed so that soils could be described on a common basis by different investigators and serves as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soils on a common basis is essential so that soils described by different site qualified personnel are comparable. Site individuals describing soils, as part of NAVFAC NW site activities, must use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities at NAVFAC NW sites.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log or logbook. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes and maximum particle size
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions such as consistency, density, structure, etc.
- USCS classification symbol

The USCS serves as a "shorthand" for classifying soil into 15 basic groups:

| | |
|---|---|
| GW[1] | Well graded (poorly sorted) gravel (>50% gravel, <5% fines) |
| GP[1] | Poorly graded (well sorted) gravel (>50% gravel, <5% fines) |
| GM1 | Silty gravel (>50% gravel, >15% silt) |
| GC1 | Clayey gravel (>50% gravel, >15% clay) |
| SW1 | Well graded (poorly sorted) sand (>50% sand, <5% fines) |
| SP1 | Poorly graded (well sorted) sand (>50% sand, <5% fines) |
| SM1 | Silty sand (>50% sand, >15% silt) |
| SC1 | Clayey sand (>50% sand, >15% clay) |
| ML2 | Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness and plasticity) |
| L2 | Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity) |
| MH2 | Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity) |
| CH2 | Inorganic, high plasticity (fat) clay (no dilatancy, high toughness and plasticity) |
| OL | Organic low plasticity silt or organic silty clay |
| OH | Organic high plasticity clay or silt |
| PT | Peat and other highly organic soils |

1 If percentage of fines is 5% to 15%, a dual identification shall be given (e.g., a soil with more than 50% poorly sorted gravel and 10% clay is designated GW-GC.

2 If the soil is estimated to have 15% to 25% sand or gravel, or both, the words "with sand" or "with gravel" (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30% or more sand or gravel, or both, the words "sandy" or "gravelly" (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use "sandy."

Figure I-E-1 defines the terminology of the USCS. Flowcharts presented in Figures I-E-2 and I-E-3 indicate the process for describing soils. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification, e.g., SC/CL, if the soil has been identified as having properties that do not distinctly place the soil into one group.

### 2.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. To become proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below.

1. Select a representative sample (approximately 1/2 of a 6-inch long by 2.5 inch diameter sample liner.)
2. Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.
3. Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch.
4. Considering the rest of the sample, estimate and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).
5. Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).
6. Estimate percentages to the nearest 5%. If one of the components is present in a quantity considered less than 5%, indicate its presence by the term "trace".
7. The percentages of gravel, sand, and fines must add up to 100%. "Trace" is not included in the 100% total.

## Figure I-E-1
## Unified Soil Classification System (USCS)

**DEFINITION OF TERMS**

| MAJOR DIVISIONS | | | SYMBOLS | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|
| **COARSE GRAINED SOILS** More Than Half of Material is Larger Than No. 200 Sieve Size | **GRAVELS** More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve | **CLEAN GRAVELS** (Less than 6% Fines) | **GW** | Well graded gravels, gravel-sand mixtures, little or no fines |
| | | | **GP** | Poorly graded gravels, gravel-sand mixtures, little or no fines |
| | | **GRAVELS** With Fines | **GM** | Silty gravels, gravel-sand-silt mixtures, non-plastic fines |
| | | | **GC** | Clayey gravels, gravel-sand-clay mixtures, plastic fines |
| | **SANDS** More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve | **CLEAN SANDS** (Less than 6% Fines) | **SW** | Well graded sands, gravelly sands, little or no fines |
| | | | **SP** | Poorly graded sands, gravelly sands, little or no fines |
| | | **SANDS** With Fines | **SM** | Silty sands, sand-silt mixtures, non-plastic fines |
| | | | **SC** | Clayey sands, sand-clay mixtures, plastic fines |
| **FINE GRAINED SOILS** More Than Half of Material is Smaller Than No. 200 Sieve Size | **SILTS AND CLAYS** Liquid Limit is Less Than 50% | | **ML** | Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines |
| | | | **CL** | Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays |
| | | | **OL** | Organic silts and organic silty clays of low plasticity |
| | **SILTS AND CLAYS** Liquid Limit is Greater Than 50% | | **MH** | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt |
| | | | **CH** | inorganic clays of high plasticity, fat clays |
| | | | **OH** | Organic clays of medium to high plasticity, organic silts |
| **HIGHLY ORGANIC SOILS** | | | **PT** | Peat and other highly organic soils |

**GRAIN SIZES**

| SILTS AND CLAYS | SAND | | | GRAVEL | | COBBLES | BOULDERS |
|---|---|---|---|---|---|---|---|
| | FINE | MEDIUM | COARSE | FINE | COARSE | | |

200 40 10 4 3/4" 3" 12"

U.S. STANDARD SERIES SIEVE CLEAR SQUARE SIEVE OPENINGS

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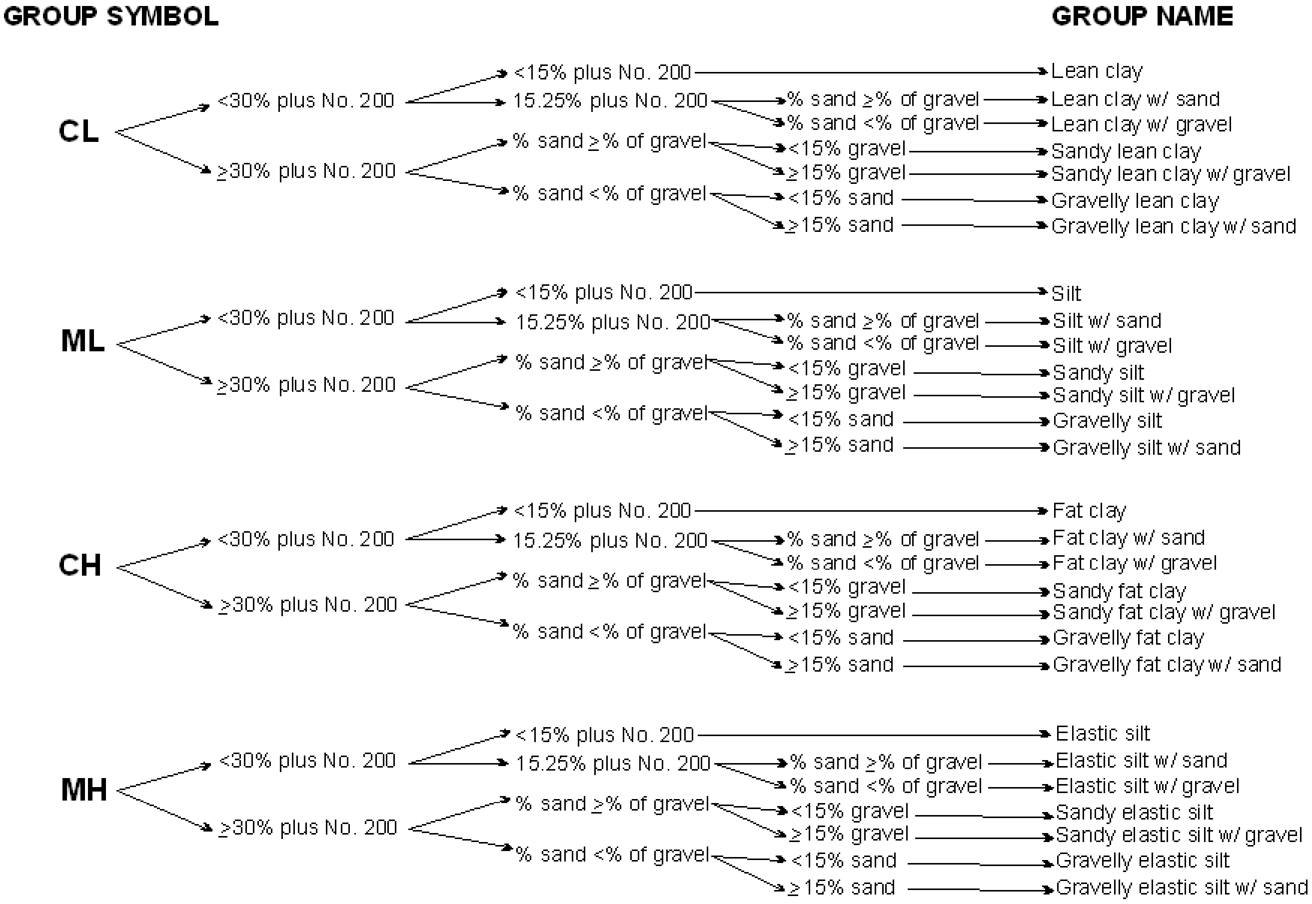
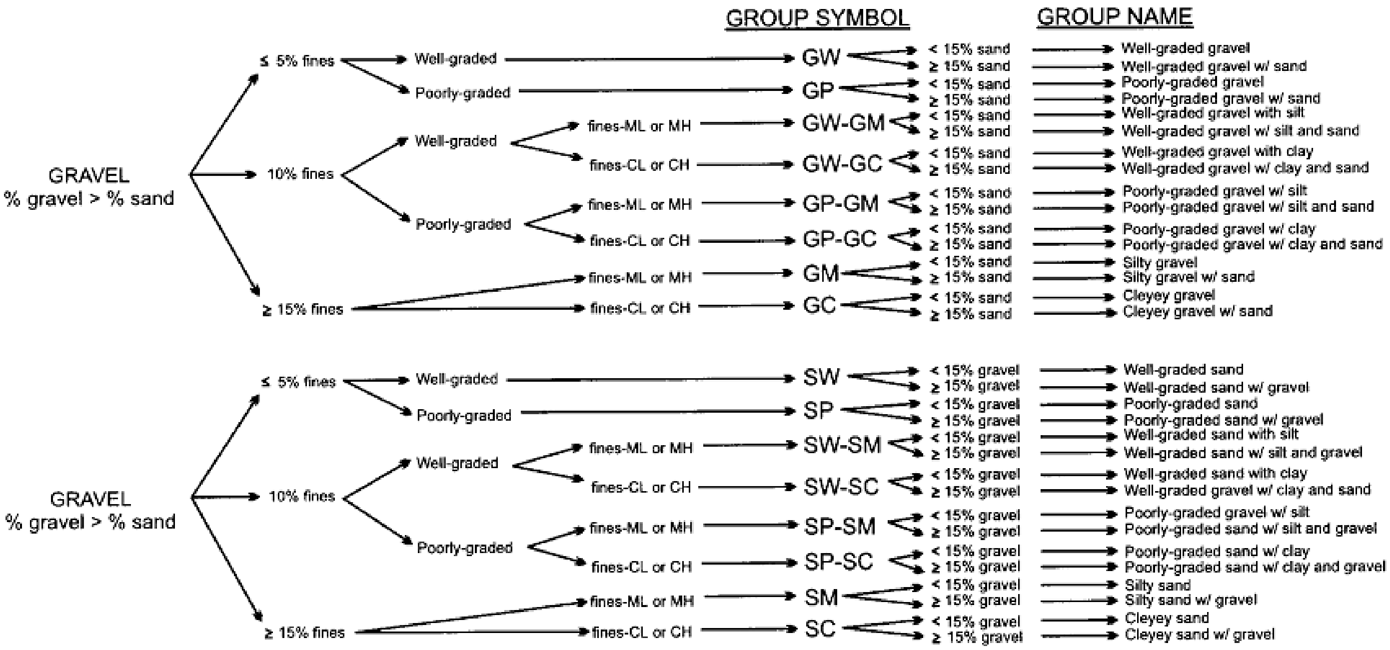
## Figure I-E-2
## Flow Chart for Fine Grain Soils Classification



## Figure I-E-3
## Flow Chart for Soils with Gravel



## 2.1.2 Soil Dilatancy, Toughness, and Plasticity

### *2.1.2.1 Dilatancy*

To evaluate dilatancy, the following procedures shall be followed:

1. From the specimen, select enough material to mold into a ball about 1/2 inch (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
2. Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table I-E-1. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

**Table I-E-1**
**Criteria for Describing Dilatancy**

| Description | Criteria |
|---|---|
| None | No visible change in specimen. |
| Slow | Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing. |
| Rapid | Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing. |

### *2.1.2.2 Toughness*

Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table I-E-2.

**Table I-E-2**
**Criteria for Describing Toughness**

| Description | Criteria |
|---|---|
| Low | Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft. |
| Medium | Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness. |
| High | Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness. |

#### *2.1.2.3 Plasticity*

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials are defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, water should be added prior to performing classification. If a soil sample is too sticky, the sample should be spread thin and allowed to lose some soil moisture.

The criteria for describing plasticity in the field, using the rolled thread method, are presented in Table I-E-3.

**Table I-E-3**
**Criteria for Describing Plasticity**

| Description | Criteria |
|---|---|
| Non-Plastic | A 1/8-inch thread cannot be rolled. |
| Low plasticity | The thread can barely be rolled. |
| Medium plasticity | The thread is easy to roll and not much time is required to reach the plastic limit. |
| High plasticity | It takes considerable time rolling the thread to reach the plastic limit |

### 2.1.3 Angularity

The angularity of the coarse sand and gravel particles is described according to the following criteria:

- Rounded—particles have smoothly-curved sides and no edges;
- Subrounded-particles have nearly plane sides, but have well-rounded corners and edges;
- Subangular—particles are similar to angular, but have somewhat rounded or smooth edges; and
- Angular—particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

### 2.1.4 Color, Moisture, and Odor

The natural moisture content of soils is very important information. The terms for describing the moisture condition and the criteria for each are shown in Table I-E-4.

**Table I-E-4**
**Soil Moisture Content Qualifiers**

| Qualifier | Criteria |
|---|---|
| Dry | Absence of moisture, dry to the touch |
| Moist | Damp but no visible water. |
| Wet | Visible water, usually soil is below water table |

Color is described by hue and chroma using the Munsell Soil Color Chart. For the sake of uniformity, all site geologists shall utilize this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists The Munsell color chart is a small booklet of numbered color chips with names like "5YR 5/6, yellowish-red". Mottling or banding of colors should be noted. It is particularly important to note and describe staining because it may indicate contamination.

If odors are noted, they should be described if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer (OVA) may be used to detect the presence of volatile organic contaminants. In general, respirators should be worn if strong organic odors are present.

### 2.1.5 In-place Conditions

The conditions of undisturbed soil samples shall be described in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

#### *2.1.5.1 Density/Consistency*

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term "density" is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term "consistency" is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 lbs. (63.5 kg) dropped over a distance of 30 inches (0.76 m). The number of blows required to penetrate each 6 inches of soil is recorded in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the "standard penetration resistance," or the "N-value." The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch I.D. Modified California Sampler equipped with brass or stainless steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

The sampler should be driven and blow counts recorded for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed "refusal" and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, the number of blows per partial increment shall be recorded on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Representative descriptions of soil density/consistency vs. N-values are presented in Table I-E-5.

### Table I-E-5a
### Measuring Soil Density with A California Sampler
### Relative Density (Sands, Gravels)

|  | **Field Criteria (N-Value)** |  |
|---|---|---|
| **Description** | **1 3/8" I.D. Sampler** | **2" I.D. Sampler using 1.43 factor** |
| Very loose | 0-4 | 0-6 |
| Loose | 4-10 | 6-14 |
| Medium dense | 10-30 | 14-43 |
| Dense | 30-50 | 43-71 |
| Very Dense | >50 | >71 |

### Table I-E-5b
### Measuring Soil Density with a California Sampler Consistency:
### Fine-Grained Cohesive Soils

|  | **Field Criteria (N-Value)** |  |
|---|---|---|
| **Description** | **1 3/8" I.D. Sampler** | **2" I.D. Sampler using 1.13 factor** |
| Very soft | 0-2 | 0-2 |
| Soft | 2-4 | 2-4 |
| Medium Stiff | 4-8 | 4-9 |
| Stiff | 8-16 | 9-18 |
| Very Stiff | 16-32 | 18-36 |
| Hard | >32 | >36 |

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot (PSF). The values are as follows:

**Table I-E-6**
**Measuring Soil Consistency with a Hand-held Penetrometer**

| Description | Pocket Penetrometer Reading (PSF) |
|---|---|
| Very Soft | 0 to 250 |
| Soft | 250 to 500 |
| Medium Stiff | 500 to 1000 |
| Stiff | 1000 to 2000 |
| Very Stiff | 2000 to 4000 |
| Hard | >4000 |

Consistency can also be estimated using thumb pressure using the following table:

**Table I-E-7**
**Measuring Soil Consistency Using Thumb Pressure**

| Description | Criteria |
|---|---|
| Very soft | Thumb will penetrate soil more than 1 inch (25 mm) |
| Soft | Thumb will penetrate soil about 1 inch (25 mm) |
| Firm | Thumb will penetrate soil about 1/4 inch (6 mm) |
| Hard | Thumb will not indent soil but readily indented with thumbnail |
| Very hard | Thumbnail will not indent soil |

#### *2.1.5.2 Cementation*

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

| | | |
|---|---|---|
| Quartz | - | siliceous; |
| Chert | - | chert-cemented or chalcedonic; |
| Opal | - | opaline; |
| Carbonate | - | calcitic, dolomitic, sideritic (if in doubt, calcareous should be used); |
| Iron oxides | - | hematitic, limonitic (if in doubt, ferruginous should be used); |
| Clay minerals | - | if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as "kaolin-cemented," "chlorite-cemented," etc. |
| Miscellaneous minerals | - | pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc. |

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

| | | |
|---|---|---|
| Weak | - | friable, crumbles or breaks with handling or slight finger pressure; |
| Moderate | - | friable, crumbles or breaks with considerable finger pressure; |
| Strong | - | not friable, will not crumble or break with finger pressure. |

### *2.1.5.3 Structure*

This variable is used to qualitatively describe physical characteristics of soils that are important to incorporate into hydrogeological or geotechnical descriptions of soils at a site. Appropriate soil structure descriptors are as follows:

Granular - spherically-shaped aggregates with faces that do not accommodate adjoining faces.

Stratified - alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness.

Laminated - alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness.

Blocky - cohesive soil that can be broken down into small angular or subangular lumps that resist further breakdown.

Lensed - inclusion of a small pocket of different soils, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soils are present, the soil being described can be termed homogeneous if the description of the lenses is included.

Prismatic or Columnar - particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top.

Platy - particles are arranged about a horizontal plane.

#### *2.1.5.4 Other Features*

Mottled - soil that appears to consist of material of two or more colors in blotchy distribution.

Fissured - breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)

Slickensided - fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

### 2.1.6 Development of Soil Description

Standard soil descriptions will be developed according to the following examples. There are three principal categories under which all soils can be classified. They are described below.

#### *2.1.6.1 Coarse-grained Soils*

Coarse-grained soils are divided into sands and gravels. A soil is classified as a sand if over 50% of the coarse fraction is "sand-sized." It is classified as a gravel if over 50% of the coarse fraction is composed of "gravel-sized" particles. The written description of a coarse-grained soil shall contain, in order of appearance:

Typical name including the second highest percentage constituent as an adjective, if applicable (underlined), grain size of coarse fraction, Munsell color and color number, moisture content, relative density, sorting, angularity, other features such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts, etc.) in parentheses.

Example: Poorly-sorted SAND with SILT, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately

20% coarse-grained sand-sized shell fragments, and 80% medium-grained quartz sand, and 5% to 15% ML).

#### *2.1.6.2 Fine-grained Soils*

Fine-grained soils are further subdivided into clays and silts according to their plasticity. Clays are rather plastic, while silts have little or no plasticity. The written description of a fine-grained soil should contain, in order of appearance:

Typical name including the second highest percentage constituent as an adjective, if applicable (underlined), Munsell color, moisture content, consistency, plasticity, other features such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: SANDY Lean CLAY, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70% fines, 30% sand, with minor amounts of disarticulated bivalves (about 5%)).

#### *2.1.6.3 Organic Soils*

For highly organic soils, the types of organic materials present will be described as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, from black to brown, when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

Example: ORGANIC CLAY, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100% fines), weak reaction to HCl.

### 2.2 ROCK CLASSIFICATION

The purpose of rock classification is to thoroughly describe the physical and mineralogical characteristics of a specimen and to classify it according to an established system. The generalized rock classification system described below was developed for NAVFAC NW because, unlike the USCS for soils, there is no universally accepted rock classification system. In some instances, a more detailed and thorough rock classification system may be appropriate. Any modifications to this classification system, or the use of an alternate classification system should be considered during preparation of the site Work Plan and Field Sampling Plan. Both the Project Manager and the Technical Director/QA Program Manager must approve modifications to this classification system, or the use of another classification system.

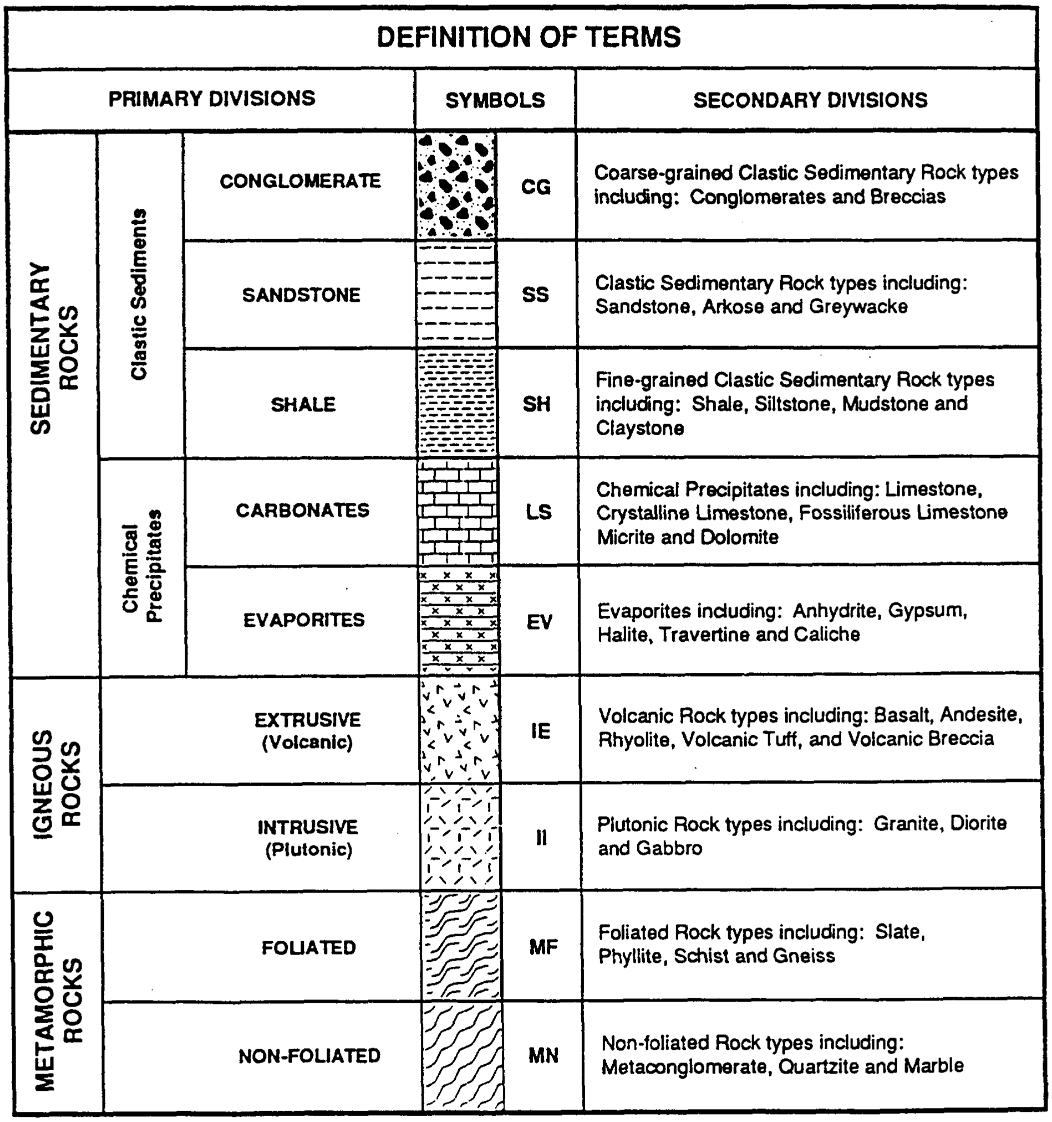
Describing rock specimens on a common basis is essential so that rocks described by different site geologists are comparable. Site geologists describing rock specimens as a part of NAVFAC NW activities must use the classification system described herein, or if necessary, another more detailed classification system. Use of a common classification system provides the most useful geologic database for all present and future subsurface investigations and remedial activities at NAVFAC NW sites.

In order to provide a more consistent rock classification between geologists, a rock classification template has been designated as shown in Figure I-E-4. The template includes classification of rocks by origin and mineralogical composition. All site geologists when classifying rocks shall use this template.

The site geologist shall describe the rock specimen and record the description in a borehole log or logbook. The items essential in any written rock description are as a Classification group (i.e., metamorphic foliated).

Revised March 2015

## Figure I-E-4
## Rock Classification System



**DEFINITION OF TERMS**

| PRIMARY DIVISIONS | | | SYMBOLS | | SECONDARY DIVISIONS |
|---|---|---|---|---|---|
| SEDIMENTARY ROCKS | Clastic Sediments | CONGLOMERATE | | CG | Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias |
| | | SANDSTONE | | SS | Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke |
| | | SHALE | | SH | Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone |
| | Chemical Precipitates | CARBONATES | | LS | Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite |
| | | EVAPORITES | | EV | Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche |
| IGNEOUS ROCKS | | EXTRUSIVE (Volcanic) | | IE | Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia |
| | | INTRUSIVE (Plutonic) | | II | Plutonic Rock types including: Granite, Diorite and Gabbro |
| METAMORPHIC ROCKS | | FOLIATED | | MF | Foliated Rock types including: Slate, Phyllite, Schist and Gneiss |
| | | NON-FOLIATED | | MN | Non-foliated Rock types including: Metaconglomerate, Quartzite and Marble |

- Classification Name (i.e., schist)
- Color
- Mineralogical composition and percent
- Texture/Grain size (i.e., fine-grained, pegmatitic, aphlitic, glassy, etc.)
- Structure (i.e., foliated, fractured, lenticular, etc.)
- Rock Quality Designation (sum of all core pieces greater than two times the diameter of the core divided by the total length of the core run, expressed as a percentage) and
- Classification symbol (i.e., MF).

Example: <u>Metamorphic foliated schist</u>: Olive gray, 5Y, 3/2, Garnet 25%, Quartz 45%, Chlorite 15%, Tourmaline 15%, Fine-grained with Pegmatite garnet, highly foliated, slightly wavy, MF

## 3.0 DOCUMENTATION

Soil classification information collected during soil sampling should be documented onto the field boring logs, field trench logs, and into the field notebook. Copies of the field boring log form are presented in SOP I-B-1, *Soil Sampling*. Copies of this information shall be placed in the project files and reviewed by the Project Manager on a monthly basis at a minimum. If specified in the project SAP, lithologic data should also be submitted electronically in the appropriate Naval Environmental Data Deliverable (NEDD) format as defined in the NAVFAC NW SOPs (V5.0 or more current).

## 4.0 REFERENCES

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## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-F

Revised March 2015

# DIRECT PUSH SAMPLING TECHNIQUES

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## 1.0 PURPOSE

This section describes the standard operating procedures (SOP) for direct push sampling techniques to be used by all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) field personnel and contractors. Direct push techniques may be used as a cost-effective alternative to conventional drilling techniques for obtaining subsurface soil and groundwater samples.

## 2.0 PROCEDURES

### 2.1 METHOD SELECTION

The decision to use direct push techniques should be made on the basis of: (1) their ability to achieve the required information at the required level of quality control and (2) their cost effectiveness compared with conventional drilling methods. Major limitations of direct push techniques are their inability to penetrate rock or cobbles and a shallow maximum depth of penetration. The capabilities of direct push systems vary significantly with vendor and these differences must be considered when evaluating the applicability of the method to a specific subsurface exploration program.

### 2.2 EQUIPMENT

The following is an equipment list for items generally needed to perform direct push sampling:

- Direct push rig capable of installing borings to the desired depth in the expected formation materials and conditions
- Soil sampler(s) with disposable liners
- Retractable screen groundwater sampler(s)
- Peristaltic pump and tubing
- Sample containers with labels
- Bentonite pellets
- Bentonite Grout or Portland Type I or II cement and powdered bentonite for grouting
- High-pressure steamer/cleaner

- Long-handled bristle brushes
- Wash/rinse tubs
- Appropriate decontamination supplies as specified in the SOP for decontamination procedures
- Location map
- Plastic bags (re-sealable)
- Water level probe
- Deionized water
- Logbook
- Boring log sheets
- Drums for containment of cuttings and decontamination water

### 2.3 INSTRUMENT CALIBRATION

Before going into the field, the sampler should verify that field instruments are operating properly. Calibration times and readings should be recorded in a notebook to be kept by the field sampler. Specific instructions for calibrating the instruments are provided in the respective SOPs.

### 2.4 INSPECTION OF EQUIPMENT

Direct push equipment should be inspected for operational readiness prior to use in accordance with the manufacturer's recommendations, and for signs of fluid leakage, which could introduce contaminants to the soil. If, at any time during equipment operation, fluid is observed leaking from the rig, operations should cease and the leak immediately repaired or contained. All soil and other materials affected by the leak will be collected, containerized and labeled for proper disposal (see SOP I-A-7, *IDW Management*).

### 2.5 PREPARATION OF WORK SITE

Prior to field mobilization, the contracted, licensed well driller shall notify the appropriate state agency and obtain a "Start Card" for each location (if required). Installation-specific dig permits and outage requests may also be required. These shall be prepared by the NAVFAC NW contractor and provided to the installation public works department for processing.

The work site should be inspected prior to commencing operations to ensure that no overhead hazards exist that could impact the direct push equipment. In addition, locations planned for subsurface exploration should be cleared of utilities prior to initiation of work in accordance with SOP I-A-6 *Permit and Utility Clearance.* Hand excavation may be required in areas of dense utility corridors.

If the work is to be performed on a grade, the direct push rig should be located so that it is down-slope from the penetration point. The rig should be located downwind or crosswind of the penetration point, if possible. Required exclusion zones and decontamination areas should be established using plastic tape or cones to designate the various areas, in accordance with the site-specific HASP. If needed, traffic control should be established with the site-specific traffic control plan or outage permit.

## 2.6 EQUIPMENT DECONTAMINATION

To avoid cross-contamination, all equipment used for direct push exploration and sampling should be thoroughly decontaminated as described in SOP III-I, *Equipment Decontamination*. All sampling tools and down hole equipment must be decontaminated between each sampling event and if necessary between penetration points. At a minimum, equipment must be steam cleaned or undergo the wash and rinse process. All wash and rinse water should be collected, containerized and labeled for proper disposal. Clean equipment (e.g., drive rods and samplers) should not come into contact with contaminated soils or other contaminated materials.

## 2.7 SOIL SAMPLING

Vendors of direct push equipment offer a variety of sampling systems designed specifically for their equipment. Both continuous and discreet soil samples may be obtained using sampling equipment similar to that described in SOP I-B-1, *Soil Sampling*. The preferred methods for soil sampling using direct push techniques use stainless steel tube samplers with polyethylene terephthlate glycol (PETG) liners that are driven through the horizon to be sampled. Several sizes of core samplers are available, the most common being either 2 or 4-feet long. Liners can either be capped and sent directly to a laboratory, or cut open for field screening and grab sample (jar) collection.

## 2.8 GROUNDWATER SAMPLING

Direct push technologies offer numerous methods for obtaining groundwater samples. Depth-specific groundwater samples can be collected using a disposable-point, retractable screen mechanism that enables the collection of a one-time groundwater sample. Alternatively, “mini” wells can be installed using pre-pack screens or constructed as small diameter, traditional monitoring wells for longer term, repeatable sampling. Respective state regulations shall be consulted prior to installing “mini” wells because a construction variance is often required.

It is the responsibility of the Project Manager to evaluate and determine the appropriateness of direct push systems prior to committing to their use on any project involving groundwater sampling. New technologies are developed every several years and vendors should be consulted to determine if newer technologies are available which will provide quality performance.

Unless specified in the field sampling plan, low-flow purging is generally not performed for samples collected using direct push techniques. The procedures described below are the accepted industry standard for the collection of groundwater samples using direct push sampling devices. In circumstances where contaminants of concern may be biased due to higher turbidity readings (inorganics), purging the groundwater sampler until the water is relatively clear may result in less biased readings. This determination should be made during project planning.

### 2.8.1 Manual Pumping

The following procedures describe direct-push groundwater sample collection using manual pumping to extract groundwater samples.

1. Attach the retractable sampling screen to the bottom of a steel rod. Push the rod below ground surface with a hydraulic lever attached to the truck. Connect rods together to reach the predetermined depth.

2. When the depth is reached, remove the plug at the top of the screen and lift the push rod string back approximately 4 feet to expose the sampling screen. Install a ball check valve at the bottom of the LDPE tubing and insert the tubing (check valve first) into the push rod string. Insert the tubing to the bottom of the push rod string. Lift the tubing up and down by hand to bring water to the surface. Purge a small amount of water (< 1 liter) prior to sample collection.

3. Transfer the sample to the laboratory sample containers.

### 2.8.2 Peristaltic Pumping

Follow the same procedures as described for manual pumping. Attach the LDPE tubing to the peristaltic pump and operate the pump to retrieve a sample. A tubing check valve is not required for this method.

## 2.9 BOREHOLE ABANDONMENT

Methods for abandoning boreholes created with direct push systems will vary among vendors. The desired method for abandonment must be coordinated with the vendor in the planning stages of the project to ensure that proper abandonment will be achieved. All abandonment activities must conform to applicable state regulations.

Some direct push boreholes will close naturally as the drive rods and sampling tools are withdrawn. This may occur in loose, unconsolidated soils, such as sands. However, all boreholes should be closed using one of the procedures described in this SOP, unless natural caving precludes such closure.

The three methods for closing direct push boreholes are

1. Adding granulated or pelletized bentonite and hydrating in layers, proceeding from the bottom of the hole to the surface.

2. Pouring a grout mixture into the hole.

3. Filling the entire hole with granular or pelletized bentonite and hydrating by means of a previously emplaced water tube that is gradually withdrawn as water is supplied to the bentonite.

The first method is recommended in shallow borings. The second method is recommended at deeper borings or where groundwater has been encountered. When grouting, a tremie pipe should be used to ensure that the grout mix is emplaced from the bottom to the top of the borehole. The tremie pipe should be lowered to within 2 inches of the bottom and gradually withdrawn as grout is added, keeping the lower end of the pipe submerged in grout at all times.

Bentonite grout is preferred when abandoning borings. If cement grout is used, the recommended grout mixture for well abandonment is 7 to 9 gallons of water per 94-pound bag of Portland cement, with 3% to 5% by weight of powdered bentonite added to the mixture. Commercial grout products are recommended to achieve the correct proportions.

Boreholes should be sealed to within 0.5 to 2.0 feet of the surface. The abandoned borehole should be inspected after 24 hours to ensure that shrinkage of the grout does not occur. If significant shrinkage has occurred, the borehole should be re-grouted. The remaining portion of the hole can be filled with local topsoil, or appropriate paving materials.

## 3.0 DOCUMENTATION

Soil classification information, sample information and all other pertinent information collected during soil sampling should be documented into the field logbook with indelible ink in accordance with SOP III-D, *Logbooks*. A borehole log form (or equivalent) (see SOP I-B-1, *Soil Sampling*) may be filled out in addition to the field logbook. Copies of this information should be sent to the Project Manager and to the project files.

## 4.0 REFERENCES

SOP I-A-7, *IDW Management*

SOP I-B-1, *Soil Sampling*

SOP III-D *Logbooks*

SOP III-I, *Equipment Decontamination*

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-G-1

Revised August 2014

# LAND SURVEYING

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## 1.0 PURPOSE

This standard operating procedure (SOP) sets forth protocols for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.

## 2.0 PROCEDURES

The procedures listed below shall be followed during land surveying conducted for NAVFAC Northwest.

- All surveying work shall be performed under the direct supervision of a land surveyor registered in the state or territory in which the work is being performed (i.e. a Professional Land Surveyor, PLS).
- Survey instruments shall be calibrated in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall have been calibrated no more than 6 months prior to the start of the survey work.
- Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration (NOAA) standards and at the minimum accuracy standards set forth below. The horizontal accuracy for location of all grid intersection and planimetric features shall be (±) 0.1 feet. The horizontal accuracy for boundary surveys shall be one in ten thousand feet (1:10,000). The vertical accuracy for ground surface elevations shall be (±) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (±) 0.01 feet.
- Surveys shall be referenced to the local established coordinate systems and all elevations and benchmarks established shall be based on North American Vertical Datum of 1988.
- Surveyed points shall be referenced to Mean Sea Level (Mean Lower Low Water Level).
- Appropriate horizontal and vertical control points shall be jointly determined prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates and elevations. All surveyed locations shall be mapped using a base map or other site mapping specified by the Project Manager.

- All surveys shall begin and end at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Pins shall be driven to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. They shall be clearly marked with brightly colored weatherproof flagging and paint.
- The point on a monitoring well casing that is surveyed shall be clearly marked by filing grooves into the casing on either side of the surveyed point.

## 3.0 DOCUMENTATION

Using generally accepted practices, field notes shall be recorded daily by the surveyor in paper or electronic format. The data shall be neat, legible and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and submitted to the Navy or designee.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey
- General weather conditions
- The name of the surveying firm
- The names and job titles of personnel performing the survey work
- Equipment used, including serial numbers
- Field book designations, including page numbers.

Drawings and calculations submitted by the surveyor shall be signed, sealed and certified by a land surveyor registered (PLS stamped) in the state or territory in which the work was done.

Dated records of land surveying equipment calibration shall be provided by the surveyor along with equipment serial numbers and calibration records.

## 4.0 REFERENCES

The detailed requirements in the Geographic Data, Survey Specifications subsection of the parent compendium (NAVFAC Northwest SOPs V5.0) also apply and are not repeated here in this field procedure. These should be consulted as part of any Land Surveying effort. In addition, NAVFAC Northwest Cadastral Team, Record of Survey or other requirements may apply to the project, an example of their requirements can be found with the Survey Specifications referenced above.

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

I-G-2

Revised August 2014

# GPS SURVEYING

## 1.0 PURPOSE

This standard operating procedure (SOP) sets forth the protocols for recording and processing Global Positioning System (GPS) data. This document describes GPS data management for field data collection referencing Trimble systems including Pro 6T/6H, GeoXH 6000, Geo 7x or other handheld units capable of obtaining sub-meter accuracy.

## 2.0 PROCEDURE

### 2.1 PROCESS OVERVIEW

Surveyors typically collect GPS data using a data logger and record data both manually and electronically. In addition to the field forms and electronic field data, each surveyor maintains field notebooks summarizing their observations and other pertinent field data. The electronic data is exported electronically from the device, post-processed (if applicable), and then imported into GIS or CAD software.

In many areas of the U.S., GPS data can be recorded in real-time using the Coast Guard Differential GPS beacon system, Omnistar® or other satellite service. However, random positional errors can be encountered when collecting real-time data that makes positional validation difficult. Therefore, it is important to post-process all GPS data if corrections are not applied in real-time. Post-processing removes the random drift of the GPS positional signal by correcting the field rover GPS unit against a GPS base station that has a known position. Most projects will use CORS (Continuously Operated Reference Station) base stations surveyed by the NGS (National Geodetic Survey) to provide the post-processing solutions. This is an accepted industry standard. Using Trimble GPS rover units corrected against CORS base stations should allow projects to achieve sub-meter positional accuracy.

### 2.2 FIELD DATA COLLECTION

The GPS equipment is portable and uses satellite technology to provide accurate location information. Each object or *feature* collected with a GPS data collector can be one of three shapes: a *point*, a *line*, or an *area / polygon*. Each feature has real-world coordinates, as well as descriptive information or *attributes* such as site name or type, or observations recorded. The location and attribute information gained from the GPS data collection effort can be integrated with existing base data.

Preparatory tasks completed prior to the start of GPS data collection and field work include preparation and loading of “waypoints” to GPS units for field navigation, development of a data dictionary / data structures or interactive data collection forms for collecting survey information, and unit configuration to ensure that only good quality GPS data is recorded.

### 2.2.1 GPS Operation

Data dictionaries / structures, electronic forms, GIS MXD files and base layer data can be loaded onto the GPS devices. These electronic files facilitate collection of field measurements directly into the GPS device. They also serve to standardize the data collection effort, verify proper data recording, and ensure that all required data fields are present. This approach also reduces the amount of equipment surveyors will need to carry when they are collecting their measurements.

### 2.2.2 GPS Accuracy

The accuracy of GPS receivers without real-time or post-processed differential correction is on the order of 100 meters / 330 feet (2dRMS). After differential correction, the horizontal accuracy of each position can be better than 50 cm / 1.6 feet (RMS) + 1 ppm times the distance between the base and rover. The vertical accuracy of each position can be sub-meter + 2 ppm times the distance between the base and rover. Using real-time corrections, the accuracy of each position can be as good as a submeter, but is subject to a number of operational conditions. Note: 2dRMS means that approximately 95% of the positions are within the specified value. RMS means that approximately 68% of the positions are within the specified value.

### 2.2.3 Increasing GPS Accuracy

To verify the positional accuracy of a survey, standard survey practice requires that a known control be recorded during a survey. At a minimum, one first-order NGS monument (or equivalent) must be recorded during the GPS survey for each day of the survey. Therefore, during post-processing, general errors in the base or rover GPS units may be revealed. However, in recording only one monument, there is no way of fixing the error (only in knowing that error exists). Ideally, three first-order NGS control points completely surrounding the survey area should be recorded during the survey day – ideally one at the start of the survey, and two at the end of the day. This will allow a Professional Land Surveyor (PLS)/GIS post-processor to be able to shift and rotate the data if serious positional errors are found with all three control points.

### 2.2.4 Field Data Recording

To ensure that only quality data is recorded, the following data collection settings are recommended for the GPS unit:

Number of Satellites: Over-determined 3D (>=5 satellites)

PDOP Mask: 6

SNR: 6

Elevation Mask: 15 degrees

### 2.2.5 Naming the Data Logger Files

File naming conventions should be developed for all electronic field data. The file name should include information about the field surveyor / crew, date stamp for when the data was collected, and a unique identifier for the file if more than one file is collected throughout the day. It is recommended that the user save data several times throughout the day in the rare case that a data file becomes corrupt. An example file naming convention is shown in the following example:

Field Data File: JGB_20140607_A

JGB: First, second, and third characters represent initials of GPS operator or field crew

20140607: YYYYMMDD

A: Eighth character represents a unique character if more than one file is collected in the day.

### 2.2.6 Base Station Data Processing

The field staff and the PLS/GIS specialist should review GPS data for attribute correctness. Then, the PLS/GIS specialist should post-processes the data. In the post-processing, the uncontrolled drift of the measurements recorded in the rover GPS units are corrected against the known drift recorded in the base station GPS units using Trimble Positions (or equivalent / most current) software. The .SSF file created by the GPS device is corrected by use of the base station data. The correction process converts the raw data file (.SSF) to a corrected file (.COR). In addition to post-processing to only one base station, the data can be post-processed to several base stations to give the data more positional accuracy. After post-processing, the data is converted to an ESRI file geodatabase or point file (.csv/.txt) for import to GIS or CAD software.

### 2.2.7 Field Staff Spatial/Attribute Review

After each survey, all field data should be reviewed by a field crew member for accuracy and completeness. This can be done during or after the post-processing as this review is performed only to ensure that the field crew assigned the proper attribute data to the file. Any incomplete data can be filled-in by referencing the field notes. Field staff compares the number of data points collected in the GPS device file to the number of data points listed on the field forms to make sure they match. During this step, the field crew checks to see that all of the data in the data file is accounted for.

### 2.2.8 PLS/GIS Specialist Post-Processing

For Trimble GPS units, Positions software is used to download the electronic file to review the source file content, and post-process the data. The post-processor reviews the data file to check the settings the GPS data was collected under by the field crew. This process ensures the field crew used the proper GPS configuration settings while collecting the data. Thereafter, the data is post-processed against a base station. Ideally, it is post-processed against a 5-second base station within close proximity to the survey site. The referenced Trimble GPS units should be able to achieve a horizontal accuracy of 50 cm / 1.6 feet (RMS) at a 1 km base line (distance from the base to the rover). Accuracy degrades by 1 ppm as the distance between the base station and the rover increases. For example, 1 mm of degradation occurs for every kilometer between the base and rover. Data must be captured within 500 km (310 miles) of the base station to obtain sub-meter accuracy (RMS). If a 5-second base is not available, a thirty-second base is acceptable as long as the rover GPS units are recording each position for a minimum of one minute. This process ensures both the rover and the base records a minimum of one epoch per location. Recorded time that is less than this amount causes the position to be interpolated by the software, decreasing its accuracy.

Every 100 km (62 miles) in distance between the rover and base adds 0.1 m (0.33 feet) to the positional accuracy. Therefore, it is best to use a base that is very close to the survey site.

To help guarantee sub-meter results at the 95% (2dRMS) level, three NGS control points can be surveyed as stated above in the "Increasing GPS Accuracy" section. Therefore, if the three NGS control points show corrected horizontal accuracy of 0.2 (0.66 feet) , 0.4 (1.31 feet), and 0.6 meters (2.0 feet) respectively, it can be determined that the average of those values reflects the relative GPS survey accuracy for that day, i.e. 0.4 meters (1.31 feet).

In addition, the GPS field survey positions can be post-processed against several base stations in a short amount of additional time. It also allows the PLS/GIS Specialist to verify the positional accuracy of the GPS data by computing average and standard deviation values for the field survey positions in relation to more than one base. Thus, ensuring there are no errors in the base correction.

The post-processing methods, GPS configuration settings, and GPS collection methods should be recorded in metadata documentation defending the stated accuracy of the GPS survey.

### 2.2.9 GIS File Production

After the geographic and attribute data has been reviewed, and the file has been post-processed, the data is exported to an ESRI file geodatabase or shapefile format for use in a GIS. A shapefile should only be used if a CAD platform is anticipated for map production. Alternatively, the data may also be exported in a simple ASCII point file (.csv or .txt) with delimiters separating attributes.

## 3.0 DOCUMENTATION

Surveyors shall record field notes daily using industry accepted practices. The data shall also be neat, legible and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be transferred to the Navy.

Surveyor's field notes / documentation shall, at a minimum, clearly indicate:

- The date of the survey
- General weather conditions
- The name of the surveying firm
- The names and job titles of personnel performing the survey work
- Equipment used, including serial numbers and calibration records
- Field book designations, including page numbers

Drawings and calculations submitted by the surveyor shall be signed, sealed and certified by a Professional Land Surveyor (PLS) registered in the state or territory in which the work was done. Dated records of land surveying equipment calibration and equipment serial numbers shall also be provided in the in the submitted documentation.

## 4.0 REFERENCES

The detailed requirements in the Geographic Data, Survey Specifications subsection of the parent compendium (NAVFAC Northwest SOPs V5.0) also apply and are not repeated here in this field procedure. These should be consulted as part of any GPS Surveying effort. In addition, NAVFAC Northwest Cadastral Team, Record of Survey or other requirements may apply to the project, an example of their requirements can be found with the Survey Specifications referenced above.

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

III-A

Revised April 2015

# LABORATORY QC SAMPLES (WATER, SOIL)

## 1.0 PURPOSE

This section sets forth the standard operating procedure (SOP) for identifying the number and type of laboratory Quality Control (QC) samples that will be analyzed during each Task Order associated with the U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) IRP. Laboratory QC analyses serve as a check on the precision and accuracy of analytical methods and instrumentation and potential contamination that may occur during laboratory sample preparation and analyses. Laboratory QC analyses include but are not limited to blank, duplicate, surrogate, blank spike, laboratory control sample, and matrix spike/ matrix spike duplicate analyses. These laboratory QC analyses are discussed in general below.

## 2.0 PROCEDURES

Laboratory QC checks include all types of samples specified in the requested analytical methods, such as the analysis of laboratory blank, duplicate, and matrix spike samples. Types of QC samples are discussed in general below. The procedures presented below are minimum requirements; QC requirements of each analytical method must also be followed, and take precedence over this SOP.

### 2.1 LABORATORY BLANKS

Laboratory blank samples are analyzed to assess the degree to which laboratory contamination by reagent or method preparation may have affected sample analytical results. At a minimum, one laboratory blank will be analyzed per matrix per analytical method for each batch of at most 20 samples.

In evaluating the blank results, all blank data are reviewed to identify any compounds detected in the blanks. The laboratory shall be contacted to discuss detection of analytes in blank samples only in the event of unusual contamination, but not for common laboratory contaminants at low levels. The following compounds are considered to be common laboratory contaminants: acetone, methylene chloride, 2-butanone, and common phthalate esters. The data for samples analyzed during the same time period as the blank are then evaluated to identify the presence of any contaminants found in the blanks. The presence of the blank contaminants found in associated samples is then evaluated to avoid potential misinterpretation of actual sample constituents. Briefly, as discussed in the data validation SOPs, any analyte detected in both the sample and the associated blank is qualified as not detected if the sample concentration is less than 5 times the blank concentration (5x rule). For common laboratory contaminants (methylene chloride, acetone, toluene, 2-butanone, and common phthalate esters), a 10x rule applies.

## 2.2 DUPLICATES

Laboratory duplicates are analyzed to evaluate the reproducibility, or precision, of the analytical procedures for a given sample. Results of duplicate analyses are reported as the RPD, which is calculated by dividing the absolute value of the difference in concentration between the duplicate and original sample analyses by the arithmetic mean of their concentrations and multiplying the result by 100. One duplicate sample is analyzed for each batch of at most 20 samples analyzed of similar matrix. Duplicate analyses are normally performed on sample portions analyzed for inorganic constituents. For organic analyses, duplicate analyses are performed on matrix spike samples (see Section 5.3 of this procedure).

## 2.3 MATRIX SPIKES/MATRIX SPIKE DUPLICATES

Matrix spike (MS) analyses are conducted by the laboratory to assess the accuracy of specific analytical methods and to provide information on the effect of the sample matrix on the analytical methodology. Spike analyses are performed by adding compounds of known concentration to a sample, an unspiked portion of which has previously been analyzed or is concurrently analyzed; spikes are representative target compounds for each analytical method performed. The spiked sample is reanalyzed and the original and the spiked sample results are compared. One matrix spike is analyzed for each batch of at most 20 samples of similar matrix. Since MS samples only provide information about the specific sample matrix used for the spike, MS analyses should be performed for each type of matrix collected.

For the matrix spike duplicate (MSD), a separate sample is separately spiked and analyzed. As discussed in Section 5.2, results of matrix spike duplicate analyses are reported the RPD, which is calculated by dividing the difference in concentration between the matrix spike duplicate and the matrix spike sample analyses by the arithmetic mean of their concentrations. One matrix spike duplicate analysis is required for at most each 20 samples of similar matrix.

## 2.4 BLANK SPIKES, SURROGATES, AND LABORATORY CONTROL SAMPLES

Blank spikes, surrogates, and laboratory control samples are used to demonstrate that the laboratory process for sample preparation and analysis is under control.

Analytes selected for spiking of blank spikes and laboratory control samples are usually the same compounds used to spike MS/MSD samples and are representative target compounds.

At least two pesticides should be used as surrogates when pesticide analyses are being performed, and one polychlorinated biphenyl (PCB) when PCBs are analyzed. For wet chemistry methods, a single spike of an appropriate control for each method may be used for laboratory control sample analyses (i.e., cyanide, a control standard of sodium cyanide from a source other than that used for calibration may be spiked into water samples and analyzed with the water samples). For metals, at least three metals typically analyzed by inductively coupled plasma (ICP) must be monitored, and each element analyzed by graphite furnace atomic absorption and cold-vapor atomic absorption needs to be monitored. Blank spikes and laboratory control samples should be analyzed at a frequency of 1 per batch of at most 20 samples analyzed of similar matrix. Surrogates are required to be analyzed with all samples analyzed for volatile organics, base/neutral-acid extractables, and pesticides/PCBs.

## 3.0 DOCUMENTATION

Records of laboratory QC samples analyzed during IRP Task Order activities will be maintained on laboratory bench sheets, raw data sheets, in the laboratory computerized data system, and on QC summary forms as requested. These QC summary forms will be provided in the laboratory analytical reports and laboratory data packages transmitted for each IRP Task Order.

## 4.0 REFERENCES

NFESC. 1999. Navy Installation and Restoration Chemical Data Quality Manual.

NFESC. 1996. Navy Installation Restoration Laboratory Quality Assurance Guide. February.

SOP I-A-8, *Data Validation Planning and Coordination*

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

III-B

Revised April 2015

# FIELD QC SAMPLES (WATER, SOIL, SEDIMENT, TISSUE)

## 1.0 PURPOSE

This standard operating procedure (SOP) describes the number and types of field Quality Control (QC) samples that will be collected during U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) site field work. Quality control samples are controlled samples introduced into the analysis stream, whose results are used to review data quality and to calculate the accuracy and precision of the chemical analysis program. The purpose of each type of QC sample collection is described in this procedure. Collection and analysis frequency for quality control samples vary by project and are found in the project QA plan. Note that project-specific or contract requirements may supersede the requirements presented in this SOP.

## 2.0 PROCEDURES

The equipment required for the collection of QC samples is identical to the equipment required for the collection of environmental samples.

Field QC checks may include submission of trip blank, equipment rinsate, field blank, duplicate, and reference samples to the laboratory. Suggested frequency and types of QC check samples are discussed in the following guidance documents: *RCRA Technical Enforcement Guidance Document*, Section 4.6.1 (EPA 1986); the use and frequency of these field QC samples should be incorporated as appropriate. Types of field QC samples are discussed in general below. The frequency at which field QC samples should be collected for each QC level is provided in Table III-B-1.

The use of performance evaluation (PE) samples is discussed in SOP III-H, *Performance Evaluation Sample Procedures.*

### 2.1 TRIP BLANK

One trip blank is prepared off site by the laboratory using ASTM Type I organic-free water and included in each shipping container with samples scheduled for analysis of VOCs, regardless of the environmental medium. Trip blanks are placed in sample coolers by the laboratory prior to transport to the site so that they accompany the samples throughout the sample collection/ handling/ transport process. Once prepared, trip blanks remain unopened throughout the transportation and storage processes and are analyzed along with the associated environmental samples. Trip blanks are analyzed for VOCs and reported as water samples, even though the associated environmental samples may be from a matrix such as soil, tissue, or product.

One set of two 40 milliliter vials will constitute a trip blank and will accompany each cooler containing samples to be analyzed for volatile organics (VOCs) by methods such as CLP VOCs, 8010/601, 8020/602, 8240/624, modified 8015 (only if purge and trap analysis is performed, e.g., for gasoline, not for extraction and analysis for diesel fuel), and equivalent state-specific methods. Trip blanks will be analyzed for VOCs only (EPA 1987).

Trip banks are not typically analyzed in association with tissue samples and are therefore not required for tissue sampling programs.

**Table III-B-1**
**Field QC Samples per Sampling Event**

| | Level C2 | | Level D2 | | Level E2 | |
|---|---|---|---|---|---|---|
| Type of Sample | Metal | Organic | Metal | Organic | Metal | Organic |
| Trip blank (for volatiles only) | NA1 | 1/cooler | NA1 | 1/ cooler | NA[1] | 1/cooler |
| Equipment rinsate[3] | 1/day | 1/day | 1/day | 1/day | 1/day | 1/day |
| Field blank | 1/decontamination water source/event/for all QC levels and all analytes | | | | | |
| Field duplicates[4] | 10% | 10% | 10% | 10% | 5% | 5% |

Background samples at least 1/sample media/sample event[5]

Notes:

[1] NA means not applicable.

[2] QC levels are discussed in Section 2.8, Quality Control (QC) Levels.

[3] Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.

[4] The duplicate must be taken from the same sample that will become the laboratory matrix/spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.

[5] Sample event is defined from the time sampling personnel arrive at the site until they leave the site for more than a period of one week; the use of controlled-lot source water makes one sample per lot rather than per event an option.

Source: NFESC. 1999. Navy Installation and Restoration Chemical Data Quality Manual.

## 2.2 EQUIPMENT RINSATE SAMPLES

Equipment rinsate samples are collected by pumping organic-free, analyte-free water over and/or through the sampling equipment (such as a bailer, sampling pump, or mixing bowl) following its final decontamination rinse. This rinse water is collected into the sample containers directly or with the use of a funnel if necessary. The rinse water may be poured by use of an electric or hand submersible pump by tipping the jug of water upside down, or by use of a stopcock.

Equipment rinsate samples are collected daily for sampling equipment used repetitively to collect environmental samples. One equipment rinsate sample shall be collected per day per sampling technique utilized that day (NFESC 1999 and EPA 1986). At least one equipment rinsate sample is analyzed for each group of 20 samples of a similar matrix type and concentration. Equipment rinsate samples are preserved, handled, and analyzed in the same manner as all environmental samples. Analytical results of equipment rinsate samples are used to access equipment cleanliness and the effectiveness of the decontamination process.

When disposable or dedicated sampling equipment is utilized, only one equipment rinsate sample will be collected per equipment lot or project phase. Disposable and/or dedicated sampling equipment may include stainless steel bowls or trowels that will be used for collection of only one soil sample, disposable bailers for ground-water sampling, dedicated submersible pumps for ground-water sampling, or other such equipment. This disposable and/or dedicated sampling equipment is typically pre-cleaned and individually wrapped by the manufacturer prior to delivery to the site. In this case, the equipment rinsate sample is used to provide verification that contaminants are not being introduced to the samples via sampling equipment.

Sampling devices (e.g., gloved hands, dip nets, or traps) for collection of tissue samples are generally non-intrusive into the organisms collected, so equipment rinsate samples will not be collected as long as the devices have been properly cleaned following SOP III-I, *Equipment Decontamination*, and the devices appear clean.

## 2.3 FIELD BLANKS

Field blanks are generally prepared on site during the sampling event by pouring American Society for Testing and Materials (ASTM) Type I organic-free water into randomly selected sample containers. Commercially available distilled water may be a satisfactory substitute for the ASTM organic-free water depending specific project requirement. At least one field blank is analyzed for each group of 20 samples of a similar matrix type and concentration.

Field blanks, consisting of samples of the source water used as the final decontamination rinse water, will be analyzed to assess whether the wash or rinse water contained contaminants that may have been carried over into the site samples.

The final decontamination rinse water source, the field blank source water, and equipment rinsate source water should all be from the same purified water source. Tap water used for steam cleaning augers or used in the initial decontamination buckets need not be collected and analyzed as a field blank, because augers typically do not touch the actual samples and because the final decontamination rinse water should be from a purified source.

Field blanks are collected at a frequency of one per sampling event per each source of water for all levels of QC. A sampling event is considered to be from the time sampling personnel arrive at a site until they leave for more than a week. Field blanks will be analyzed for the same analyses as the samples collected during the period that the water sources are being used for decontamination. If the same lot of the water source is used, a field blank needs to be collected only once per lot.

## 2.4 FIELD DUPLICATE

At least one duplicate sample is analyzed from each group of 10 samples of a similar matrix type and concentration. Field duplicate samples should be collected from areas most likely to be contaminated and are preserved, handled, and analyzed in the same manner as all environmental samples. Field duplicates have the same location identification, sampling date and time, and depth interval as the associated environmental sample, but are assigned a unique sample number that is associated with the environmental sample number by virtue of the identical timestamp and location information.

Field duplicates for groundwater and surface water samples will generally consist of replicates. Field duplicates for soil samples will consist primarily of collocates. Soil field duplicates that are to be analyzed for volatile constituents will consist only of collocates; no soil samples that are to be analyzed for volatiles will be replicated (i.e., homogenized or otherwise processed or split) in the field. A separate sample will be collected to provide duplicates for non-volatile analyses. The sample may be homogenized and split in the field to form an original and duplicate (replicate) sample, or an additional volume into a separate sample container may be collected to form a duplicate (collocate) sample. Alternatively, replicates may be formed by homogenization in the laboratory. Duplicates will be analyzed for the same analytical parameters as their associated original sample.

Field duplicates for biological tissue samples will consist of splits of the original sample. Twice the required volume of organisms for one sample will be collected and placed into one food-grade self-sealing bag. The sample will later be homogenized in the laboratory and split, producing an original and a replicate sample. Replicates will be analyzed for the same analytical parameters as their associated original samples.

## 2.5 REFERENCE SAMPLES

There are two types of background levels of chemicals:

- Naturally occurring levels, which are concentrations of chemicals present in the environment that have not been influenced by humans (e.g., iron, aluminum)
- Anthropogenic levels, which are concentrations of chemicals that are present in the environment due to human-made, non-site sources (e.g., industry, automobiles)

Reference samples are samples taken from media similar to site media, but that are collected outside the zone of contamination, usually offsite.

Reference samples will be collected for each medium sampled at a site. Site-specific conditions will dictate the number of reference samples necessary to characterize background concentrations of contaminants of concern. However, at least one reference sample from each medium will be collected during each sampling event at a site. The samples will be analyzed for all the analytes for which site samples of that medium are analyzed. Background analysis, especially for metals, should be performed to assess the typical naturally occurring levels.

At least one reference sample will be collected for each biological species collected at a site. It may be difficult to find a nearby offsite location similar enough to the project site that has the same biological species available for offsite reference sample collection. Therefore, reference sample locations may need to be more distant from the site than for soil or water offsite reference samples. Collection methods will be identical for site and reference samples.

State-specific procedures may be required to establish background conditions for the site. This SOP is not intended to address such procedures and they should be consulted as necessary.

## 2.6 TEMPERATURE BLANKS

Temperature blanks are used to measure cooler temperatures upon receipt of the coolers at the laboratory. One temperature blank will be prepared and submitted to the project laboratory with each cooler. The temperature blank will consist of a sample jar containing water, which will be packed in the cooler in the same manner as the rest of the samples and labeled “temperature blank.”

## 2.7 LABORATORY QUALITY CONTROL SAMPLES

The analytical laboratory uses a series of QC samples specified in each standard analytical method and laboratory SOP to assess laboratory performance. Analyses of laboratory QC samples are performed for samples of similar matrix type and concentration and for each sample batch. The types of laboratory QC samples are matrix spike/matrix spike duplicates, laboratory control standards, laboratory duplicates, method blanks, and surrogates. In addition, there may be other project-specific technical QC requirements.

### 2.7.1 Matrix Spike/matrix Spike Duplicate

Matrix spike/matrix spike duplicates (MS/MSDs) are used to assess sample matrix interferences and analytical errors, as well as to measure the accuracy and precision of the analysis. For MS or MSD samples, known concentrations of analytes are added to the environmental samples; the samples are then processed through the entire analytical procedure and the recovery of the analytes is calculated. Results are expressed as percent recovery of the known spiked amount for matrix spikes and the relative percent difference (RPD) for MS/MSDs. The MS/MSDs will be collected and analyzed at a rate of 5 percent of the field samples for each matrix and analytical method or at least one for each analytical batch, whichever frequency is greater.

Generally, a specific sampling location is used to collect field QC samples; however, it may not be possible to collect MS/MSD samples for all analyses at the same sampling location because of a limited volume of available material. In those instances, MS/MSD samples designated for various analyses will be collected from different locations (for example a MS/MSD for metals is collected at location X and an MS/MSD for PCBs is collected at location Y). Additionally, samples designated for MS/MSD analyses will not be collected from locations with potentially high concentrations of target analytes that may mask the added spike compounds. MS/MSD samples have the same location identification, sampling time, depth interval, and sample number as the associated environmental sample.

## 2.8 QUALITY CONTROL (QC) LEVELS

NAVFAC NW QC Levels III, IV are defined in SOP I-A-8 and Data Validation Procedure SOPs II-A through II-O. Level IV QC is appropriate to use for laboratory analysis for sites where cleanup decisions will be based on risk assessment. Sites on or eligible for the National Priorities List (NPL) will also have laboratory analyses conducted at Level IV QC. The QC level selected for laboratory analyses for many sites, therefore, will be NAVFAC NW Level IV. Other QC levels may be appropriate for certain types of samples or analyses; criteria for selection of the appropriate QC level for individual projects and field work activities are discussed in SOP I-A-8, *Data Validation Planning and Coordination*.

## 3.0 DOCUMENTATION

Records of the collection of field QC samples should be kept in the sample logbook by the methods discussed in SOPs III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* and III-D, *Logbooks*.

## 4.0 REFERENCES

EPA. 1987. Data Quality Objectives for Remedial Response Activities: Development Process

NFESC. 1999. Navy Installation and Restoration Chemical Data Quality Manual.

EPA. 1992. RCRA Technical Enforcement Guidance Document.

SOP III-I, Equipment Decontamination

SOP, III-D, *Logbooks*

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

III-C

Revised April 2015

# FIELD QC SAMPLES (AIR)

## 1.0 PURPOSE

This procedure describes the standard quality control (QC) and quality assurance (QA) procedures for air monitoring field samples.

## 2.0 PROCEDURE

NAVFAC NW air monitoring programs for airborne pollutants consist of complex activities using monitoring equipment and laboratory analysis techniques. This approach is necessary to accurately quantify concentrations of airborne pollutants in ambient air. Therefore, it is critical that one ensures and maintains a high-quality program, by implementing the appropriate QA/QC program elements.

The terms quality assurance and quality control (QA/QC) are often confused. Both activities are concerned with maintaining consistent and verifiable quality in each element of the program. Strictly speaking, QC applies to measures taken, on an ongoing basis, by personnel involved in producing the primary output of the activity. These actions are taken to maintain performance parameters within acceptable levels. An example of a QC activity is a routine zero/span calibration check of a monitoring instrument by the responsible operating technician.

Quality assurance, on the other hand, refers to checks or tests performed by personnel other than the primary operators to verify that the performance parameters have, in fact, been maintained within acceptable limits. Examples of QA activities are performing a quarterly audit of monitoring instruments and checking output data for "out-of-limits" values. In the discussion that follows, QA/QC is used as a general term to encompass both QA and QC activities.

A rigorous QA/QC effort is necessary during the operation of NAVFAC NW site air monitoring programs to meet monitoring objectives. Major QA/QC elements that should be implemented during the operational phase of an air monitoring program include QA/QC management, sample QA/QC, analytical QA/QC, and data reduction QA/QC.

QA management involves implementing project-specific task order administrative procedures to control QA/QC functions. The potential for, and types of, quality problems vary depending on the activity: sampling, analysis, or data reduction. Therefore, individual QA/QC requirements must be developed for each of these activities. Summaries of typical sampling and analysis frequencies, QA/QC requirements, and calibration requirements for sampling and analysis instrumentation are presented in Tables III-C-1 and III-C-2, respectively. Data recording procedures to be specified in the air sampling activity include: (1) periodic readings of the temperature, air flow, volumes, and other parameters; (2) documentation of meteorological conditions at appropriate time points; (3) documentation of instrument operating variables (i.e., resin cartridge number); (4) documentation of any upset conditions such as sudden leakage or pressure surges; and (5) documentation of calibration or maintenance activities. A logbook for the overall field program in which sampling descriptions, meteorological data, and upset conditions are documented should be maintained. In addition, a sampling data sheet should be prepared for each sample or set of samples in which the periodic readings and instrument parameters are recorded. Certain measurements, such as filter numbers and weights or impinger volumes that are required for analytical purposes, may be recorded on a separate sheet with provisions for recording subsequent analytical data on the same sheet. Separate maintenance and calibration logbooks should be maintained for each sampling/monitoring instrument. In most cases, sampling data forms specific for a given Task Order must be prepared because of difference in the sampling design between Task Orders.

**Table III-C-1**
**Typical Sampling/Analysis Frequencies**
**for QC Samples (Air)**

| Type of Sample* | Description | Typical Frequency |
|---|---|---|
| Field Blanks | Collection media shipped to the field and exposed to the sampling environment, recapped or reclosed without a volume of air passing into or through them. | At least one per day or one per each sample batch up to 10% of sample total. |
| Laboratory Blanks | Unexposed media that do not go to the field but are analyzed by the laboratory to confirm that analyte(s) of concern are not present. | At least one per day or one per each sample batch up to 10% of sample total. |
| Trip Blanks | Collection media shipped to the field, remains unopened or unexposed to the test environment and are returned to the laboratory. | At least one per shipment container. |
| Spiked Samples | Media to which a known amount of the analyte(s) of interest have been added by the laboratory and shipped to the field for use. | At least one per batch up to 10% of sample total. |
| Collocated Samples | Air samples collected immediately adjacent to each other in the same time period. | At least one per matrix in each sampler array matrix up to 10% of sample total. |
| Instrument Calibration Standards | Calibration devices or material traceable to known certified standards. | Test at least twice daily at beginning and ending of sampling period. |

* Specification of the manner in which these types of samples are collected shall be described within the specific Task Order Work Plan or Field Sampling Plan.

### Table III-C-2
### Calibration Requirements for
### FIELD Air Sampling and Analysis Instrumentation

| Device | Parameter Calibrated | Method of Calibration | Approximate Frequency | Comments |
|---|---|---|---|---|
| **Sampling Instrumentation** | | | | |
| Sampling flow rate measurement device | Flow rate | Flow calibration kit; primary standard film calibrator; calibration flow meter; dry test meter | Depends on sampler; generally immediately prior to and after sampling event | |
| Sample volume measurement device (usually a dry test meter) | Total volume | Wet test meter or any appropriate volume standard | Depends on sampler; generally immediately prior to and after sampling event | Must be determined at known atmospheric pressure and temperature. Flow rate should be similar to that used for sampling. |
| **Analytical Instruments** | | | | |
| Continuous monitors (i.e. FID, PID, FPD, etc.)* | Response | Use standard concentrations.<br>Calibrate with chemical of concern or reference compound if relative response of analyte(s) is known | Daily or more frequently, if required | |
| Field Gas Chromatographic Instruments | Calibrate instrument and verify column performance and retention time for each analyte | Injection of standard using the same process as for sample injection | Daily or more frequently, if required | |
| GC/MS* | Calibrate instrument and verify response and retention time for each analyte | Same as for other gas chromatographic instruments | Same as for other chromatographic gas instruments | Same as for other gas chromatographic instruments |

Revised April 2015

| Device | Parameter Calibrated | Method of Calibration | Approximate Frequency | Comments |
|---|---|---|---|---|
| GC/MS | Mass spectral resolution and tuning parameters | (a) Introduction of perfluorotributyl-amine compound (tuning compound) directly into MS.<br>(b) Injection of tuning verification standard (i.e., 4-bromo-fluoro-benzene) into GC | Daily | Selection of tuning standards (i.e., decafluorotriphenyl phosphine or 4-bromofluoro-benzene) will be dependent on type of analysis being performed |

FID - Flame Ionization Detector
PID - Photoionization Detector
FPD - Photometric Detector
GC/MS - Gas Chromatograph/Mass Spectrometer
NIST - National Institute of Standards and Technology
SRM - Standard Reference Material
CRM - Certified Reference Material

In addition to site-specific air sampler(s) and meteorological station parameters, the monitored area or locale elevation (i.e., feet above mean sea level) should be noted, and data for the following meteorological parameters taken/recorded every four hours: ambient air temperature, relative humidity, and barometric pressure. The two former values are obtained with a field or pocket type thermo-hygrometer; barometric pressure values may be obtained from either a nearby National Weather Service station or an airport that measures/records this parameter. Most meteorological data is recorded as either 15-minute or 1-hour averages; this includes wind speed and wind direction.

Sample labeling, preservation, storage, and transport procedures should be specified, and these procedures should be carefully explained to field personnel prior to sampling to ensure proper implementation. Sample labels, prepared in advance, should include sufficient information to associate the sample with a particular data sheet as well as the overall program record notebook. In general, each sample should be given a unique identification number with a prefix describing the type of sample.

Sample preservation, storage, and transport procedures must be appropriate for the type of analyses required. Particulate samples generally should be placed in air-tight containers and stored in the dark to minimize analyte degradation. Resin cartridges and impingers generally require more attention, because of analyte instability in the matrix, and should be shipped to the laboratory on the same day that the sample was collected for analysis. These sample types should be placed in airtight, glass containers and stored at subambient temperatures (U.S. Environmental Protection Agency methods generally specify a storage temperature of 4 degrees Celsius) until analysis. Exposure to solvents must be avoided for resin cartridges during all stages of handling in order to avoid sample contamination. Air samples collected in Tedlar™ bags should be placed within an opaque plastic bag (i.e., plastic garbage can bag) and then placed in a cardboard box with blue ice for shipment to the laboratory on the same day that the sample was collected for analysis.

Chain-of-custody forms are required. The objective of the chain-of-custody procedure is to document the movement of a sample from collection until analysis to ensure its integrity.

## 2.1 ROUTINE QA/QC CHECKS

The field air monitoring program should incorporate the following four-component approach for routine QC and QA checks:

- Use collocated (i.e., two separate ambient air samples collected side-by-side at the same sampling location) samples for precision checks. Alternatively, split each sample stream into two collection devices (collocation does not guarantee collection of identical samples).
- Use blanks (i.e., field and trip blanks) for ambient locale and shipping container contamination checks.
- Use analytical standards and equipment calibrations for accuracy checks.
- Perform data review for internal consistency.

During each air monitoring program, one station with two sets of collocated air samplers should be used in accordance with siting criteria. The goal should be to obtain at least 10% of collocated samples for each monitoring network. The analytical results from the collocated air samples should be used to assess the precision and overall homogeneity of the samples, including the influence of the combined field and analytical procedures.

The purpose for collecting sample blanks (i.e., field blank) is to document that extraneous concentrations of the target analyte(s) are not introduced into the collection medium simply by handling or working with it in a normal, routine fashion. Generally, one field blank per collection medium per day is sufficient to demonstrate that the levels of target analyte(s) found in the normal handling of the media in the field. In some instance, where the field environment is known to have high levels of contaminants, collecting more field blanks may be deemed appropriate. However, those requirements should be identified in the Field Sampling Plan. The frequency of field blanks collected for a particular project is project-specific and should be presented in detail in the Work Plan or Field Sampling Plan.

The exact procedure for collecting field blanks is specific to each type of medium. However, the general concept is to handle the field blank media in exactly the same fashion as the media used for actual sample collection, except no sample volume of air is moved through the media. For example, glass sorbent tubes used for field blank are shipped, labeled, have their ends broken open, are placed in the sampling mechanism, removed from the sampling mechanism, capped, logged, and packed for shipment in an identical manner to the sorbent tubes used to collect air samples. The difference is that no air is pulled through the field blank sorbent tubes. Table III-C-3 lists general procedures for collecting field blanks for some of the collection media.

Canisters (i.e., Summa™ - stainless steel, SilcoCan™ - fused silica/stainless steel) used for ambient air sampling purposes should be tested to determine vacuum/pressure condition before and after sampling. Evacuated canisters should undergo two separate tests. First, the canister is checked with a vacuum gauge to determine negative pressure, and then the attached critical flow orifice that is used to control flow during the prescribed sampling interval is tested with a rotometer. Canisters used with a positive displacement sampling pump (i.e., canister at atmospheric pressure at the start of the sampling period and then pressurized under constant flow pump conditions to approximately two atmospheres) should be tested for pressure conditions with a pressure gauge. Additionally, the sample pump flow rate should be determined with either a film calibrator or a flowmeter kit and stopwatch.

A vacuum/pressure gauge known to be free of contaminants is attached to the fitting upstream of the canister's main valve. The main valve is then opened and the gauge is read to confirm that the evacuated canister has maintained the same vacuum reading, within ± 5%, reported by the laboratory or provider of the canister. The same method is used by the laboratory to confirm the fill of a pressurized canister. The canister should be within ± 5% of the pressure valve reported by the field crew. Canisters outside the gauge error margin should be flagged as suspect and their data should be qualified accordingly.

## 2.2 PERIODIC QA/QC CHECKS

Periodic field QA/QC checks should be implemented to supplement the more frequent routine QC checks required by the project. These periodic checks will serve to determine compliance with siting and operating criteria and should be made after the specific Task Order air monitoring plan is in full operation. The periodic QA/QC checks should include air matrix spiked samples, instrument performance audits of the air monitoring and meteorological equipment, and system audits.

The accuracy of sample analysis can be routinely checked by submitting spiked and blank gas samples as part of the laboratory analysis package. Spiked samples should contain a known concentration of some of the same compounds for which the laboratory is performing analysis. Blank samples are collection media that have no measurable amounts of the substance(s) of interest. The analysis of spiked and blank samples should be reported along with the normal samples collected during the project.

Instrument performance audits conducted on air sampling and meteorological measurement equipment are to be conducted by qualified air quality technicians who are not directly involved in the routine operation of the air monitoring activity. In addition, the auditing equipment used to conduct the tests must be independent and different from that used to calibrate or maintain the air monitoring instrumentation. The audited instruments are challenged with known input values (e.g. air flow rates, electrical signals, timing mechanisms, temperature environments, etc.) and the instruments' observed response to the known inputs is reported.

The system audit provides an onsite qualitative evaluation of the installation of air sampler array and the meteorological monitoring station. The system audit documents the following:

## Table III-C-3
## Common Field Blank Collection Procedures (Air)

| Media | Field Blank Collection Procedure |
|---|---|
| Glass Sorbent Tubes | The tubes are removed from their shipping package and labeled as if they were to be used to collect samples. The tube ends are snapped off and the tubes are placed in the sampler mechanism (e.g., personal sampling pump or flow control device). Without turning on the sampler mechanism, the tubes are then removed, capped, logged, and placed in the shipping container along with regular samples for transport to the laboratory. Analysis of the field blank tubes is identical to the tubes used to collect air samples. |
| Filters | The filters to be used as field blanks are removed from their shipping package and tagged or labeled along with the filters intended for sample collection. They are installed in the filter holder, attached to the sampling mechanism (pump), removed without turning on the sampling mechanism, placed in a protective envelope, logged on the appropriate form, and shipped along with regular samples to the laboratory for analysis.<br>Note: Many filter media come preloaded in individual cassettes with capped ends. If filter cassettes are used, field blank procedures similar to those described for sorbent tubes will apply. Filters used for particulate measurement are pre-numbered and pre-weighed. Handling should be minimized. |
| Liquid Impingers | The impinger solution is placed in the impinger as it would be under normal sampling procedures. Without moving a volume of air through the impinger, an aliquot of solution (5-10 milliliters) is transferred into a shipment bottle, labeled, logged, and packaged for shipment to the laboratory along with the exposed sample impinger solutions. |
| Tedlar™ Bags | The empty bags intended for field blanks are removed from the shipping package and labeled as if they are to be used for normal sample collection. The field blank bags are then filled with ultra-pure nitrogen, logged, and packaged for shipment to the laboratory along with normally collected air samples. |
| Summa™ Canisters | The canisters intended for field blanks are removed from the shipping container and labeled as if they are to be used for normal sample collection. The field blank canisters are then filled with ultra-pure nitrogen, logged, and packaged for shipment to the laboratory along with canisters used for normally collected air samples. |

General physical condition and operability of the air sampling and meteorological instrumentation

- Operational QC procedures in use (i.e., calibrations, single-point checks, instrument operation check lists, documentation)
- Instrument siting and exposure criteria
- Data acquisition, validation, and reporting procedures

The frequency of periodic QA/QC checks depends on the duration of the project. Where a long-term (i.e., 6 to 12 months, or more) project is in effect, the periodic QA/QC checks should be performed quarterly. For short-term projects lasting only a few weeks or less, an initial QA/QC check at the beginning, followed by a final check at the project's end, may be sufficient.

Any problems or discrepancies discovered during the performance and system audits are documented in a report and discussed with the respective Project Manager who will initiate the required corrective actions.

### 2.3 LABORATORY QA/QC PROGRAM

Laboratory analytical techniques must properly identify the sample components and accurately and precisely measure concentrations. This requires the preconcentration and/or storage of air samples. Therefore, methods chosen for time-integrated monitoring usually involve a longer analytical time period, more sophisticated equipment, and more rigorous QA procedures. Canister sampling includes replicate analyses and duplicate canisters to assess analytical and sampling precision. Analysis of co-located duplicate samples with laboratories is desirable to check laboratory analytical performance.

Laboratory QC methods for an NAVFAC NW project site must include the requirements noted in Section 3.0 of the *Navy Installation Restoration Laboratory Quality Assurance Guide (Interim Guidance Document)* (NFESC 1996). For air monitoring projects, these requirements should address the following elements: laboratory control samples, matrix spikes/matrix spike duplicates, duplicates, blanks, surrogates, other laboratory QC samples, field QC samples, internal standards, calibration standards, and canister cleanup and certification. Inter-laboratory analysis of duplicate or collated samples is desirable to check laboratory analytical performance.

## 3.0 DOCUMENTATION

Field QA/QC Samples (Air) shall be documented as prescribed in the respective NAVFAC NW Task Order and/or associated Air Monitoring Plan. These items shall be sent to the Project Manager and the project files.

## 4.0 REFERENCES

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USEPA. 1989. "Air/Superfund National Technical Guidance Study Series, Volume IV-Procedures for Dispersion Modeling and Air Monitoring for Superfund Air Pathway Analysis," EPA-450/1-89-004, Section 3, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA. 1989. "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV - Meteorological Measurements," EPA-600/4-90-003, Research Triangle Park, NC.

## 5.0 ATTACHMENTS

None.

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# LOGBOOKS

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities of U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and/or their contractors pertaining to the identification, use, and control of logbooks and associated field data records. This SOP establishes a standard format for recording field observations and describes the methods for use and maintenance of field logbooks.

## 2.0 PROCEDURE

### 2.1 EQUIPMENT

- Waterproof hardbound field logbook (typically 4-inch by 7-inch to 8-inch by 10.5-inch) with numbered pages
- Waterproof/indelible marking pen
- Ruler/straight edge
- Clipboard

### 2.2 LOGBOOK MAINTENANCE

Prior to commencement of field work, logbooks will be assigned to field personnel by the Project Manager. If personnel changes must be made during a project, the successor may use the same logbook. In this case, the logbook cover page will indicate all persons who have made entries and the dates. This may be inappropriate if there are a large number of people involved.

The logbook user is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The logbook user is also responsible for safeguard of the logbook while having custody of it.

Individuals performing specific tasks associated with a field project may keep a separate logbook; however, these logbooks must conform to this procedure and will become a permanent part of the central project file. The Project Manager is responsible for reviewing and signing all field logbooks associated with the project.

## 2.3 RECORDING FIELD ACTIVITIES

The field team provides a permanent record of daily activities, observations, and measurements through the use of a field logbook. All logbook entries will be made in indelible black or blue ink. No erasures are permitted. If an incorrect entry is made, the data will be crossed out with a single line and initialed and dated by the originator. Entries can be organized into easily understood tables if possible.

All logbook pages will be signed and dated at the bottom. Times will be recorded next to each entry. If a full page is not used during the course of a workday, a diagonal line will be drawn through the unused portion of the page and signed (in this case, it would not be necessary to sign the bottom of the page). If the project is completed and the logbook has not been completely filled, a diagonal line will be drawn across the first blank page after the last entry, and “no further entries” written before the page is signed and dated.

Daily entries will be made during field activities by, at a minimum, one field team member to provide daily records of all significant events, observations, and measurements during field operations. Notes will start at the beginning of the first blank page and extend through as many pages as necessary. All page numbers will be consecutively numbered as the logbook is filled.

The inside cover page of each logbook will contain the following information:

- Book number
- Project name
- Contract number
- Project number
- Navy Activity/Installation
- Site name
- Start date
- End date
- Person to whom the logbook is assigned
- Agency/Company name
- Agency/Company address
- Agency/Company phone number

The field logbook serves as the primary record of field activities. When possible, the field book should be dedicated to a singular Navy Activity/Installation to facilitate long-term records archiving. Entries shall be made chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, names of all samples collected shall be included in the logbook even if recorded elsewhere.

All field descriptions and observations are entered into the logbook, as described in Attachment III-D-1.

Typical information to be entered includes, but is not limited to, the following:

- Date and time of all onsite activities
- Site location and description
- Weather conditions
- Field work documentation
- Descriptions of and rationale for approved deviations from the Work Plan or Field Sampling Plan
- Field instrumentation readings
- Personnel present
- Photograph references
- Sample locations
- Sample identifications, as described in SOP I-A-11, Sample Naming
- Field QC sample information
- Field descriptions, equipment used, and field activities accomplished to reconstruct field operations
- Meeting information
- Daily health and safety meeting notes
- Important times and dates of telephone conversations, correspondence, or deliverables
- Field calculations
- PPE level
- Calibration records
- Subcontractors present
- Equipment decontamination procedures and effectiveness
- Procedures used for containerization of investigative-derived waste

Logbook page numbers shall appear on each page to facilitate identification of photocopies.

If a person's initials are used for identification, or if uncommon acronyms are used, these should be identified on a page at the beginning of the logbook.

At least weekly and preferably daily, the preparer shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

A technical review of each logbook shall be performed by a knowledgeable individual such as the Project Manager.

## 3.0 DOCUMENTATION

The field logbook shall be retained as a permanent project record. If a particular Task Order requires submittal of photocopies of logbooks, this shall be performed as required.

## 4.0 REFERENCES

SOP I-A-11, *Sample Naming*

## 5.0 ATTACHMENTS

Attachment III-D-1 Description of Logbook Entries

## Attachment 1
## Description of Logbook Entries

Logbook entries shall contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms as described previously.

| | |
|---|---|
| **Name of Activity** | For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing. |
| **Task Team Members and Equipment** | Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information. |
| **Activity Location** | Indicate location of sampling area as specified in the Field Sampling Plan. Record valid Navy Installation/Active and Site, at a minimum. |
| **Weather** | Indicate general weather and precipitation conditions. |
| **Level of Personal Protective Equipment** | The level of personal protective equipment (PPE), e.g., Level D, should be recorded. |
| **Methods** | Indicate method or procedure number employed for the activity. |
| **Sample IDs** | Indicate the unique identifier associated with the physical samples. Identify QC samples. Value can be numeric or alphanumeric and must not already exist in the database. |
| **Sample Type and Volume** | Indicate the medium, container type, preservative, and the volume for each sample. |
| **Sample Collection Information** | Indicate the location of sample, date and time of collection, sample matrix, sample depth interval, sample methods, sample handling, including filtration and preservation, analysis required and packaging and shipping information. |
| **Time and Date** | Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year. |
| **Analyses** | Indicate the appropriate code for analyses to be performed on each sample, as specified in the Field Sampling Plan. |
| **Field Measurements** | Indicate measurements and field instrument readings taken during the activity. |
| **Chain of Custody and Distribution** | Indicate chain-of-custody for each sample collected and indicate to whom samples are transferred and the destination. |
| **References** | If appropriate, indicate references to other logs or forms, drawings or photographs employed in the activity. |

| | |
|---|---|
| **Narrative (including time and location)** | Create a factual, chronological record of the team's activities throughout the day, including the time and location of each activity. Include descriptions of any general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact to the work schedule, requested information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself.<br>It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate. |
| **Recorded by** | Include the signature of the individual responsible for the entries contained in the logbook and referenced forms. |
| **Checked by** | Include the signature of the individual who performs the review of the completed entries. |

NAVFAC NW Standard Operating Procedure Number:

III-E

Revised April 2015

# RECORD KEEPING, SAMPLE LABELING, AND CHAIN-OF-CUSTODY PROCEDURES

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish standard protocols for all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) field personnel and their contractors for use in maintaining field and sampling activity records, writing sample logs, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.

## 2.0 PROCEDURES

Standards for documenting field activities, labeling the samples, documenting sample custody, and completing chain-of-custody and analytical request forms are provided in this procedure. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

### 2.1 RECORD KEEPING

The field logbook serves as the primary record of field activities. Entries shall be made chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Field logs such as soil boring logs and ground-water sampling logs will also be used. These procedures are described in SOP III-D, *Logbooks*.

### 2.2 SAMPLE LABELING

A sample label with adhesive backing shall be affixed to each individual sample container. Clear tape shall be placed over each label (preferably prior to sampling) to prevent the labels from tearing off, falling off, or being smeared, and to prevent loss of information on the label. The following information shall be recorded with a waterproof marker on each label:

- Project name or number (optional)
- Sample ID
- Date and time of collection
- Sampler's initials
- Matrix (optional)
- Sample preservatives (if applicable)

- Analysis to be performed on sample. This shall be identified by the method number or name identified in the subcontract with the laboratory. For water samples, a separate container is typically used for each separate test method, whereas with soil samples, multiple analyses can be performed on the soil obtained from one sample container. In order to avoid lengthy lists on each container and confusion, soil sample containers may not list every analysis to be performed.

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels. The adhesive glue used on the labels must be such that it does not contaminate the sample.

## 2.3 CUSTODY PROCEDURES

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Custody of samples shall be maintained in accordance with EPA chain-of-custody guidelines as prescribed in EPA's *NEIC Policies and Procedures*, National Enforcement Investigations Center, Denver, Colorado, revised May 1986; EPA *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (TEGD), *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA OSWER Directive 9355 3-01), Appendix 2 of the *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*, and *Test Methods for Evaluating Solid Waste* (EPA SW-846). A description of sample custody procedures is provided below.

### 2.3.1 Sample Collection Custody Procedures

According to EPA's *NEIC Policies and Procedures*, a sample is considered to be in custody if:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

Custody seals shall be placed on sample containers immediately after sample collection and on shipping coolers if the cooler is to be removed from the sampler's custody. Custody seals will be placed in such a manner that they must be broken to open the containers or coolers. The custody seals shall be labeled with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed.

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment III-E-1.

Field personnel shall also log individual samples onto carbon copy chain-of-custody forms when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 2.4 indicating sample number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The samplers will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment III-E-2. An example of a completed COC form is provided in Attachment III-E-3 and described in Section 2.4.

### 2.3.2 Laboratory Custody Procedures

The following are custody procedures to be followed by an independent laboratory receiving samples for chemical analysis; the procedures in their Laboratory Quality Assurance Plan (LQAP) must follow these same procedures. A designated sample custodian shall take custody of all samples upon their arrival at the analytical laboratory. The custodian shall inspect all sample labels and COC forms to ensure that the information is consistent, and that each is properly completed. The custodian will also measure the temperature of the samples in the coolers upon arrival. The custodian shall also note the condition of the samples including:

- If the samples show signs of damage or tampering.
- If the containers are broken or leaking.
- If headspace is present in sample vials.
- Proper preservation of samples (made by pH measurement, except VOCs and purgeable TPH). The pH of these samples will be checked by the laboratory analyst, after the sample aliquot has been removed from the vial for analysis.
- If any sample holding times have been exceeded.

All of the above information shall be documented on a sample receipt sheet by the custodian.

Any discrepancy or improper preservation shall be noted by the laboratory as an out-of-control event and shall be documented on an out-of-control form with corrective action taken. The out-of-control form shall be signed and dated by the sample control custodian and any other persons responsible for corrective action. An example of an out-of-control form is included as Attachment III-E-4.

The custodian shall then assign a unique laboratory number to each sample and distribute the samples to secured storage areas maintained at 4°C. The unique laboratory number for each sample, contractor sample ID, client name, date and time received, analysis due date, and storage details shall also be manually logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The custodian shall also sign the shipping bill and maintain a copy.

Laboratory personnel shall be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. Samples should be logged in and out on internal laboratory COC forms each time they are removed from storage for extraction or analysis.

## 2.4 COMPLETING CHAIN-OF-CUSTODY/ANALYTICAL REQUEST FORMS

COC form/analytical request completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form also is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment III-E-2 is an example of a generic COC/analytical request form that may be used by field personnel. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Attachment III-E-3 is an example of a completed site-specific COC/analytical request form, with box numbers identified and discussed in text below.

Box 1 Project Manager: This name shall be the name that will appear on the report. Do not write the name of the Project Coordinator or point of contact for the project instead of the Project Manager.

Project Name: Write it, as it is to appear on the report.

Project Number: Write it as it is to appear on the report. It shall include the project number, task number, and general ledger section code. The laboratory subcontract number should also be included.

Box 2 Bill to: List the name and address of the person/company to bill only if it is not in the subcontract with the laboratory.

Box 3 Sample Disposal Instructions: These instructions will be stated in the Basic Ordering Agreement (BOA) or each Task Order statement of work with each laboratory.

Shipment Method: State the method of shipment, e.g., hand carry; air courier via FEDEX, AIRBORNE, DHL or equivalent.

Comment: This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis. For example: a specific metals list, explanation of Mod 8015, Mod 8015 + Kerosene, samples expected to contain high analyte concentrations.

Box 4 Cooler Number: This will be written somewhere on the inside or outside of the cooler and shall be included on the COC. Some laboratories attach this number to the trip blank identification, which helps track VOC samples. If a number is not on the cooler, field personnel shall assign a number, write it on the cooler, and write it on the COC.

QC Level: Enter the reporting/QC requirements, e.g., NAVFAC NW QC Level C, D, or E.

Turnaround time (TAT): TAT for contract work will be determined by a sample delivery group (SDG), which may be formed over a 14-day period, not to exceed 20 samples. Standard turnaround time once the SDG has been completed is 35 calendar days from receipt of the last sample in the SDG. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each COC to remind the laboratory.

Box 5 Type of containers: The type of container used, e.g., 1-liter glass amber, for a given parameter in that column.

Preservatives: Field personnel must indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Box 6 Sample number: Five-character alpha-numeric identifier to be used by the laboratory to identify samples. The use of this identifier is important since the labs are restricted to the number of characters they are able to use. See SOP I-A-11, Sample Naming.

Description (sample identification): This name will be determined by the location and description of the sample, as described in SOP I-A-11, Sample Naming. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer COC version is used, the sample identification can be input but printed with this block black. A cross-referenced list of sample number and sample identification must be maintained separately.

Date Collected: Collection date must be recorded in order to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

Time Collected: When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations; e.g., 1815 instead of 6:15 p.m.

| | |
|---|---|
| | Record local time; the laboratory is responsible for calculating holding times to local time. |
| | Lab Identification: This is for laboratory use only. |
| Box 7 | Matrix and QC: Identify the matrix: e.g., water, soil, air, tissue, fresh water sediment, marine sediment, or product. If a sample is expected to contain high analyte concentrations, e.g., a tank bottom sludge or distinct product layer, notify the laboratory in the comment section. Mark an "X" for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) purposes. The sample provided for MS/MSD purposes is usually a field duplicate. |
| Box 8 | Analytical Parameters: Enter the parameter by descriptor and the method number desired. When requesting metals that are modifications of the standard lists, define the list in the comment section. This would not be necessary when requesting standard list metals such as priority pollutant metals (PPM), target compound list from ILM03.0, and Title 22 metals which are groups of metals commonly requested and should not cause any confusion as to what metals are being analyzed. Whenever possible, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion. |
| | In the boxes below the analytical parameter, indicate the number of containers collected for each parameter by marking an "X". If more than one container is used for a sample, write a number in the desired box to indicate a request for analysis and to indicate the number of containers sent for that analysis. |
| Box 9 | Sampler's Signature: The person who collected samples must sign here. |
| | Relinquished By: This space shall contain the signature of the person who turned over the custody of the samples to a second party other than an express mail carrier such as FEDEX, DHL or Air Borne Express. |
| | Received By: Typically, this is a written signature by a representative of the receiving laboratory, or a field crewmember who delivered the samples in person from the field to the laboratory. A courier such as FedEx or DHL does not sign because they do not open the coolers. It must also be used by the prime contracting laboratory when samples are sent to a subcontractor. |
| | Relinquished By: In the case of subcontracting, the primary laboratory will sign the Relinquished By space and fill out an additional COC to accompany the samples being subcontracted. |
| | Received By (Laboratory): This space is for the final destination (e.g., at a subcontracted laboratory). |
| Box 10 | Lab Number and Questions: This box is to be filled in by the laboratory only. |
| Box 11 | Control Number: This number is the "COC" followed by the first sample number in a cooler, or contained on a COC. This control number must be unique and never used twice. Record the date the COC is completed. It should be the same date the samples are collected. |
| Box 12 | Total No. of Containers/row: Sum the number of containers in that row. |
| Box 13 | Total No. of Containers/column: Sum the number of containers in that column. |

Because COC forms contain different formats based upon who produced the form, not all of the information listed in items 1 to 13 may be recorded. However, as much of this information as possible shall be included.

COC forms tailored to each Task Order can be drafted and printed onto multi-ply forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; TAT; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, reduce the number of trip blanks by placing all samples to be analyzed for VOA, gasoline, and BTEX compounds into one cooler. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

## 3.0 DOCUMENTATION

The COC/analytical request form shall be faxed daily, if possible, to the Task Order Laboratory Coordinator for accuracy verification. Following the completion of sampling activities, the sample logbook and COC forms will be transmitted to the Project Manager for storage in project files. The Project Manager shall review COC forms on a monthly basis at a minimum. The data validators shall also receive a copy. Along with the data delivered, the original COC/analytical request form shall be submitted by the laboratory. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

## 4.0 REFERENCES

SOP I-A-11, *Sample Naming*

SOP III-D, *Logbooks*

State of California Water Resources Control Board. 1988. Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports.

USEPA. 1986. EPA NEIC Policies and Procedures, National Enforcement Investigations Center, Denver, Colorado.

USEPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA OSWER Directive 9355 3-01).

USEPA. 1992. RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD).

USEPA. 1995 and as updated. Test Methods for Evaluating Solid Waste (SW-846), Third edition.

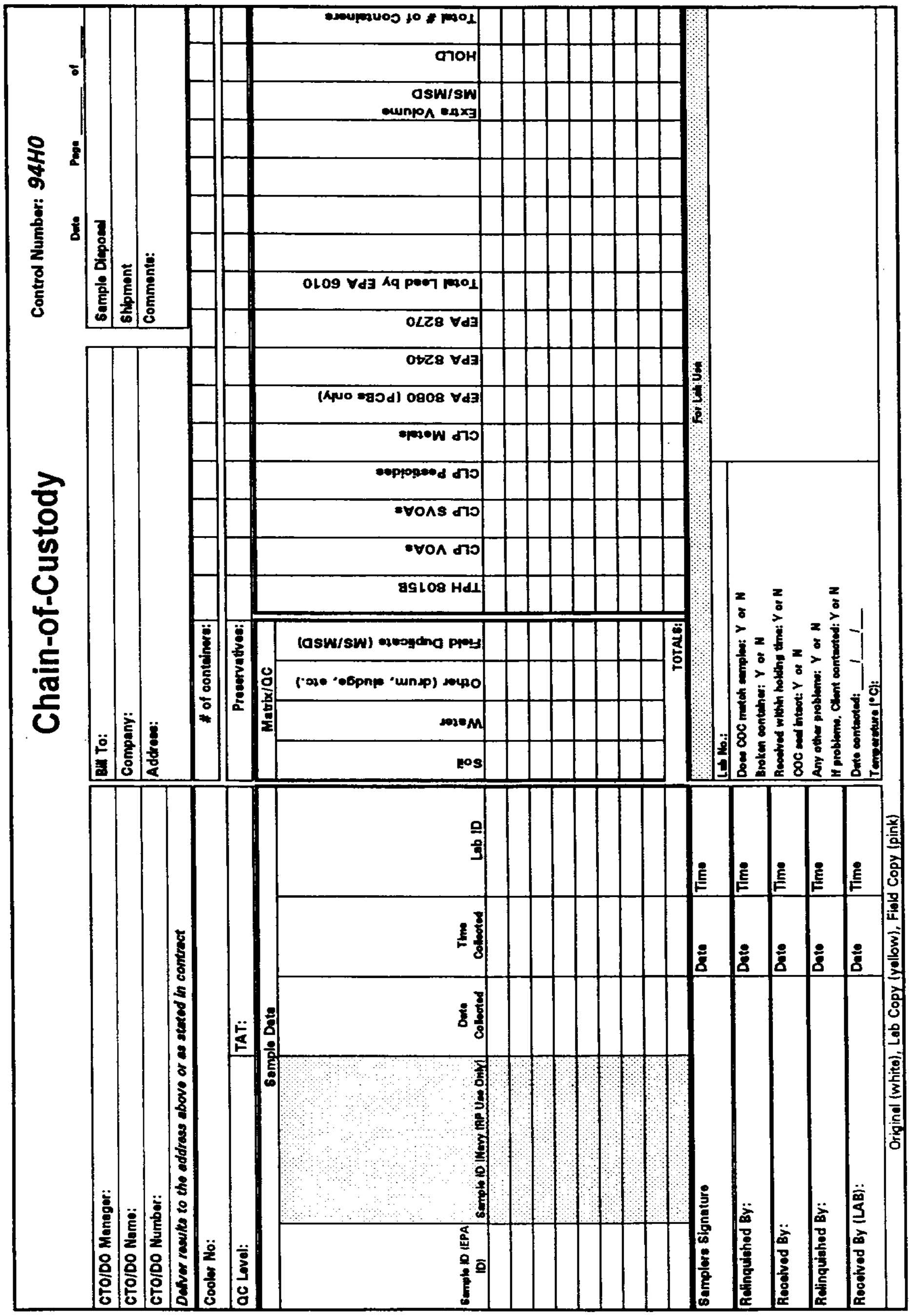
## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment III-E-1 | Chain-of-Custody Seal |
| Attachment III-E-2 | Generic Chain-of-Custody/Analytical Request Form |
| Attachment III-E-3 | Sample Completed Chain-of-Custody/Analytical Request Form |
| Attachment III-E-4 | Sample Out-of-Control Form |

## Attachment III-E-1
## Chain-of-Custody Seal

<table>
<tr><td rowspan="3">[LABORATORY]</td><td>SAMPLE NO.</td><td>DATE</td><td>SEAL BROKEN BY</td></tr>
<tr><td colspan="2">SIGNATURE</td><td>DATE</td></tr>
<tr><td colspan="3">PRINT NAME AND TITLE (Inspector, Analyst or Technician</td></tr>
</table>

## Attachment III-E-2
## Generic Chain-of-Custody/Analytical Request Form



### Chain-of-Custody

**Control Number:** *94H0*

Date Page ______ of ______

| | |
|---|---|
| **CTO/DO Manager:** | **Bill To:** |
| **CTO/DO Name:** | **Company:** |
| **CTO/DO Number:** | **Address:** |
| ***Deliver results to the address above or as stated in contract*** | |
| **Cooler No:** | |
| **QC Level:** **TAT:** | |

**Sample Disposal**
**Shipment**
**Comments:**

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **# of containers:** | | | | | | | | | | | | | | | | |
| | | | | | | | | **Preservatives:** | | | | | | | | | | | | | | | | |
| **Sample Data** | | | | | **Matrix/QC** | | | | | | | | | | | | | | | | | | | |
| **Sample ID (EPA ID)** | **Sample ID (Navy IRP Use Only)** | **Date Collected** | **Time Collected** | **Lab ID** | **Soil** | **Water** | **Other (drum, sludge, etc.)** | **Field Duplicate (MS/MSD)** | **TPH 8015B** | **CLP VOAs** | **CLP SVOAs** | **CLP Pesticides** | **CLP Metals** | **EPA 8080 (PCBs only)** | **EPA 8240** | **EPA 8270** | **Total Lead by EPA 6010** | | | | | **Extra Volume MS/MSD** | **HOLD** | **Total # of Containers** |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | **TOTALS:** | | | | | | | | | | | | | | | | |

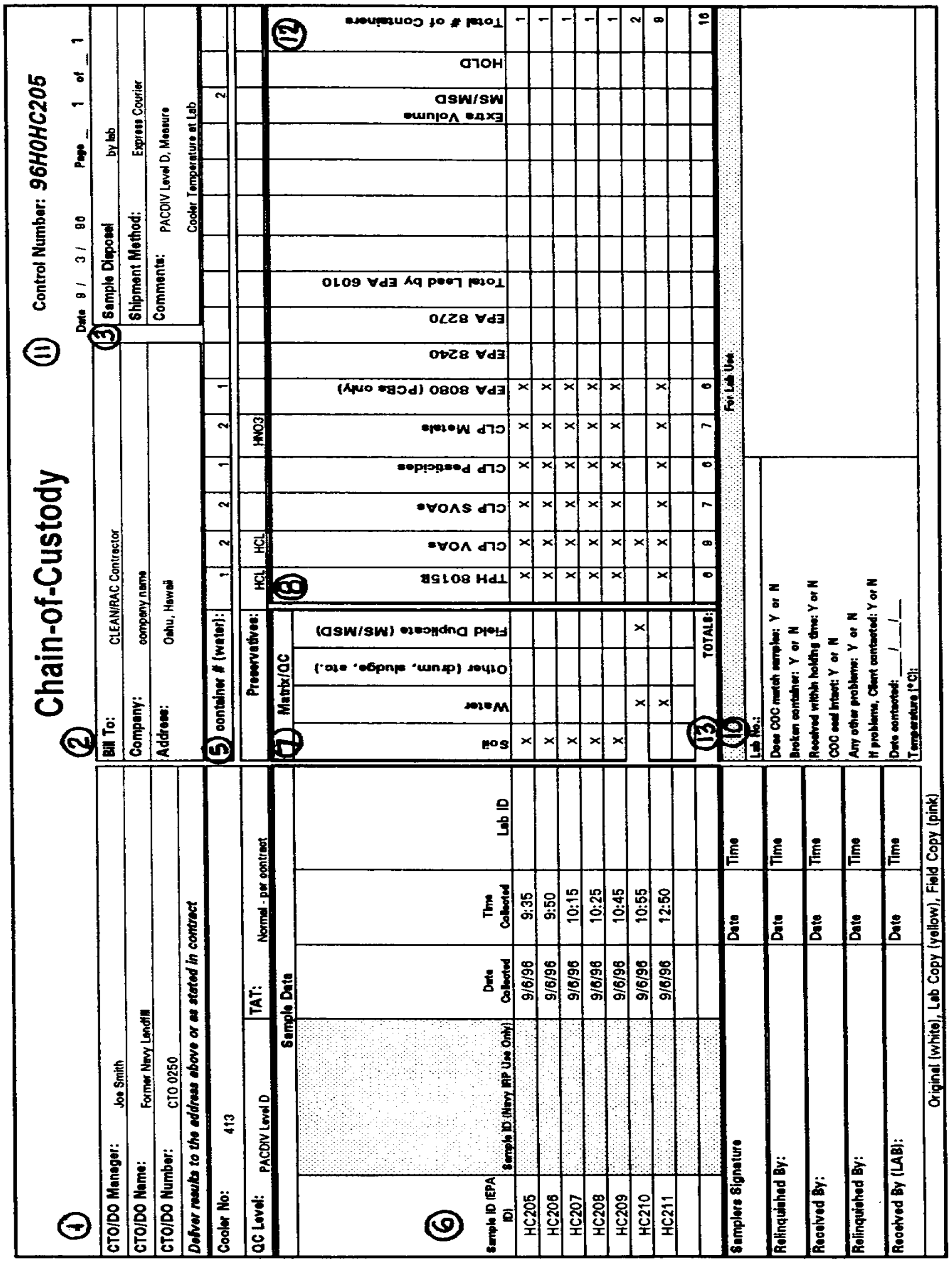
| | | |
|---|---|---|
| **Samplers Signature** | **Date** | **Time** |
| **Relinquished By:** | **Date** | **Time** |
| **Received By:** | **Date** | **Time** |
| **Relinquished By:** | **Date** | **Time** |
| **Received By (LAB):** | **Date** | **Time** |

**For Lab Use**

**Lab No.:**
**Does COC match samples: Y or N**
**Broken container: Y or N**
**Received within holding time: Y or N**
**COC seal intact: Y or N**
**Any other problems: Y or N**
**If problems, Client contacted: Y or N**
**Date contacted: ____/____/____**
**Temperature (°C):**

Original (white), Lab Copy (yellow), Field Copy (pink)

# Attachment III-E-3
# Sample Completed Chain-Of-Custody/ Analytical Request Form



## Chain-of-Custody

⑪ **Control Number:** 96H0HC205

Date 9 / 3 / 96 Page 1 of 1

①

**CTO/DO Manager:** Joe Smith
**CTO/DO Name:** Former Navy Landfill
**CTO/DO Number:** CTO 0250
***Deliver results to the address above or as stated in contract***

②

**Bill To:** CLEAN/RAC Contractor
**Company:** company name
**Address:** Oahu, Hawaii

③

**Sample Disposal** by lab
**Shipment Method:** Express Courier
**Comments:** PACDIV Level D, Measure Cooler Temperature at Lab

④ **Cooler No:** 413

**QC Level:** PACDIV Level D **TAT:** Normal - per contract

⑤ ⑥ ⑦ ⑧ ⑫

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **container # (water):** | 1 | 2 | 2 | 1 | 2 | 1 | | | | | | | | 2 | | |
| | | | | | | | | **Preservatives:** | HCL | HCL | | | HNO3 | | | | | | | | | | | |
| **Sample Data** | | | | | **Matrix/QC** | | | | | | | | | | | | | | | | | | | |
| **Sample ID (EPA ID)** | **Sample ID (Navy IRP Use Only)** | **Date Collected** | **Time Collected** | **Lab ID** | **Soil** | **Water** | **Other (drum, sludge, etc.)** | **Field Duplicate (MS/MSD)** | **TPH 8015B** | **CLP VOAs** | **CLP SVOAs** | **CLP Pesticides** | **CLP Metals** | **EPA 8080 (PCBs only)** | **EPA 8240** | **EPA 8270** | **Total Lead by EPA 6010** | | | | | **Extra Volume MS/MSD** | **HOLD** | **Total # of Containers** |
| HC205 | | 9/6/96 | 9:35 | | X | | | | X | X | X | X | X | X | | | | | | | | | | 1 |
| HC206 | | 9/6/96 | 9:50 | | X | | | | X | X | X | X | X | X | | | | | | | | | | 1 |
| HC207 | | 9/6/96 | 10:15 | | X | | | | X | X | X | X | X | X | | | | | | | | | | 1 |
| HC208 | | 9/6/96 | 10:25 | | X | | | | X | X | X | X | X | X | | | | | | | | | | 1 |
| HC209 | | 9/6/96 | 10:45 | | X | | | | X | X | X | X | X | X | | | | | | | | | | 1 |
| HC210 | | 9/6/96 | 10:55 | | | X | | X | | X | | | | | | | | | | | | | | 2 |
| HC211 | | 9/6/96 | 12:50 | | | X | | | X | X | X | X | X | X | | | | | | | | | | 9 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | ⑬ | | | **TOTALS:** | 6 | 9 | 7 | 6 | 7 | 6 | | | | | | | | | | 16 |

⑨

| | | |
|---|---|---|
| **Samplers Signature** | **Date** | **Time** |
| **Relinquished By:** | **Date** | **Time** |
| **Received By:** | **Date** | **Time** |
| **Relinquished By:** | **Date** | **Time** |
| **Received By (LAB):** | **Date** | **Time** |

⑩ **For Lab Use**

**Lab No.:**
**Does COC match samples:** Y or N
**Broken container:** Y or N
**Received within holding time:** Y or N
**COC seal intact:** Y or N
**Any other problems:** Y or N
**If problems, Client contacted:** Y or N
**Date contacted:** ___/___/___
**Temperature (°C):**

Original (white), Lab Copy (yellow), Field Copy (pink)

## Attachment III-E-4
## Sample Out-Of-Control Form

| | | | |
|---|---|---|---|
| OUT OF CONTROL FORM | Status | Date | Initial |
| | Noted OOC | | |
| | Submit for CA* | | |
| | Resubmit for CA* | | |
| | Completed | | |

| | | |
|---|---|---|
| Date Recognized: | By: | Samples Affected<br>(List by Accession<br>AND Sample No.) |
| Dated Occurred: | Matrix | |
| Parameter (Test Code): | Method: | |
| Analyst: | Supervisor: | |

| | | | |
|---|---|---|---|
| 1. Type of Event<br>(Check all that apply) | | 2. Corrective Action (CA)*<br>(Check all that apply) | |
| ☐ | Calibration Corr. Coefficient <0.995 | ☐ | Repeat calibration |
| ☐ | %RSD>20% | ☐ | Made new standards |
| ☐ | Blank >MDL | ☐ | Reran analysis |
| ☐ | Does not meet criteria: | ☐ | Sample(s) redigested and rerun |
| ☐ | Spike | ☐ | Sample(s) reextracted and rerun |
| ☐ | Duplicate | ☐ | Recalculated |
| ☐ | LCS | ☐ | Cleaned system |
| ☐ | Calibration Verification | ☐ | Ran standard additions |
| ☐ | Standard Additions | ☐ | Notified |
| ☐ | MS/MSD | ☐ | Other (please explain) |
| ☐ | BS/BSD | | |
| ☐ | Surrogate Recovery | | |
| ☐ | Calculations Error | | |
| ☐ | Holding Times Missed | | |
| ☐ | Other (Please explain | Comments: | |
| | | | |

3. Results of Corrective Action

☐ Return to Control (indicated with)

☐ Corrective Actions Not Successful - DATA IS TO BE FLAGGED with _____________.

| | |
|---|---|
| Analyst: | Date: |
| Supervisor: | Date: |
| QA Department: | Date: |

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NAVFAC NW Standard Operating Procedure Number:

III-F

Revised April 2015

# SAMPLE CONTAINERS AND PRESERVATION

---

## 1.0 PURPOSE

This standard operating procedure (SOP) describes the conventional containers used for sample collection and delivery to a laboratory for analysis. Additionally it will discuss sample preservation and holding times.

## 2.0 PROCEDURES

The purpose of sample preservation is to prevent or retard the degradation and modification of chemicals or to retard biological activity in samples during transit and storage. Efforts to preserve the integrity of the samples must be initiated as soon as possible after the time of sampling and continue until analyses are performed. Preservatives must be added to the sample container as soon as possible after the time of sample collection. The recommended procedure is to request that bottles be provided by the analytical laboratory and be pre-preserved.

Complete and unequivocal preservation of samples, domestic sewage, industrial wastes, or natural waters, is impossible in practice. Regardless of the nature of the sample, complete stability for every constituent is not likely to be achieved. At best, preservation techniques can retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. Degradation of the sample ceases only if it is preserved at a temperature of absolute zero (-273°C). However, freezing of a sample to extend hold times is not permitted. Therefore, as a general rule, it is best to analyze the samples as soon as possible after collection. This is especially true when the analyte concentration is expected to be in the low microgram per liter (mg/l) range.

Methods of preservation are relatively limited and are intended generally to perform the following:

- Retard biological action
- Retard hydrolysis of chemical compounds and complexes
- Reduce volatility of constituents
- Reduce absorption effects

Preservation methods are generally:

- pH control

- Chemical addition
- Refrigeration and/or chilling using ice

The recommended preservative for various constituents is given in the Exhibits at the end of this SOP. Preservation techniques for some analyses requiring more than simple refrigeration or filtering are discussed in Section 2.2. The exhibits also provide the estimated volume of sample required for the analysis, the suggested type of container, and the maximum recommended holding times for samples to be properly preserved.

When selecting preservation techniques and sample container type, always refer to the guidance provided in the documentation of the analytical methods to be used.

## 2.1 SAMPLE CONTAINERS

Select sample containers based on the analytical parameters of interest. Use containers made of materials that are non-reactive. Glass and polyethylene containers are the most commonly accepted, and both are used when sampling many constituents. When metals are the analytes of interest, however, polyethylene containers with Teflon-lined caps are preferred. When organics are the analytes of interest, use glass containers with Teflon-lined caps.

## 2.2 SAMPLE PRESERVATION

Utilize pre-preserved sample bottles whenever possible. If this is not possible or practical, perform appropriate chemical preservation in the field for various analytical parameters as soon as possible after the time of sample collection. Cool samples after collection and during shipment. All samples should be kept out of direct sunlight as much as possible and stored in the dark (e.g., in a cooler). Regardless of the method of preservation, analyses should be performed as soon after sampling as possible.

In some instances, the optimal method for sample preservation may be inappropriate due to the restrictions placed on the transport of certain chemicals by shippers. When shipping restrictions prevent the use of some reagents for sample preservation, use the most appropriate and permissible technique. The project chemist or laboratory should be able to assist in deciding the best alternative method of preservation.

## 2.3 MAXIMUM HOLDING TIME

Complete and unequivocal preservation of a sample for an extended period of time is a practical impossibility. Regardless of the nature of the sample, complete stability for every constituent is not likely to be achieved. Maximum holding times are assigned to each analyte and are designed for quality assurance purposes to minimize degradation effects on the analysis. Therefore, as a rule, it is better to analyze the sample as soon as possible after collection. This is especially true when low contaminant concentrations are expected.

## 2.4 REVIEW

The Field Manager or an approved designee shall check all sample control documentation to ensure that the samples, transport, and analysis events have met the criteria outlined in this SOP and the field sampling plan. Any discrepancies shall be noted and the documentation will be returned to the originator for correction or explanation. The reviewer will acknowledge that corrections have been incorporated by signing and dating each reviewed document.

## 3.0 DOCUMENTATION

All sample collection information must be recorded within the field logbook. Each sample collected will be clearly associated with a sample type (i.e. normal, field duplicate, equipment blank) sample location, matrix type, collection time, collection date, analysis and sampling depth if appropriate.

With every sample submitted for analysis, a completed chain of custody (COC) must accompany the shipment and a copy retained for the project records. The COC/analytical request form must be used to track all sample identifiers.

## 4.0 REFERENCES

None.

## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment III-F-1 | Example Sample Collection Form |

# Attachment III-F-1
# Example Sample Collection Form

Revised April 2015

## FORM 11-2
## SAMPLE COLLECTION INFORMATION

| | | |
|---|---|---|
| Installation ID: | Establishing Contract ID: | Prime Contractor Name: |

| | | | |
|---|---|---|---|
| Site Name: | DO/CTO: | Establishing Phase: | Collection Date: |

| Location Name | Sample Name | Depth Range (feet bgs) | | Collection Time | Sample Matrix | Sample Type | Sampling Equipment | Composite (Y/N) |
|---|---|---|---|---|---|---|---|---|
| | | Start Depth | End Depth | | | | | |
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |

### Sampling Equipment

| | |
|---|---|
| 2V | Double Van Veen Grab |
| AC | Air Canister |
| AP | Pump - Air Lift (bladder) |
| AS | Ashing |
| B | Bailer |
| BR | Brass (California) Ring |
| BS | Beach Seine |
| C | Continuous Flight Auger |
| CC | Continuous Core Sampler |
| CH | Charcoal Sampling Tube |
| CL | Clover Leaf Dredge Sampler |
| CN | Cone Penetrometer |
| CO | Core Sampler |
| CP | Pump - Centrifugal |
| DF | Diffusion Bag Samplers |
| DG | Drill Rig |
| DS | Dredge Sampler (brass, etc.) |
| DT | Driver Tube (geoprobe, direct push, CPT rig) |
| E2 | Pump - Electric Submersible |
| EC | Encore Soil Sampler |
| FC | Cassette Filter |
| G | Grab |
| GP | Gas-Operated, Double Acting Piston Pump |
| H | Hollow Stem Auger |
| HA | Hand Auger |
| HB | Bucket Auger |
| HC | Hand Collected |
| HD | Hand Drill - Portable Powered |
| HK | Hook and Line |
| HP | Hydropunch |
| HU | Air Sampler - High Volume w/puf Resin |
| HV | Air Sampler - High Volume |
| HX | Air Sampler - High Volume w/XAD Resin |
| IF | Isolation Flux Chamber |
| LV | Air Sampler - Low Volume Continuous |
| LY | Lysimeter |
| MPPS | Micro Push Point Sampler |
| NC | Nickel Coated Brass Bomb Sampler |
| NX | NX Rock Coring |
| PP | Pump - Peristaltic |
| PS | Passive Soil Gas Sampling Probe |
| PU | Pump - Standard, Type not Recorded |
| RS | Hollow Glass Sampling Rod |
| SC | Scoop/Trowel |
| SD | Sediment Drag or Sled |
| SK | Skimmer |
| SS | Split Spoon |
| ST | Submersible Turbine Pump |
| SY | Syringe |
| T | Shelby Tube/ASTM-D1587 |
| TB | Tedlar Bag |
| TL | Trawl |
| TR | Animal Trap |
| TS | Thief Sampler and/or Thief Type Sampler |
| UNK | Unknown |
| VC | Vacuum (gas) |
| VS | Van Dorn Sampler |
| VV | Van Veen |
| W | Swab or Wipe |
| WB | Westbay Sampling System |

Recorder: ____________________ Date: ____________

Checker____________________ Date: ____________

| Sample Matrix | | | | | |
|---|---|---|---|---|---|
| AA | Ambient Air | MA | Mastic | WI | Ground Water Influent (into system) |
| AC | Composite Air Sample | MO | Mortar | WL | Leachate |
| ACS | Air - Crawlspace | MR | Marine Sediment | WM | Marine Water |
| AD | Air - Drilling | MS | Metal Shavings | WN | Porewater |
| AI | Air - Indoor | NS | Near-Surface Soil | WO | Ocean Water |
| AIN | Integrated Air Sample | PA | Paper | WP | Drinking Water |
| AIR-ABS | Activity Based Sampling (ABS) Air Sample | PC | Paint Chips | WQ | Water for QC Samples |
| AO | Air - Outdoor | PP | Precipitate | WR | Ground Water Effluent (from system) |
| AQ | Air Quality Control Matrix | RE | Residue | WS | Surface Water |
| AQS | Aqueous | RK | Rock | WT | Composite Ground Water Sample |
| ASB | Asbestos | SB | Bentonite | WU | Storm Water |
| ASBF | Asbestos-Fibrous | SBS | Sub-Surface Soil (>6") | WW | Waste Water |
| ASBNF | Asbestos-Non-Fibrous | SC | Cement/Concrete | XR | XRF Data |
| AVE | Air-Vapor Extraction, Effluent | SD | Drill Cuttings - Solid Matrix | | |
| AX | Air Sample from Unknown Origin | SE | Sediment | **Sample Type** | |
| BK | Brick | SEEP | Seep | AB | Ambient Condition Blank |
| BS | Brackish Sediment | SF | Filter Sandpack | BIOCON | Bioassay Control Sample |
| CA | Cinder Ash | SJ | Sand | BS | Blank Spike |
| CK | Caulk | SK | Asphalt | BSD | Blank Spike Duplicate |
| CN | Container | SL | Sludge | EB | Equipment Blank |
| CR | Carbon (usually for a remediation system) | SM | Water Filter (solid material used to filter water) | EBD | Equipment Blank/Rinsate Duplicate |
| DF | Dust/Fallout | SN | Miscellaneous Solid Materials - Building Materials | FB | Field Blank |
| DR | Debris/Rubble | SO | Soil | FD | Field Duplicate |
| DS | Storm Drain Sediment | SP | Casing (PVC, stainless steel, cast iron, iron pipe) | FR | Field Replicate |
| DT | Trapped Debris | SQ | Soil/Solid Quality Control Matrix | FS | Field Spike |
| EF | Emissions Flux | SS | Scrapings | IDW | Purge and Rinseate Water |
| EW | Elutriate Water | SSD | Subsurface Sediment | LB | Lab Blank |
| FB | Fibers | STKG | Stack Gas | LR | Lab Replicate |
| FL | Forest Litter | STPM | Stripper Tower Packing Media | MB | Material Blank |
| GE | Soil Gas Effluent - Stack Gas (from system) | SU | Surface Soil (less than 6 inches) | MIS | Multi-Incremental Sample |
| GI | Soil Gas Influent (into system) | SW | Swab or Wipe | MS | Matrix Spike |
| GL | Headspace of Liquid Sample | SZ | Wood | N | Normal (Regular) |
| GQ | Gaseous or Headspace QC | TA | Animal Tissue | PE | Performance Evaluation |
| GR | Gravel | TP | Plant Tissue | PURGE | Purge Water Sample |
| GS | Soil Gas | TQ | Tissue QC | RD | Regulatory Duplicate |
| GSS | Soil Gas - Subslab | TX | Tissue | SB | Source Blank |
| GT | Grit | UNK | Unknown | SBD | Source Blank Duplicate |
| IC | IDW Concrete | W | Water (not groundwater, unspecified) | SCREEN | Screening Sample |
| IDD | IDW Solid | WA | Drill Cuttings - Aqueous Mix | SD | Matrix Spike Duplicate |
| IDS | IDW Soil | WB | Brackish Water | SPLIT | Sample Split |
| IDW | IDW Water | WC | Drilling Water (used for well construction) | SRM | Standard Reference Material |
| IW | Interstitial Water | WD | Well Development Water | TB | Trip Blank |
| LA | Aqueous Phase of Multiphase Liquid/Soil | WF | Freshwater (not groundwater) | TBD | Trip Blank Duplicate |
| LF | Product (floating or free) | WG | Ground Water | TBR | Trip Blank Replicate |
| LQ | Organic Liquid Quality Control Matrix | WH | Equipment Wash Water (i.e. water used for washing equipment) | | |

## Instructions

## Form 11-2 (Sample Collection Information)

The purpose of this form is to collate sample collection information for data entry to serve as a quick reference for sample information. Every sample that is collected should be recorded on one of these forms. The information recorded on this form must come from the field logbook, which is the official record. This form must be filled out in its entirety; if a value or piece of information is unknown or not applicable, a horizontal line should be drawn through that field.

The information on this form must be checked against the field logbook for accuracy and completeness by a field staff member before the form is submitted for data entry. Data from this form will not be entered without the signature of the individual who checked the form for accuracy and completeness.

**Installation ID:** Unique identifier for installation associated with the location (example: WHIDBEY)

**Establishing Contract ID:** Unique contract ID assigned by Division Contraction Office (example: D459559365800)

**Prime Contractor Name:** Name of company that established location (example: URS)

**Site Name:** Site name associated with the location (example: Site 11)

**DO/CTO:** Contract Task Order (CTO) or Delivery Order (DO) number assigned by the Navy. The format is NNNN (example: 0012)

**Establishing Phase**: Task Phase, Subtask Number or Annual Quarter (example: 1)

**Collection Date:** Date samples were collected

**Location Name:** Unique name used for the location (example: MW-2R)

**Sample Name:** Unique sample name assigned by the contractor and/or derived from historical data submittal (example: MW-1-11/02/98)

**Depth Range (feet bgs):** Start and end depth of sample collection, if applicable.

**Collection Time:** Time at which sample was collected

**Sample Matrix:** Matrix type code from options at the bottom of form (example: MR)

**Sample Type:** Sample type code from options at bottom of form (example: N)

**Sampling Equipment:** Sampling equipment code from options at bottom of form (example: G)

**Composite:** A Y/N field indicating whether or not the sample is a composite

**Recorder:** Signature of individual who completed form and date completed

**Checker:** Signature of individual who checked the data against the field logbook and date checked

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NAVFAC NW Standard Operating Procedure Number:

III-G

Revised April 2015

# SAMPLE HANDLING, STORAGE, AND SHIPPING

## 1.0 PURPOSE

This standard operating procedure (SOP) sets forth the methods for use by U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) field personnel and their contractors engaged in handling, storing, and transporting water, soil and/or sediment samples.

## 2.0 PROCEDURE

### 2.1 HANDLING AND STORAGE

Immediately following collection, all samples will be labeled according to the procedures in SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures*. The lids of the containers shall not be sealed with duct tape, but may be covered with custody seals or placed directly into sealed plastic bags. The sample containers shall be placed in an insulated cooler with frozen gel packs (such as "blue ice") or ice in double, self-sealing bags. Samples should occupy the lower portion of the cooler, while the ice should occupy the upper portion. An absorbent material (e.g., proper absorbent cloth material) may be placed on the bottom of the cooler to contain liquids in case of spillage. All empty space between sample containers shall be filled with bubble wrap, Styrofoam "peanuts," or other appropriate material. Prior to shipping, glass sample containers should be wrapped on the sides, tops, and bottoms with bubble wrap or other appropriate padding and/or surrounded by packing material to prevent breakage during transport. Prior to shipment, the ice or cold packs in the coolers may require replacement to maintain samples as close to 4°C as possible during transport of the samples to the analytical laboratory. Samples shall be shipped as soon as possible to allow the laboratory to meet holding times for analyses. The procedures for maintaining sample temperatures at 4°C, pertains to all water, soil, and sediment field samples.

### 2.2 SHIPPING

All appropriate U.S. Department of Transportation (DOT) regulations (e.g., 49 Code of Federal Regulations (CFR), Parts 171-179) shall be followed in shipment of air, soil, water, and other samples.

#### 2.2.1 Hazardous Materials Shipment

Field personnel must state whether any sample is suspected to be a hazardous material. A sample should be assumed to be hazardous unless enough evidence exists to indicate it is nonhazardous. If not suspected to be hazardous, shipments may be made as described in the Section 2.2.2 for non-hazardous materials. If hazardous, the procedures summarized below must be followed.

Any substance or material that is capable of posing an unreasonable risk to life, health, or property when transported is classified as hazardous. Hazardous materials identification should be performed by checking the list of dangerous goods for that particular mode of transportation. If not on that list, materials can be classified by checking the Hazardous Materials Table (49 CFR 172.102 including Appendix A) or by determining if the material meets the definition of any hazard class or division (49 CFR Part 173), as listed in Attachment III-G-2.

All persons offering for shipment any hazardous material must be properly trained in the appropriate regulations, as required by HM-126F, Training for Safe Transportation of Hazardous Materials. The training covers loading, unloading, handling, storing, and transporting of hazardous materials, as well as emergency preparedness in the case of accidents. Carriers such as commercial couriers must also be trained.

When shipping hazardous materials, including bulk chemicals or samples suspected of being hazardous, the proper shipping papers (49 CFR 172 Subpart C), package marking (49 CFR 172 Subpart D), labeling (49 CFR 172 Subpart E), placarding (49 CFR 172 Subpart F, generally for carriers), and packaging must be used. Attachment III-G-1 shows an example of proper package markings. A copy of 49 CFR should be referred to each time a hazardous material or potentially hazardous samples are shipped.

According to Section 2.7 of the International Air Transport Association (IATA) Dangerous Goods Regulations publication, very small quantities of certain dangerous goods may be transported without certain marking and documentation requirements as described in 49 CFR Part 172. However, other labeling and packing requirements must still be followed. Attachment III-G-2 shows the volume or weight for different classes of substances. A "Dangerous Goods in Excepted Quantities" label must be completed and attached to the associated shipping cooler (Attachment III-G-3). Certain dangerous goods are not allowed on certain airlines in any quantity.

As stated in item 4 of Attachment III-G-4, the Hazardous Materials Regulations do not apply to hydrochloric acid (HCl), nitric acid ($HNO_3$), sulfuric acid ($H_2SO_4$), and sodium hydroxide (NaOH) added to water samples if their pH or percentages by weight criteria are met. These samples may be shipped as non-hazardous materials as discussed below.

### 2.2.2 Nonhazardous Materials Shipment

If the samples are suspected to be nonhazardous, based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as nonhazardous.

When a cooler is ready for shipment to the laboratory, copies of the chain-of-custody form shall be placed inside a sealed plastic bag and placed inside of an insulated cooler. The coolers will then be sealed with waterproof tape and labeled "Fragile," "This-End-Up" (or directional arrows pointing up), or other appropriate notices. Custody seals will be placed on the coolers as discussed in SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures*.

### 2.2.3 Shipments from Outside the Continental United States

Shipment of sample coolers to the U.S. from locations outside the continental U.S. is controlled by the USDA and is subject to their inspection and regulation. Documentation is required to prove that the analytical laboratory receiving samples is certified. The laboratory must have certification by USDA to receive and properly dispose of soil; this is called a "USDA Soil Import Permit." In addition, all sample coolers must be inspected by a USDA representative, affixed with a label indicating that the coolers contain environmental samples, and shipping forms stamped by the USDA inspector prior to shipment. In addition, samples shipped from U.S. territorial possessions or foreign countries, must be cleared by the U.S. Customs Service upon entry into the United States. As long as the commercial invoice is properly completed (see below), shipments typically pass through U.S. Customs without the need to open coolers for inspection.

Completion and use of proper paperwork will, in most cases, minimize or eliminate the need of the USDA and U.S. Customs to inspect the contents. Attachment III-G-5 shows an example of how paperwork may be placed on the outside of coolers for nonhazardous materials. For hazardous materials, refer to Section 2.2.1.

In summary, the paperwork listed below should be taped to the outside of the coolers to assist sample shipments. If a shipment is made up of multiple pieces (e.g., more than one cooler), the paperwork need be attached only to one cooler, provided that the courier agrees. All other coolers in the shipment need only be taped and have address and chain-of-custody seals affixed.

1. **Courier Shipping Form & Commercial Invoice** - See Attachments III-G-6, III-G-7, and III-G-8 for examples of the information to be included on these forms. Both forms should be placed inside a clear plastic adhesive-backed pouch, which adheres to the package (typically supplied by the courier) and placed on the cooler lid as shown in Attachment 5.

2. **Soil Import Permit and USDA Letter** (soil only) - See Attachments III-G-9 and III-G-10 for examples. The laboratory shall supply these documents prior to mobilization. The USDA in Hawaii often does stop shipments of soil without these documents. The 2" x 2" USDA label (described below), the USDA letter, and soil impact permit should be stapled together and placed inside a clear plastic pouch. Clear plastic and adhesive-backed pouches are typically supplied by the mailing courier.

3. The analytical laboratory should supply the Soil Import Permit. Although original labels are preferred, copies of this label, which are cut out to the 2" x 2" dimensions, are acceptable. Placing one label (as shown in Attachment III-G-5) covered with clear packing tape and one stapled to the actual permit is suggested.

4. The USDA does not control water samples, thus the requirements for soils listed above do not apply.

5. **Custody Seals**. Task Order personnel must sign and date custody seals. At least two seals should be placed in such a manner that they stick to both the cooler lid and body. The seals shall be placed so the cooler/container cannot be opened without breaking the seal. The custody seals are

then covered with clear packing tape. This prevents the seal from coming loose and enables detection of tampering.

6. **Address Label**. A label stating the destination (the sending and laboratory, company, or location address) should be affixed to each cooler. The label should also include both telephone numbers.
7. **Special Requirements for Hazardous Materials -** see Section 2.2.1.

Upon receipt of sample coolers at the laboratory, the sample custodian shall inspect the sample containers as discussed in SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures*. The samples shall then be immediately extracted and/or analyzed, or stored in a refrigerated storage area until they are removed for extraction and/or analysis. Whenever the samples are not being extracted or analyzed, they shall be returned to refrigerated storage.

## 3.0 DOCUMENTATION

Records shall be maintained as required by implementing these procedures.

## 4.0 REFERENCES

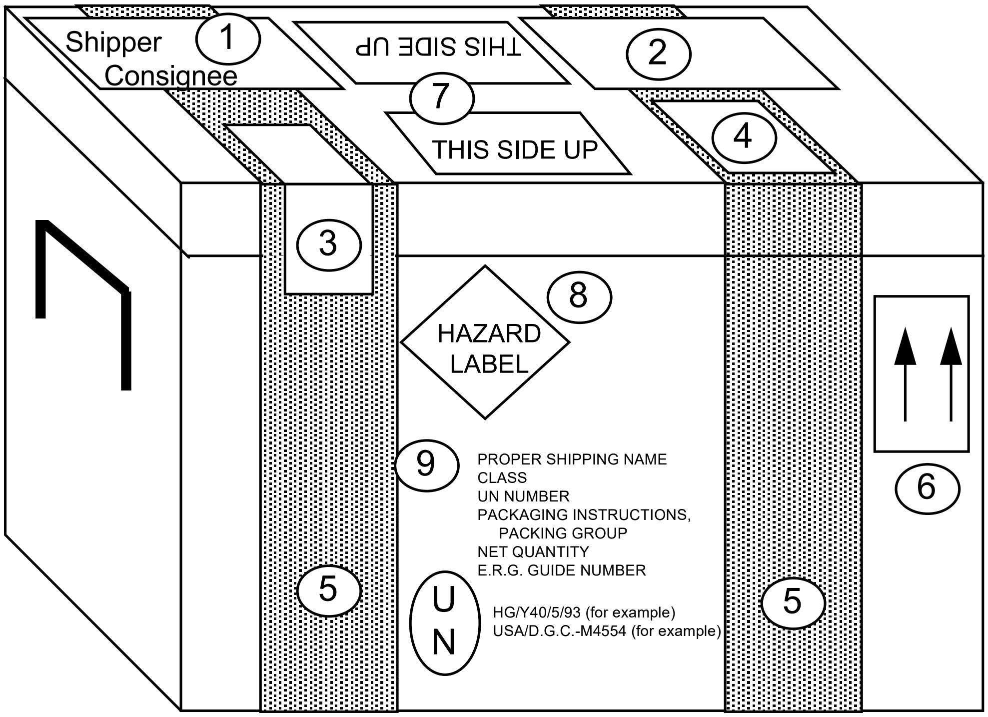
HM-126F, Training for Safe Transportation of Hazardous Materials

SOP III-E, Record Keeping, Sample Labeling, and Chain-of-Custody Procedures

## 5.0 ATTACHMENTS

| | |
|---|---|
| Attachment III-G-1 | Example Package Marking |
| Attachment III-G-2 | Packing Groups |
| Attachment III-G-3 | Label for Dangerous Goods in Excepted Quantities |
| Attachment III-G-4 | SW-846 Preservative Exception |
| Attachment III-G-5 | Sample Cooler Marking Figure |
| Attachment III-G-6 | Example Courier Form |
| Attachment III-G-7 | Commercial Invoice - Soil |
| Attachment III-G-8 | Commercial Invoice - Water |
| Attachment III-G-9 | Soil Import Permit |
| Attachment III-G-10 | Soil Samples Restricted Entry Labels |

## Attachment III-G-1
## Example Hazardous Material Package Marking



1 **AIR BILL/COMMERCIAL INVOICE**

2 **USDA PERMIT (Letter to Laboratory from USDA)**

3 **CUSTODY SEAL**

4 **USDA 2" X 2" SOIL IMPORT PERMIT**

5 **WATERPROOF STRAPPING TAPE**

6 **DIRECTION ARROWS STICKER - TWO REQUIRED**

7 **THIS SIDE UP STICKERS**

8 **HAZARD LABEL**

9 **HAZARDOUS MATERIAL INFORMATION**

10 **PACKAGE SPECIFICATIONS**

# Attachment III-G-2
# Packing Groups

| Packing Group of the Substance | | Packing Group I | | Packing Group II | | Packing Group III | |
|---|---|---|---|---|---|---|---|
| CLASS or DIVISION of PRIMARY or SUBSIDIARY RISK | | Packagings | | Packagings | | Packagings | |
| | | Inner | Outer | Inner | Outer | Inner | Outer |
| 1: | Explosives | -------------------- Forbidden (Note A) ------------------- | | | | | |
| 2.1: | Flammable Gas | -------------------- Forbidden (Note B) ------------------- | | | | | |
| 2.2: | Non-Flammable, non-toxic gas | ------------------ See Notes A and B ----------------- | | | | | |
| 2.3: | Toxic gas | -------------------- Forbidden (Note A) ------------------- | | | | | |
| 3. | Flammable liquid | 30 mL | 300 mL | 30 mL | 500 mL | 30 mL | 1 L |
| 4.1 | Self-reactive substances | Forbidden | | Forbidden | | Forbidden | |
| 4.1: | Other flammable solids | Forbidden | | 30 g | 500 g | 30 g | 1 kg |
| 4.2: | Pyrophoric substances | Forbidden | | Not Applicable | | Not Applicable | |
| 4.2 | Spontaneously combustible substances | Not Applicable | | 30 g | 500 g | 30 g | 1 kg |
| 4.3: | Water reactive substances | Forbidden | | 30 g or 30 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |
| 5.1: | Oxidizers | Forbidden | | 30 g or 30 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |
| 5.2: | Organic peroxides (Note C) | See Note A | | 30 g or 30 mL | 500 g or 250 mL | Not Applicable | |
| 6.1: | Poisons - Inhalation toxicity | Forbidden | | 1 g or 1 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |
| 6.1: | Poisons - oral toxicity | 1 g or 1 mL | 300 g or 300 mL | 1 g or 1 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |
| 6.1: | Poisons - dermal toxicity | 1 g or 1 mL | 300 g or 300 mL | 1 g or 1 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |
| 6.2: | Infectious substances | -------------------- Forbidden (Note A) ------------------- | | | | | |
| 7: | Radioactive material (Note D) | -------------------- Forbidden (Note A) ------------------- | | | | | |
| 8: | Corrosive materials | Forbidden | | 30 g or 30 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |
| 9: | Magnetized materials | -------------------- Forbidden (Note A) ------------------- | | | | | |
| 9: | Other miscellaneous materials (Note E) | Forbidden | | 30 g or 30 mL | 500 g or 500 mL | 30 g or 30 mL | 1 kg or 1 L |

Note A: Packing groups are not used for this class or division.

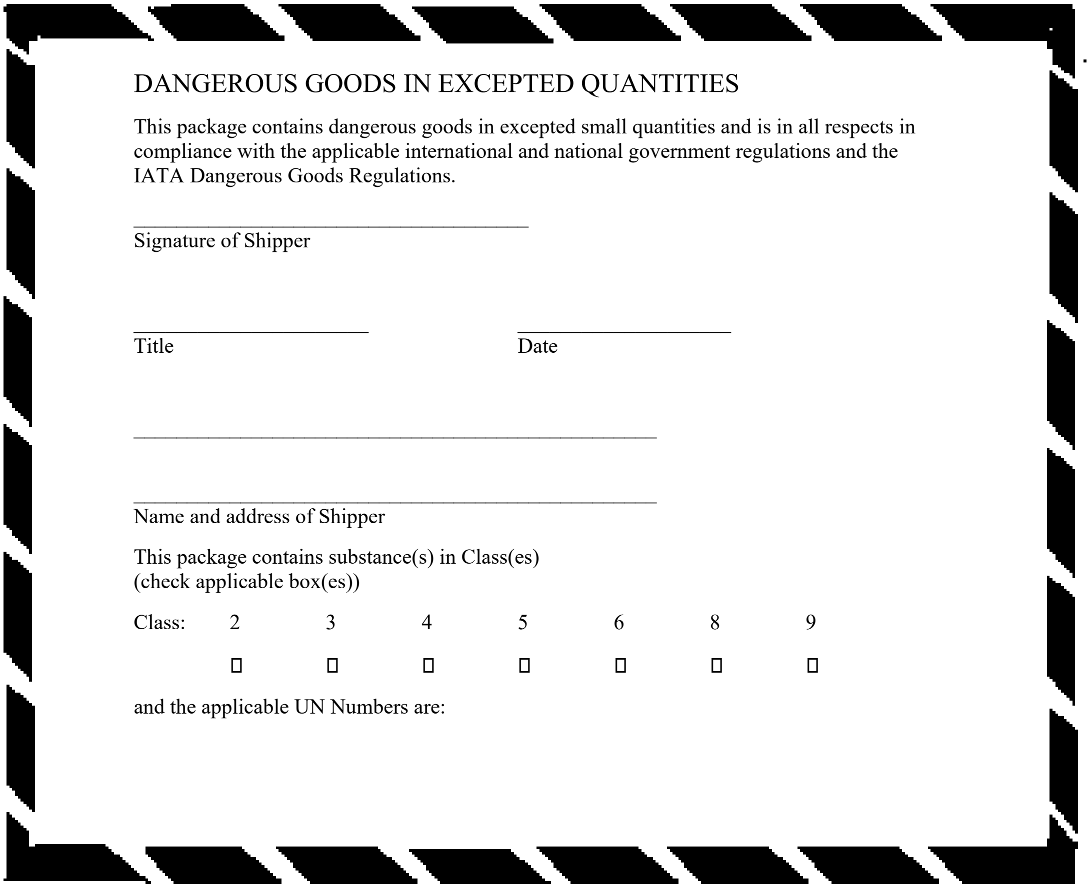
Note B: For inner packagings, the quantity contained in receptacle with a water capacity of 30 mL. For outer packagings, the sum of the water capacities of all the inner packagings contained must not exceed 1 L.

Note C: Applies only to Organic Peroxides when contained in a chemical kit, first aid kit or polyester resin kit.

Note D: See 6.1.4.1, 6.1.4.2 and 6.2.1.1 through 6.2.1.7, radioactive material in excepted packages.

Note E: For substances in Class 9 for which no packing group is indicated in the List of Dangerous Goods, Packing Group II quantities must be used.

## Attachment III-G-3
## Label For Dangerous Goods In Excepted Quantities



DANGEROUS GOODS IN EXCEPTED QUANTITIES

This package contains dangerous goods in excepted small quantities and is in all respects in compliance with the applicable international and national government regulations and the IATA Dangerous Goods Regulations.

_____________________________________
Signature of Shipper

______________________
Title

____________________
Date

_________________________________________________

_________________________________________________
Name and address of Shipper

This package contains substance(s) in Class(es)
(check applicable box(es))

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Class: | 2 | 3 | 4 | 5 | 6 | 8 | 9 |
| | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

and the applicable UN Numbers are:

## ATTACHMENT III-G-4
## Preservative Exception

| Measurement | Vol. Req. (mL) | Container[2] | Preservative [3,4] | Holding Time[5] |
|---|---|---|---|---|
| MBAS | 250 | P,G | Cool, 4ºC | 48 Hours |
| NTA | 50 | P,G | Cool, 4ºC | 24 Hours |

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-82 (1976) Method D-3370.

2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.

3. Sample preservation should be performed immediately upon sample collection. For composite samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4ºC until compositing and sample splitting is completed.

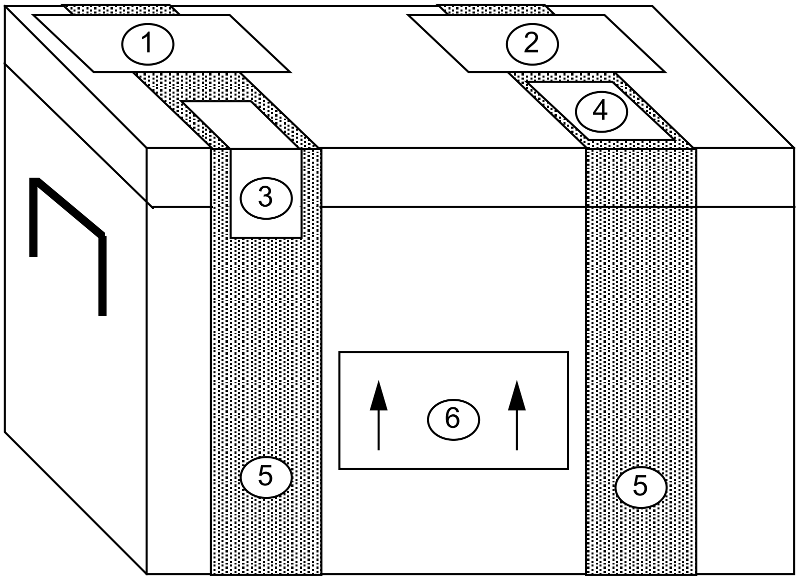
4. When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. for the preservation requirements of Table 1, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentration of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid ($HNO_3$) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid ($H_2SO_4$) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or grater); Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.

6. Should only be used in the presence of residual chlorine.

## Attachment III-G-5

## Non-Hazardous Material Cooler Marking Figure For Shipment From Outside the Continental United States



**① AIR BILL/COMMERCIAL INVOICE**
**② USDA PERMIT (Letter to Laboratory from USDA)**
**③ CUSTODY SEAL**
**④ USDA 2" X 2" SOIL IMPORT PERMIT**
**⑤ WATERPROOF STRAPPING TAPE**
**⑥ DIRECTION ARROWS STICKER - TWO REQUIRED**

## Attachment III-G-6
## Example Courier Form

**FedEx** *USA Airbill* FedEx Tracking Number 801704855619   0200 Form I.D. No.   SPL11   **Sender's Copy**

**1 From** (please print and press hard)

Date ______ Sender's FedEx Account Number [redacted] Account Number

Sender's Name Joe Smith   Phone (808) 545-2462

Company OGDEN ENVIRONMENTAL/CRC ACCT

Address 680 IWILEI RD STE 660   Dept./Floor/Suite/Room

City HONOLULU   State HI   ZIP 96817

**2** Your Internal Billing Reference Information (Optional) (First 24 characters will appear on invoice)

**3 To** (please print and press hard)

Recipient's Name Sample Receipt   Phone (   ) Lab Phone #

Company Lab Name

☐ Check here if residence (Extra charge applies for FedEx Express Saver)

Address Lab Address
(To "HOLD" at FedEx location, print FedEx address here)   (We Cannot Deliver to P.O. Boxes or P.O. ZIP Codes)   Dept./Floor/Suite/Room

City ______ State ______ ZIP ______

**For HOLD at FedEx Location check here**
☐ Hold Weekday (Not available with FedEx First Overnight)
☐ Hold Saturday (Not available at all locations) (Available for FedEx Priority Overnight and FedEx 2Day only)

**For Saturday Delivery check here**
☐ (Extra Charge. Not available to all locations) (Available for FedEx Priority Overnight and FedEx 2Day only)

**Service Conditions, Declared Value, and Limit of Liability** – By using this Airbill, you agree to the service conditions in our current Service Guide or U.S. Government Service Guide. Both are available on request. SEE BACK OF SENDER'S COPY OF THIS AIRBILL FOR INFORMATION AND ADDITIONAL TERMS. We will not be responsible for any claim in excess of $100 per package whether the result of loss, damage, or delay, non-delivery, misdelivery, or misinformation, unless you declare a higher value, pay an additional charge, and document your actual loss in a timely manner. Your right to recover from us for any loss includes intrinsic value of the package, loss of sales, interest, profit, attorney's fees, costs, and other forms of damage, whether direct, incidental, consequential, or special, and is limited to the greater of $100 or the declared value but cannot exceed actual documented loss. The maximum declared value for any FedEx Letter and FedEx Pak is $500. Federal Express may, upon your request, and with some limitations, refund all transportation charges paid. **See the FedEx Service Guide for further details.**

**Questions?**
**Call 1·800·Go·FedEx** (800)463-3339

*The World On Time*®

**4a Express Package Service** ***Packages under 150 lbs.*** Delivery commitment may be later in some areas.
☐ FedEx Priority Overnight (Next business morning)
☐ FedEx Standard Overnight (Next business afternoon)
☐ FedEx 2Day* (Second business day)
☐ FedEx Express Saver* (Third business day)
☐ FedEx First Overnight (Earliest next business morning delivery to select locations) (Higher rates apply)
*FedEx Letter Rate not available. Minimum charge: One pound rate.

**4b Express Freight Service** ***Packages over 150 lbs.*** Delivery commitment may be later in some areas.
☐ FedEx Overnight Freight (Next business day)
☐ FedEx 2Day Freight (Second business day)
☐ FedEx Express Saver Freight (Up to 3 business days)
(Call for delivery schedule. See back for detailed descriptions of freight services.)

**5 Packaging** ☐ FedEx Letter ☐ FedEx Pak (Declared value limit $500.) ☐ FedEx Box ☐ FedEx Tube ☐ Other Pkg.

**6 Special Handling**
**Does this shipment contain dangerous goods?** ☐ Yes (As per attached Shipper's Declaration) ☐ Yes (Shipper's Declaration not required)
☐ Dry Ice
Dry Ice, 9, UN 1845 III ______ x ______ kg. 904
(Dangerous Goods Shipper's Declaration not required)
CA ☐ Cargo Aircraft Only

**7 Payment**
Bill to: ☐ Sender (Account no. in section 1 will be billed) ☐ Recipient ☐ Third Party ☐ Credit Card (Enter FedEx account no. or Credit Card no. below) ☐ Cash/Check

FedEx Account No. ______
Credit Card No. ______ Exp. Date ______

| Total Packages | Total Weight | Total Declared Value* | Total Charges |
|---|---|---|---|
| | | $ .00 | $ |

*When declaring a value higher than $100 per shipment, you pay an additional charge. See **SERVICE CONDITIONS, DECLARED VALUE, AND LIMIT OF LIABILITY** section for further information.

**8 Release Signature** *Sign to authorize delivery without obtaining signature.*

Your signature authorizes Federal Express to deliver this shipment without obtaining a signature and agrees to indemnify and hold harmless Federal Express from any resulting claims.

287

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## Attachment III-G-7
## Commercial Invoice - Soil

| | |
|---|---|
| DATE OF EXPORTATION<br>1/1/94 | EXPORT REFERENCES (i.e., order no., invoice no., etc.)<br><CTO #> |
| SHIPPER/EXPORTER (complete name and address)<br>Joe Smith<br>Ogden<br>c/o <hotel name><br><hotel address> | CONSIGNEE<br>Sample Receipt<br><Lab Name><br><Lab Address> |
| COUNTRY OF EXPORT<br>Guam, USA | IMPORTER - IF OTHER THAN CONSIGNEE |
| COUNTRY OF ORIGIN OF GOODS<br>Guam, USA | |
| COUNTRY OF ULTIMATE DESTINATION<br>USA | |

INTERNATIONAL AIR WAYBILL NO. ☐ (NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)

| MARKS/ NOS | NO. OF PKGS | TYPE OF PACKAGING | FULL DESCRIPTION OF GOODS | QTY | UNIT OF MEASURE | WEIGHT | UNIT VALUE | TOTAL VALUE |
|---|---|---|---|---|---|---|---|---|
| | 3 | coolers | Soil samples for laboratory analysis only | | | | $1.00 | $3.00 |
| | TOTAL NO. OF PKGS. | | | | | TOTAL WEIGHT | | TOTAL INVOICE VALUE |
| | 3 | | | | | | | $3.00 |
| | | | | | | | | Check one<br>☐ F.O.B.<br>☐ C&F<br>☐ C.I.F. |

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

| Name/Title | Signature | Date |
|---|---|---|
| Joe Smith, Ogden | Joe Smith | 1/1/94 |

## ATTACHMENT III-G-8
## Commercial Invoice - Water

| | |
|---|---|
| DATE OF EXPORTATION<br>1/1/94 | EXPORT REFERENCES (i.e., order no., invoice no., etc.)<br><CTO #> |
| SHIPPER/EXPORTER (complete name and address)<br>Joe Smith<br>Ogden<br>c/o <hotel name><br><hotel address> | CONSIGNEE<br>Sample Receipt<br><Lab Name><br><Lab Address> |
| COUNTRY OF EXPORT<br>Guam, USA | IMPORTER - IF OTHER THAN CONSIGNEE |
| COUNTRY OF ORIGIN OF GOODS<br>Guam, USA | |
| COUNTRY OF ULTIMATE DESTINATION<br>USA | |

| | | |
|---|---|---|
| INTERNATIONAL AIR WAYBILL NO. | | (NOTE: All shipments must be accompanied by a Federal Express International Air Waybill) |

| MARKS/ NOS | NO. OF PKGS | TYPE OF PACKAGING | FULL DESCRIPTION OF GOODS | QTY | UNIT OF MEASURE | WEIGHT | UNIT VALUE | TOTAL VALUE |
|---|---|---|---|---|---|---|---|---|
| | 3 | coolers | Water samples for laboratory analysis only | | | | $1.00 | $3.00 |
| | TOTAL NO. OF PKGS. | | | | | TOTAL WEIGHT | | TOTAL INVOICE VALUE |
| | 3 | | | | | | | $3.00 |
| | | | | | | | | Check one<br>☐ F.O.B.<br>☐ C&F<br>☐ C.I.F. |

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

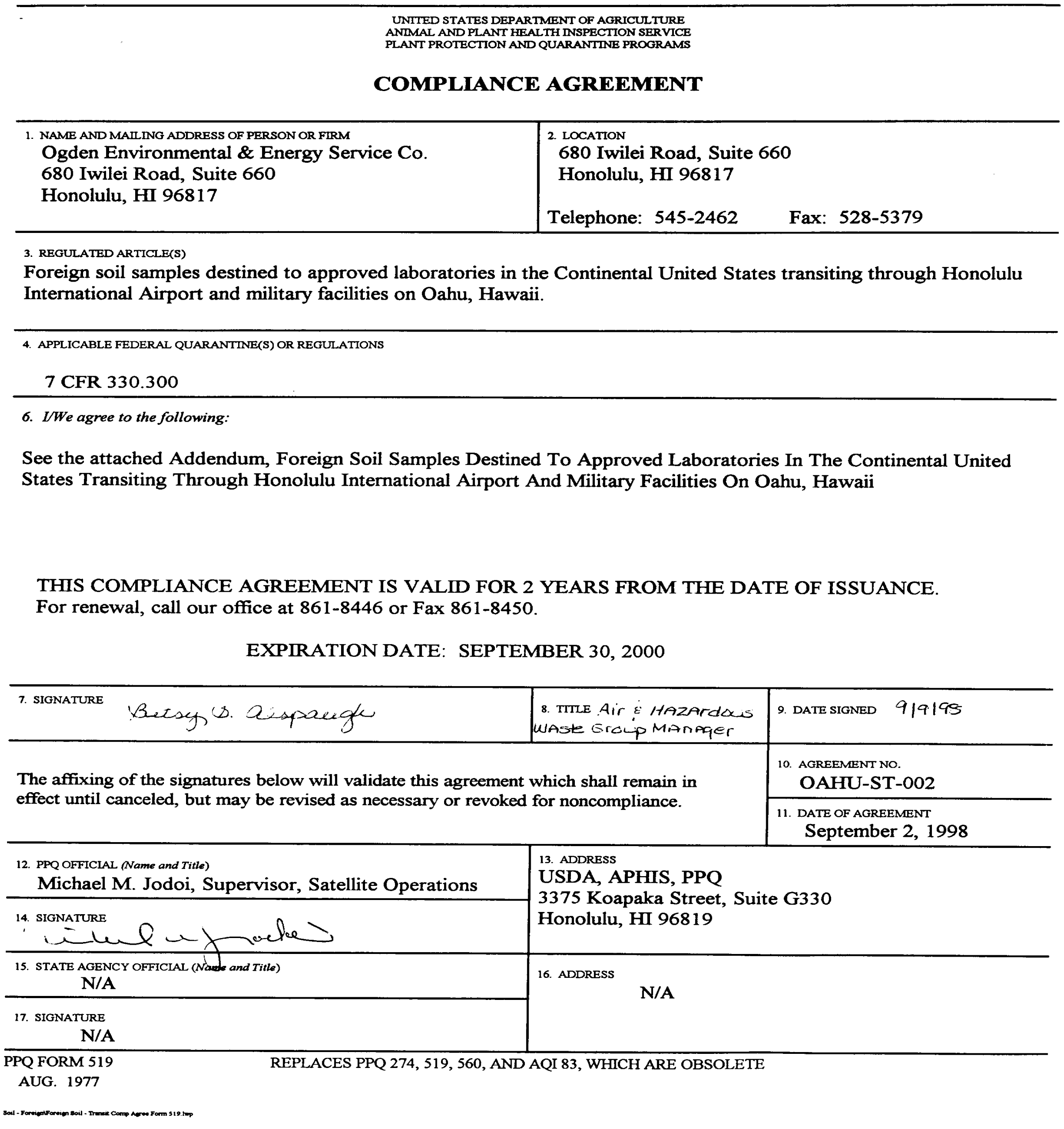
DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

| | | |
|---|---|---|
| Joe Smith, Ogden | Joe Smith | 1/1/94 |
| Name/Title | Signature | Date |

# Attachment III-G-9
## Soil Import Permit



UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE PROGRAMS

**COMPLIANCE AGREEMENT**

1. NAME AND MAILING ADDRESS OF PERSON OR FIRM
Ogden Environmental & Energy Service Co.
680 Iwilei Road, Suite 660
Honolulu, HI 96817

2. LOCATION
680 Iwilei Road, Suite 660
Honolulu, HI 96817

Telephone: 545-2462 Fax: 528-5379

3. REGULATED ARTICLE(S)
**Foreign soil samples destined to approved laboratories in the Continental United States transiting through Honolulu International Airport and military facilities on Oahu, Hawaii.**

4. APPLICABLE FEDERAL QUARANTINE(S) OR REGULATIONS

7 CFR 330.300

6. *I/We agree to the following:*

See the attached Addendum, Foreign Soil Samples Destined To Approved Laboratories In The Continental United States Transiting Through Honolulu International Airport And Military Facilities On Oahu, Hawaii

THIS COMPLIANCE AGREEMENT IS VALID FOR 2 YEARS FROM THE DATE OF ISSUANCE.
For renewal, call our office at 861-8446 or Fax 861-8450.

EXPIRATION DATE: SEPTEMBER 30, 2000

7. SIGNATURE Betsy D. Aispaugh

8. TITLE Air & Hazardous Waste Group Manager

9. DATE SIGNED 9/9/98

The affixing of the signatures below will validate this agreement which shall remain in effect until canceled, but may be revised as necessary or revoked for noncompliance.

10. AGREEMENT NO. OAHU-ST-002

11. DATE OF AGREEMENT September 2, 1998

12. PPQ OFFICIAL *(Name and Title)*
Michael M. Jodoi, Supervisor, Satellite Operations

13. ADDRESS
USDA, APHIS, PPQ
3375 Koapaka Street, Suite G330
Honolulu, HI 96819

14. SIGNATURE

15. STATE AGENCY OFFICIAL *(Name and Title)*
N/A

16. ADDRESS
N/A

17. SIGNATURE
N/A

PPQ FORM 519
AUG. 1977

REPLACES PPQ 274, 519, 560, AND AQI 83, WHICH ARE OBSOLETE

Soil - Foreign\Foreign Soil - Transit Comp Agree Form 519.hwp

## Attachment III-G-10
## Soil Samples Restricted Entry Labels

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE
HYATTSVILLE, MARYLAND 20782
soil samples
restricted entry

The material contained in this package is imported under authority of the Federal Plant Pest Act of May 23, 1957.

For release without treatment if addressee is currently listed as approved by Plant Protection and Quarantine.

PPQ FORM 550 (JAN 83) Edition of 12/77 may be used

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PPQ FORM 550 Edition of 12/77 may be used
(JAN 83)

# PERFORMANCE EVALUATION

## 1.0 PURPOSE

This section sets forth the standard operating procedure (SOP) for using performance evaluation (PE) samples on U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) sampling projects. PE samples are used to assess analytical accuracy in the laboratory during the time frame that project samples are analyzed for a given method.

## 2.0 PROCEDURES

PE samples shall be obtained from a vendor/supplier for the analyte(s) of interest. For example, if only a subset of analytes from an analytical category are suspected, the PE sample need only be spiked with these (e.g., benzene and trichloroethene from the volatile organic compounds analytical category may be the only compounds of concern for a specific project). This sample is shipped to the analytical laboratory along with other site samples and analyzed. It should be double blind, i.e., the identity of the PE sample, analytes, and concentrations are unknown to the laboratory. In order to serve as a double blind PR sample, it is important that the sample, to the extent practical, mimic the actual field samples in terms of the number, type, and concentration of contaminants, and the sample matrix composition. In some instances, a water blanks may be added to the bottle count to provide a complete sample set when not all of the analysis are being spiked.

The concentration of interest shall also be specified. If site samples are expected to be at low concentrations, it is better to specify that a low concentration of the analytes be spiked into the PE sample. Generally, spikes at 2 to 3 times the reporting limit and near the regulatory action level (if any) are useful for water samples to verify the reporting limits provided by the laboratory, while spikes greater than 5 times the reporting limit are more useful for assessing the recovery of compounds that are expected to be present at a site. Soil PE samples are more difficult to interpret because of widely different soil types which may affect contaminant extraction efficiency (unless soil from the site itself is spiked), so these should be spiked with concentrations at least five times the reporting limit.

The PE samples shall be ordered from a qualified vendor far enough in advance that it can be prepared, then shipped to the field site a day or two prior to shipping it back to the laboratory along with other site samples. Care must be taken to ensure PE samples do not exceed their holding time. It may be necessary to send the vendor sample containers that will be used for the project so that the laboratory cannot distinguish between sample containers and identify which sample is the PE sample. The vendor shall be responsible for adding the proper volume and type of preservative to each container. The PE samples shall be shipped overnight on ice and immediately placed in the sample stream. The date and time of the preparation of the PE samples are not evaluated.

The PE sample shall be labeled similarly to other field samples so that the laboratory cannot distinguish which sample is the PE sample. Sample naming, labeling, handling, and shipping are discussed in SOPs I-A-7, *IDW Management*; and III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, and III-G, *Sampling Handling, Storage, and Shipping Procedures*. If it is necessary to send a PE sample to the laboratory in advance of field sampling (this is not normally recommended), enough volume must be provided for the laboratory to use as a matrix spike/matrix spike duplicate (MS/MSD) sample also.

PE samples shall be submitted to the laboratory and analyzed as close to the beginning of a project as possible (e.g., within the first week of a one to two month field sampling effort). This should allow sufficient time for the PE sample results to be evaluated and appropriate corrective actions to be implemented. The evaluation should consist of comparing the analytical results for each compound to the corresponding certified concentrations supplied by the vendor. For water samples, the laboratory should be capable of identifying each of the compounds present in the PE sample and detecting these compounds at concentrations within the acceptable range specified by the vendor. Due to potential matrix interference problems associated with soil samples, it may be sufficient for the laboratory to simply identify the presence of a particular suite of analytes (i.e., the laboratory may not be capable of detecting the analytes within the acceptance criteria specified). The evaluation methodology for PE samples shall be documented into the project-specific planning documents (e.g., Work Plan, QAPP, etc.).

If the results reported by the laboratory are not found to be acceptable (i.e., the correct identity and concentration are not reported), appropriate corrective action shall be taken. Initially, the findings of the PE sample evaluation shall be submitted to the laboratory along with a request for an explanation for PE sample analysis failure. The analytical laboratory shall prepare a description of corrective actions, as necessary, that either have, or will be, taken to remedy the problem. If the laboratory cannot provide sufficient explanation for the problems, then another PE sample can be submitted for specific analysis for analytes of concern. The additional PE sample result will be used to verify that corrective action was taken. This will, of course, depend on whether the field sampling efforts are still occurring. Timely reporting of the PE results will be required, as well as early assessment of the PE sample results to ensure that additional PE samples can be submitted if problems are identified. If deemed necessary by the Technical Director/QA Program Manager, the laboratory can be audited to help confirm that they are capable of conducting the required analysis. Finally, if necessary, the laboratory can be suspended from conducting analysis for a particular method, or for the entire project.

## 3.0 DOCUMENTATION

Field sampling personnel shall label, package, and ship the PE sample similarly to other site samples. The sample information shall be recorded in the field logbook. The certified value for each analyte and the acceptable range of results provided by the vendor/supplier shall be retained and used to compare to actual results reported. The results of the evaluation shall be included in the associated deliverable (e.g., Remedial Investigation Report, Remediation Verification Report, etc.).

## 4.0 REFERENCES

SOP I-A-7, *IDW Management*

SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*

SOP III-G, *Sampling Handling, Storage, and Shipping Procedures*

## 5.0 ATTACHMENTS

None.

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NAVFAC NW Standard Operating Procedure Number:

III-I

Revised April 2015

# EQUIPMENT DECONTAMINATION

## 1.0 PURPOSE

The standard operating procedure (SOP) describes general methods of equipment decontamination (decon) for use by U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) field personnel and their contractors during field sampling activities. Some sites may require additional steps (e.g. nitric rinses for metals, hexane for chlorinated pesticides) to insure equipment is properly deconned. These should be identified and addressed in the Work Plans and/or the Quality Assurance Project Plans (QAPPs)

## 2.0 PROCEDURES

Decontamination of equipment is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program should include consideration of the following factors:

- The location where the decon procedures will be conducted
- The types of equipment requiring decon
- The frequency of equipment decontamination
- The cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- The method for containing the residual contaminants and wash water from the deconning process
- The use of a quality control measure to determine the effectiveness of the decontamination procedure (e.g. equipment rinsate samples)

This subsection describes standards for decontamination, including the techniques to be used, frequency of decontamination, cleaning solutions, and effectiveness.

### 2.1 DECONTAMINATION AREA

An appropriate location for the decontamination area at a site shall be selected on the basis of the ability to control access to the area, control residual material removed from equipment, the need to store dirty and clean equipment, and the ability to restrict access to the area being investigated. The decontamination area shall be located an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

### 2.2 TYPES OF EQUIPMENT

Examples of drilling equipment that must be deconned includes drill bits, auger sections, split spoon samplers, and hand tools. Decontamination of monitoring well development and ground-water sampling equipment includes submersible pumps, non-disposable bailers, interface probes, water level meters, bladder pumps, airlift pumps, and lysimeters. Other sampling equipment that may require decontamination includes, but is not limited to, hand trowels, hand augers, slide hammer samplers, shovels, stainless steel spoons and bowls, soil sample liners and caps, wipe sampling templates, COLIWASA samplers, and dippers. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and should be properly disposed of after one use.

### 2.3 FREQUENCY OF EQUIPMENT DECONTAMINATION

Down-hole drilling equipment and equipment used in monitoring well development and purging shall be decontaminated prior to initial use and between each borehole or well. However, down hole drilling equipment may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, the drilling tools shall be decontaminated prior to drilling deeper. Groundwater sampling should be initiated by sampling ground water from the monitoring well where the least contamination is suspected. This is more important when not using disposable equipment. All groundwater, surface water, and soil sampling devices shall be decontaminated prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

### 2.4 CLEANING SOLUTIONS AND TECHNIQUES

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment such as drill bits, augers, drill string, pump drop-pipe, etc., is steam cleaning. Steam cleaning is accomplished using a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, equipment shall be thoroughly steam washed and rinsed with potable tap water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (Citrinox®, Liquinox®, or other suitable phosphate free detergent) and potable water solution, (2) rinse with potable water, and (3) rinses with deionized or distilled water. Equipment shall be disassembled as much as is practical, prior to cleaning. An initial gross wash scrub down and quick rinse should be completed at the beginning of the process if equipment is heavily soiled. After decontamination, care needs to be taken that the cleaned equipment does not become contaminated. This may require wrapping items in foil or plastic and storing the equipment in a specified “clean” area.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. The pumps shall be decontaminated by circulating fluids through the pump while it is operating. This circulation can be done using a clean 4-inch or greater diameter pipe equipped with an end cap. The pipe shall be filled with enough decon fluid to submerge the pump, the pump placed within the capped pipe, and the pump operated while circulating the fluids within the pipe. The decontamination sequence shall include (1) detergent and potable water, (2) potable water rinse, and (3) deionized or distilled water rinse. The decontamination fluids shall be changed after each cycle. Changing of the fluids may include dumping of the detergent water, mixing detergent in the potable water rinse, using the deionized water as the potable rinse and renewing the distilled/deionized water. All decon water shall be disposed of as outlined in the field work plans.

Decontamination solvent(s) to be used during field activities will be specified in Project Work Plans or QAPPs. If solvents are used, sufficient time must be allowed to insure the solvent has evaporated from the equipment prior to reuse.

Equipment used for measuring field parameters such as pH, temperature, specific conductivity, and turbidity shall be rinsed with deionized or distilled water. New, unused soil sample liners and caps will be cleaned using the three step process, outlined above, to remove any dirt or cutting oils that may be on them prior to use.

### 2.5 CONTAINMENT OF RESIDUAL CONTAMINANTS AND CLEANING SOLUTIONS

Decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water. This may require setting up a containment area with a system for pumping the water generated decontamination water into proper containers.

Clean equipment should be stored in a separate location to prevent recontamination. Decontamination fluids contained within the bermed area shall be collected and disposed of as outlined in the field sampling plan.

Containment of fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices shall be accomplished using wash buckets or tubs. The decontamination fluids shall be collected and disposed of as outlined in the field sampling plan.

### 2.6 EFFECTIVENESS OF DECONTAMINATION PROCEDURES

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment rinsate samples or wipe testing. Equipment rinsates consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. Further descriptions of these samples and their required frequency of collection are provided in SOP III-B, *Field QC Samples (Water, Soil)*. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

## 3.0 DOCUMENTATION

The decontamination process shall be recorded in the field logbook.

## 4.0 REFERENCES

SOP III-B, *Field QC Samples (Water, Soil).*

## 5.0 ATTACHMENTS

None.

NAVFAC NW Standard Operating Procedure Number:

III-J

Revised April 2015

# EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE

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## 1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities of the U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel pertaining to the operating, calibration, and maintenance of equipment used to collect environmental data. Reliable measurements of data required by the field sampling plan are necessary because the information recorded may be the basis for development of remedial action and responses.

## 2.0 PROCEDURES

### 2.1 EQUIPMENT CALIBRATION

All water quality monitoring equipment will be calibrated and adjusted to operate within the manufacturers' specifications. Water quality instruments and equipment that require calibration are to be calibrated to specifications prior to field use. In addition, a one-point calibration check is made at midday and at intervals outlined in the field sampling plan. A final check is conducted at the end of each field day. This is not a recalibration of the meter but a check of the calibration to ensure the continued accuracy of the meter. All calibration information shall be recorded in the project logbook.

Special attention shall be paid to instruments that may be affected by the change in the ambient temperature or humidity. Calibration checks should also be performed when sampling conditions change significantly, a change of sample matrix, and/or readings are unstable or there is a change of parameter measurements that appear unusual.

### 2.2 EQUIPMENT MAINTENANCE

All field monitoring equipment, field sampling equipment, and accessories are to be maintained in accordance with the manufacturer's recommendations and specifications and/or established field practices. All maintenance will be performed by qualified personnel and documented in the field logbook.

Equipment requiring battery charging shall be charged as recommended by the manufacturer. Backup batteries for meters requiring them shall be included as part of the meters accessories. Care must be taken to protect meters from adverse elements. This may involve placing the meter in a large plastic bag to shield it from the weather.

## 3.0 DOCUMENTATION

All field equipment calibration, maintenance, and operation information shall be recorded within the field logbook. This is to document that appropriate procedures have been followed and to track the equipment operation. All entries in the field logbook must be written accurately and legibly as outlined in the SOP III-D, *Logbooks*.

Logbook entries shall contain, but are not necessarily limited to, the following:

- Equipment model and serial numbers
- Date and time of calibration or maintenance performed
- Calibration standard used
- Calibration lot number and expiration date if listed on bottle
- Calibration procedure used if there are multiple options
- Calibration and calibration check readings including units used
- Problems and solutions regarding use, calibration or maintenance of the equipment
- And other pertinent information

## 4.0 REFERENCES

SOP III-D, *Logbooks*

## 5.0 ATTACHMENTS

None.

# Appendix F:
# Investigation-Derived Waste Sampling Information

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## Worksheet 15 - IDW Solids

| Analyte Group | Analytical Method | CASRN | Analyte | LOQ | LOD | DL (MDL) | Lab Units |
|---|---|---|---|---|---|---|---|
| Chemical Characteristics | EPA 9012B | 57-12-5 | Cyanide, Total | 0.500 | 0.450 | 0.180 | mg/kg |
| | EPA 9034 | 18496-25-8 | Sulfide, Total | 10.0 | 10.0 | 5.63 | mg/kg |
| | SM 2540-G | STL00234 | Total Solids | 1.00 | N/A | 0.100 | % |
| Metals (TCLP) | EPA 1311/6010D/7470A | 7440-38-2 | Arsenic | 30.0 | 24.0 | 16.0 | µg/L |
| | | 7440-39-3 | Barium | 5.00 | 2.50 | 1.00 | µg/L |
| | | 7440-43-9 | Cadmium | 5.00 | 2.50 | 1.00 | µg/L |
| | | 7440-47-3 | Chromium | 15.0 | 3.75 | 1.60 | µg/L |
| | | 7440-50-8 | Copper | 30.0 | 20.0 | 12.0 | µg/L |
| | | 7439-92-1 | Lead | 15.0 | 11.3 | 7.10 | µg/L |
| | | 7439-97-6 | Mercury | 0.200 | 0.160 | 0.0790 | µg/L |
| | | 7440-02-0 | Nickel | 10.0 | 5.00 | 2.10 | µg/L |
| | | 7440-22-4 | Silver | 10.0 | 7.50 | 5.00 | µg/L |
| | | 7440-66-6 | Zinc | 20.0 | 10.0 | 3.70 | µg/L |
| TPH | NWTPH-Gx (Ecology) | STL00L211 | TPH-Gx (gasoline-range, C7-C12) | 5.00 | 0.500 | 0.230 | mg/kg |
| | NWTPH-Dx (Ecology) | STL00096 | TPH-Dx (diesel-range, C12-24) | 10.0 | 8.00 | 4.00 | mg/kg |
| | | STL00631 | TPH-Dx (oil-range, C24-C40) | 30.0 | 20.0 | 10.0 | mg/kg |
| Polychlorinated Biphenyls (Aroclors) | EPA 8082A | 11104-28-2 | PCB-1221 | 17.0 | 10.0 | 4.60 | µg/kg |
| | | 11141-16-5 | PCB-1232 | 17.0 | 16.0 | 8.00 | µg/kg |
| | | 53469-21-9 | PCB-1242 | 17.0 | 10.0 | 3.30 | µg/kg |
| | | 12672-29-6 | PCB-1248 | 17.0 | 10.0 | 3.30 | µg/kg |
| | | 11097-69-1 | PCB-1254 | 17.0 | 10.0 | 3.30 | µg/kg |
| | | 11096-82-5 | PCB-1260 | 17.0 | 10.0 | 6.40 | µg/kg |
| | | 37324-23-5 | PCB-1262 | 17.0 | 10.0 | 3.30 | µg/kg |
| | | 11100-14-4 | PCB-1268 | 17.0 | 10.0 | 3.30 | µg/kg |
| | | 12674-11-2 | PCB-1016 | 17.0 | 10.0 | 5.60 | µg/kg |
| VOCs | EPA 8260D | 71-55-6 | 1,1,1-Trichloroethane | 5.00 | 2.00 | 0.600 | µg/kg |
| | | 79-34-5 | 1,1,2,2-Tetrachloroethane | 5.00 | 1.00 | 0.400 | µg/kg |
| | | 79-00-5 | 1,1,2-Trichloroethane | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 75-34-3 | 1,1-Dichloroethane | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 75-35-4 | 1,1-Dichloroethene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 107-06-2 | 1,2-Dichloroethane | 5.00 | 2.00 | 0.600 | µg/kg |
| | | 78-87-5 | 1,2-Dichloropropane | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 120-82-1 | 1,2,4-Trichlorobenzene | 10.0 | 8.00 | 5.00 | µg/kg |
| | | 95-50-1 | 1,2-Dichlorobenzene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 541-73-1 | 1,3-Dichlorobenzene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 106-46-7 | 1,4-Dichlorobenzene | 5.00 | 1.00 | 0.400 | µg/kg |
| | | 78-93-3 | 2-Butanone | 10.0 | 4.00 | 2.00 | µg/kg |
| | | 591-78-6 | 2-Hexanone | 10.0 | 4.00 | 1.00 | µg/kg |
| | | 108-10-1 | 4-Methyl-2-pentanone | 10.0 | 4.00 | 1.00 | µg/kg |
| | | 67-64-1 | Acetone | 20.0 | 16.0 | 6.00 | µg/kg |
| | | 71-43-2 | Benzene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 75-27-4 | Bromodichloromethane | 5.00 | 1.00 | 0.400 | µg/kg |
| | | 75-25-2 | Bromoform | 10.0 | 8.00 | 5.00 | µg/kg |
| | | 74-83-9 | Bromomethane | 5.00 | 2.00 | 0.700 | µg/kg |
| | | 75-15-0 | Carbon disulfide | 5.00 | 2.00 | 0.600 | µg/kg |

| Analyte Group | Analytical Method | CASRN | Analyte | LOQ | LOD | DL (MDL) | Lab Units |
|---|---|---|---|---|---|---|---|
| VOCs (cont'd) | EPA 8260D (cont'd) | 56-23-5 | Carbon tetrachloride | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 108-90-7 | Chlorobenzene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 75-00-3 | Chloroethane | 5.00 | 4.00 | 1.00 | µg/kg |
| | | 67-66-3 | Chloroform | 5.00 | 2.00 | 0.600 | µg/kg |
| | | 74-87-3 | Chloromethane | 5.00 | 2.00 | 0.600 | µg/kg |
| | | 156-59-2 | cis-1,2-Dichloroethene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 10061-01-5 | cis-1,3-Dichloropropene | 5.00 | 1.00 | 0.400 | µg/kg |
| | | 124-48-1 | Dibromochloromethane | 5.00 | 1.00 | 0.500 | µg/kg |
| | | 100-41-4 | Ethylbenzene | 5.00 | 1.00 | 0.400 | µg/kg |
| | | 75-09-2 | Methylene chloride | 5.00 | 4.00 | 2.00 | µg/kg |
| | | 127-18-4 | Tetrachloroethene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 108-88-3 | Toluene | 5.00 | 2.00 | 0.600 | µg/kg |
| | | 156-60-5 | trans-1,2-Dichloroethene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 10061-02-6 | trans-1,3-Dichloropropene | 5.00 | 1.00 | 0.500 | µg/kg |
| | | 79-01-6 | Trichloroethene | 5.00 | 2.00 | 0.500 | µg/kg |
| | | 75-69-4 | Trichlorofluoromethane | 5.00 | 2.00 | 0.700 | µg/kg |
| | | 75-01-4 | Vinyl chloride | 5.00 | 2.00 | 0.600 | µg/kg |
| | | 1330-20-7 | Xylenes, Total | 10.0 | 2.00 | 1.40 | µg/kg |
| Per- and Polyfluoroalkyl Substances | LC-MS/MS DoD QSM v5.3 Table B-15 | 335-67-1 | Perfluorooctanoic acid (PFOA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 1763-23-1 | Perfluorooctanesulfonic acid (PFOS) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 375-95-1 | Perfluorononanoic acid (PFNA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 355-46-4 | Perfluorohexanesulfonic acid (PFHxS) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 375-85-9 | Perfluoroheptanoic acid (PFHpA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 375-73-5 | Perfluorobutanesulfonic acid (PFBS) | 2.00 | 1.60 | 0.400 | ng/g |
| | | 335-76-2 | Perfluorodecanoic acid (PFDA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 307-55-1 | Perfluorododecanoic acid (PFDoA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 307-24-4 | Perfluorohexanoic acid (PFHxA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 376-06-7 | Perfluorotetradecanoic acid (PFTA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 72629-94-8 | Perfluorotridecanoic acid (PFTrDA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 2058-94-8 | Perfluoroundecanoic acid (PFUnA) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 13252-13-6 | Hexafluoropropylene oxide dimer acid (HFPODA) | 3.00 | 1.60 | 0.400 | ng/g |
| | | 2355-31-9 | N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA) | 2.00 | 0.400 | 0.200 | ng/g |
| | | 2991-50-6 | N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) | 2.00 | 0.400 | 0.200 | ng/g |
| | | 763051-92-9 | 11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS) | 0.600 | 0.400 | 0.200 | ng/g |
| | | 756426-58-1 | 9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS) | 2.00 | 0.400 | 0.200 | ng/g |
| | | 919005-14-4 | 4,8-Dioxa-3H-perfluorononanoic acid (DONA) | 0.600 | 0.400 | 0.200 | ng/g |

Note: Laboratory information for chemical analysis provided by Eurofins Lancaster Laboratories Environment Testing, LLC located in Lancaster, PA and Eurofins Denver Laboratories Environmental Testing located in Denver, CO.

| | |
|---|---|
| µg/kg | microgram per kilogram |
| API | American Petroleum Institute |
| CASRN | Chemical Abstract Service Registry Number |
| DL | detection limit |
| LC | liquid chromatography |
| LOD | limit of detection |
| LOQ | limit of quantitation |
| MDL | method detection limit |
| mg/kg | milligram per kilogram |
| MS | mass spectrometry |
| N/A | not applicable |
| ng/g | nanogram per gram |
| NW | Northwest |
| PCB | polychlorinated biphenyl |
| QL | quantitation limit |
| QSM | Quality Systems Manual |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TPH | total petroleum hydrocarbon |
| VOC | volatile organic compound |

## Worksheet 15 - IDW Aqueous

| Analyte Group | Analytical Method | CASRN | Analyte | LOQ | LOD | DL (MDL) | Lab Units |
|---|---|---|---|---|---|---|---|
| Chemical Characteristics | EPA 9012B | 57-12-5 | Cyanide, Total | 0.0100 | 0.0090 | 0.0050 | mg/L |
| | SM 4500-S2-D | 18496-25-8 | Sulfide, Total | 0.300 | 0.250 | 0.100 | mg/L |
| Metals (TCLP) | EPA 1311/6010D/7470A | 7440-38-2 | Arsenic | 30.0 | 24.0 | 16.0 | µg/L |
| | | 7440-39-3 | Barium | 5.00 | 2.50 | 1.00 | µg/L |
| | | 7440-43-9 | Cadmium | 5.00 | 2.50 | 1.00 | µg/L |
| | | 7440-47-3 | Chromium | 15.0 | 3.75 | 1.60 | µg/L |
| | | 7440-50-8 | Copper | 30.0 | 20.0 | 12.0 | µg/L |
| | | 7439-92-1 | Lead | 15.0 | 11.3 | 7.10 | µg/L |
| | | 7439-97-6 | Mercury | 0.200 | 0.160 | 0.790 | µg/L |
| | | 7440-02-0 | Nickel | 10.0 | 5.00 | 2.10 | µg/L |
| | | 7440-22-4 | Silver | 10.0 | 7.50 | 5.00 | µg/L |
| | | 7440-66-6 | Zinc | 20.0 | 10.0 | 3.70 | µg/L |
| TPH | NWTPH-Gx (Ecology) | ST00L211 | TPH-Gx (gasoline-range, C7-C12) | 250 | 55.0 | 19.0 | µg/L |
| | NWTPH-Dx (Ecology) | STL00096 | TPH-Dx (diesel-range, C12-24) | 100 | 90.0 | 45.0 | µg/L |
| | | STL00631 | TPH-Dx (oil-range, C24-C40) | 250 | 240 | 100 | µg/L |
| Polychlorinated Biphenyls (Aroclors) | EPA 8082A | 11104-28-2 | PCB-1221 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 11141-16-5 | PCB-1232 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 53469-21-9 | PCB-1242 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 12672-29-6 | PCB-1248 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 11097-69-1 | PCB-1254 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 11096-82-5 | PCB-1260 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 37324-23-5 | PCB-1262 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 11100-14-4 | PCB-1268 | 0.500 | 0.300 | 0.100 | µg/L |
| | | 12674-11-2 | PCB-1016 | 0.500 | 0.300 | 0.100 | µg/L |
| VOCs | EPA 8260D | 71-55-6 | 1,1,1-Trichloroethane | 1.00 | 0.500 | 0.300 | µg/L |
| | | 79-34-5 | 1,1,2,2-Tetrachloroethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 79-00-5 | 1,1,2-Trichloroethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-34-3 | 1,1-Dichloroethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-35-4 | 1,1-Dichloroethene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 107-06-2 | 1,2-Dichloroethane | 1.00 | 0.500 | 0.300 | µg/L |
| | | 78-87-5 | 1,2-Dichloropropane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 120-82-1 | 1,2,4-Trichlorobenzene | 5.00 | 1.00 | 0.300 | µg/L |
| | | 95-50-1 | 1,2-Dichlorobenzene | 5.00 | 0.500 | 0.200 | µg/L |
| | | 541-73-1 | 1,3-Dichlorobenzene | 5.00 | 0.500 | 0.200 | µg/L |
| | | 106-46-7 | 1,4-Dichlorobenzene | 5.00 | 0.500 | 0.200 | µg/L |
| | | 78-93-3 | 2-Butanone | 10.0 | 1.00 | 0.500 | µg/L |
| | | 591-78-6 | 2-Hexanone | 10.0 | 1.00 | 0.400 | µg/L |
| | | 108-10-1 | 4-Methyl-2-pentanone | 10.0 | 1.00 | 0.500 | µg/L |
| | | 67-64-1 | Acetone | 20.0 | 2.00 | 0.700 | µg/L |
| | | 71-43-2 | Benzene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-27-4 | Bromodichloromethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-25-2 | Bromoform | 4.00 | 2.00 | 1.00 | µg/L |
| | | 74-83-9 | Bromomethane | 1.00 | 0.500 | 0.300 | µg/L |
| | | 75-15-0 | Carbon disulfide | 5.00 | 0.500 | 0.200 | µg/L |
| | | 56-23-5 | Carbon tetrachloride | 1.00 | 0.500 | 0.200 | µg/L |
| | | 108-90-7 | Chlorobenzene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-00-3 | Chloroethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 67-66-3 | Chloroform | 1.00 | 0.500 | 0.200 | µg/L |
| | | 74-87-3 | Chloromethane | 1.00 | 0.500 | 0.200 | µg/L |

| Analyte Group | Analytical Method | CASRN | Analyte | LOQ | LOD | DL (MDL) | Lab Units |
|---|---|---|---|---|---|---|---|
| VOCs (cont'd) | EPA 8260D (cont'd) | 156-59-2 | cis-1,2-Dichloroethene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 10061-01-5 | cis-1,3-Dichloropropene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 124-48-1 | Dibromochloromethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 100-41-4 | Ethylbenzene | 1.00 | 0.800 | 0.400 | µg/L |
| | | 75-09-2 | Methylene chloride | 1.00 | 0.500 | 0.300 | µg/L |
| | | 127-18-4 | Tetrachloroethene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 108-88-3 | Toluene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 156-60-5 | trans-1,2-Dichloroethene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 10061-02-6 | trans-1,3-Dichloropropene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 79-01-6 | Trichloroethene | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-69-4 | Trichlorofluoromethane | 1.00 | 0.500 | 0.200 | µg/L |
| | | 75-01-4 | Vinyl chloride | 1.00 | 0.500 | 0.200 | µg/L |
| | | 1330-20-7 | Xylenes, Total | 6.00 | 2.80 | 1.40 | µg/L |
| Per- and Polyfluoroalkyl Substances | LC-MS/MS DoD QSM v5.3 Table B-15 | 335-67-1 | Perfluorooctanoic acid (PFOA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 1763-23-1 | Perfluorooctanesulfonic acid (PFOS) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 375-95-1 | Perfluorononanoic acid (PFNA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 355-46-4 | Perfluorohexanesulfonic acid (PFHxS) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 375-85-9 | Perfluoroheptanoic acid (PFHpA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 375-73-5 | Perfluorobutanesulfonic acid (PFBS) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 335-76-2 | Perfluorodecanoic acid (PFDA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 307-55-1 | Perfluorododecanoic acid (PFDoA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 307-24-4 | Perfluorohexanoic acid (PFHxA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 376-06-7 | Perfluorotetradecanoic acid (PFTA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 72629-94-8 | Perfluorotridecanoic acid (PFTrDA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 2058-94-8 | Perfluoroundecanoic acid (PFUnA) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 13252-13-6 | Hexafluoropropylene oxide dimer acid (HFPODA) | 3.00 | 1.00 | 0.500 | ng/L |
| | | 2355-31-9 | N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA) | 2.00 | 1.20 | 0.600 | ng/L |
| | | 2991-50-6 | N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) | 3.00 | 1.00 | 0.500 | ng/L |
| | | 763051-92-9 | 11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 756426-58-1 | 9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS) | 2.00 | 1.00 | 0.500 | ng/L |
| | | 919005-14-4 | 4,8-Dioxa-3H-perfluorononanoic acid (DONA) | 2.00 | 1.00 | 0.500 | ng/L |

Note: Laboratory information for chemical analysis provided by Eurofins Lancaster Laboratories Environment Testing, LLC located in Lancaster, PA.

| | |
|---|---|
| µg/L | microgram per liter |
| API | American Petroleum Institute |
| CASRN | Chemical Abstract Service Registry Number |
| DL | detection limit |
| LC | liquid chromatography |
| LOD | limit of detection |
| LOQ | limit of quantitation |
| MDL | method detection limit |
| mg/L | milligram per liter |
| MS | mass spectrometry |
| N/A | not applicable |
| ng/L | nanogram per l |
| NW | Northwest |
| PCB | polychlorinated biphenyl |
| QL | quantitation limit |
| QSM | Quality Systems Manual |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TPH | total petroleum hydrocarbon |
| VOC | volatile organic compound |

# Worksheet 19 – IDW Field Sampling Requirements Table

| Matrix | Analytical Group | Preparation Reference/Method SOP<br>Analytical Reference/Method SOP | Containers | Sample Volume | Preservation Requirement | Maximum Holding Time (preparation/analysis) |
|---|---|---|---|---|---|---|
| **IDW Solids** | | | | | | |
| Soil and Solids [a] | Cyanide, Total | Preparation Method: EPA 9012B<br>Preparation SOP: WI11621<br>Analysis Method: EPA 9012B<br>Analysis SOP: WI11621 | 1 × 4-oz glass soil jar | 100 g | Cool to ≤6°C | Maximum holding time is 14 days from collection to analysis. |
| Soil and Solids [a] | Sulfide, Total | Preparation Method: EPA 9030B<br>Preparation SOP: DV-WC-0091<br>Analysis Method: EPA 9034<br>Analysis SOP: DV-WC-0091 | 1 x 8-oz glass soil jar | 150 g | Cool to ≤ 6°C | Maximum holding time is 7 days from collection to analysis. |
| Soil and Solids | Total Solids | Preparation Method: SM2540-G<br>Preparation SOP: WI10697<br>Analysis Method: SM2540-G<br>Analysis SOP: WI10697 | 1 × 4-oz HDPE or glass soil jar | 5 g | Cool to ≤6°C | Maximum holding time is 7 days. |
| Soil and Solids | TCLP Metals [b] | Preparation Method: EPA 1311, 3010A, 7470A<br>Preparation SOP: W11941, WI7965<br>Analysis Method: EPA 6010D, EPA 7470A<br>Analysis SOP: WI11931, WI7965 | 1 × 32-oz glass soil jar | 200 g | Cool to ≤6°C | With exception of mercury, samples prepared within 6 months of collection and digestates analyzed within 6 months of sample preparation. Mercury holding time is 28 days from collection to final analysis. |
| Soil and Solids [a] | TPH-GRO | Preparation Method: Ecology NWTPH-Gx<br>Preparation SOP: WI8224<br>Analysis Method: Ecology NWTPH-Gx<br>Analysis SOP: WI8224 | 1 x TerraCore samplers plus 3 x 40-mL pre--tared glass VOA vials | 5 g per vial | Methanol<br>Cool to ≤6°C | Maximum holding time is 14 days from collection to analysis. |
| Soil and Solids [a] | TPH-DRO/LRO | Preparation Method: EPA 3550C<br>Preparation SOP: WI10913<br>Analysis Method: Ecology NWTPH-Dx<br>Analysis SOP: WI9781 | 1 × 4-oz glass soil jar | 125 g | Cool to ≤6°C | Samples extracted within 14 days and analyzed within 40 days following extraction. |
| Soil and Solids [a] | PCBs | Preparation Method: EPA 3546<br>Preparation SOP: WI10927<br>Analysis Method: EPA 8082A<br>Analysis SOP: WI10004 | 1 × 4-oz glass soil jar | 100 g | Cool to ≤6°C | Samples extracted within 1 year of collection; extracts analyzed within 40 days following extraction. |
| Soil and Solids [a] | VOCs | Preparation Method: EPA 5035/5035A<br>Preparation SOP: WI11170<br>Method: EPA 8260D<br>Analysis SOP: WI8236 | 1 x TerraCore samplers plus 3 x 40-mL pre--tared glass VOA vials | 5 g per vial | Methanol, DI water, and/or $NaHSO_4$;<br>Cool to ≤6°C | Maximum holding time is 14 days from collection to analysis. |

| Matrix | Analytical Group | Preparation Reference/Method SOP Analytical Reference/Method SOP | Containers | Sample Volume | Preservation Requirement | Maximum Holding Time (preparation/analysis) |
|---|---|---|---|---|---|---|
| Soil and Solids [a] | PFAS | Preparation Method: QSM V5.3-Table B-15<br>Preparation SOP: WI36459<br>Analysis Method: QSM V5.3-Table B-15<br>Analysis SOP: WI36459 | 1 × 4.5-oz HDPE plastic bottle | 10 g | Cool to ≤6°C | Samples extracted within 28 days of collection; extracts analyzed within 28 days following extraction. |
| **IDW Aqueous** | | | | | | |
| Aqueous | Cyanide, Total | Preparation Method: EPA 9012B<br>Preparation SOP: WI11621<br>Analysis Method: EPA 9012B<br>Analysis SOP: WI11621 | 1 × 250-mL HDPE bottle | 250 mL | Cool to ≤6°C and adjust pH to >12 with NaOH, ascorbic acid | Maximum holding time is 14 days from collection to analysis. |
| Aqueous | Sulfide, Total | Preparation Method: SM4500 S2D<br>Preparation SOP: WI11483<br>Analysis Method: SM4500 S2D<br>Analysis SOP: WI11483 | 1 × 250-mL glass bottle | 250 mL | Cool to ≤6°C, no headspace, NaOH, ZnAc | Maximum holding time is 7 days from collection to analysis. |
| Aqueous | TCLP Metals [b] | Preparation Method: EPA 1311, 3005A, 7470A<br>Preparation SOP: WI8639, WI7965<br>Analysis Method: EPA 6010D, EPA 7470A<br>Analysis SOP: WI11931, WI7965 | 1 × 1L glass bottle | 1 L | Cool to ≤6°C | With exception of mercury, samples prepared within 6 months of collection and digestates analyzed within 6 months of sample preparation. Mercury holding time is 28 days from collection to final analysis. |
| Aqueous | TPH-GRO | Preparation Method: Ecology NWTPH-Gx<br>Preparation SOP: WI8224<br>Analysis Method: Ecology NWTPH-Gx<br>Analysis SOP: WI8224 | 3 × 40-mL glass vials; 5 ml or 25 ml | 120 mL | Cool to ≤6°C and adjust to pH <2 with HCl | Maximum holding time is 7 days if pH >2 or 14 days if pH <2. |
| Aqueous | TPH-DRO/LRO | Preparation Method: EPA 3510C<br>Preparation SOP: WI10908<br>Analysis Method: Ecology NWTPH-Dx Analysis SOP: WI19783 | 1 × 1L amber glass bottles | 1 L | Cool to ≤6°C and adjust to pH <2 with HCl | Samples extracted within 7 days and analyzed within 40 days following extraction. |
| Aqueous | PCBs | Preparation Method: EPA 3510C-LVI<br>Preparation SOP: WI10920<br>Analysis Method: EPA 8082A<br>Analysis SOP: WI9238 | 2 × 250-mL amber glass bottle | 250 mL | Cool to ≤6°C | Samples extracted within 1 year of collection; extracts analyzed within 40 days following extraction. |

| Matrix | Analytical Group | Preparation Reference/Method SOP Analytical Reference/Method SOP | Containers | Sample Volume | Preservation Requirement | Maximum Holding Time (preparation/analysis) |
|---|---|---|---|---|---|---|
| Aqueous | VOCs | Preparation Method: EPA 8260D<br>Preparation SOP: WI8194<br>Analysis Method: EPA 8260D<br>Analysis SOP: WI8194 | 3 × 40-mL vials, Teflon-lined septum caps | 40 mL | Cool to ≤6°C and adjust to pH <2 with HCl | Maximum holding time is 7 days to analysis if pH >2 or 14 days if pH <2. |
| Aqueous | PFAS | Preparation Method: QSM V5.3-Table B-15<br>Preparation SOP: WI36458<br>Analysis Method: QSM V5.3-Table B-15<br>Analysis SOP: WI36458 | 2 × 250-mL HDPE bottle | 250 mL | Cool to ≤6°C | Samples extracted within 14 days of collection; extracts analyzed within 28 days following extraction. |

| | |
|---|---|
| °C | degrees Celsius |
| DRO | diesel range organics |
| g | gram |
| GRO | gasoline range organics |
| HCl | hydrogen chloride |
| HDPE | high-density polyethylene |
| IDW | investigation derived waste |
| L | liter |
| LRO | lube oil range organics |
| mL | milliliter |
| N/A | not applicable |
| $NaHSO_4$ | sodium bisulfate |
| NaOH | sodium hydroxide |
| oz | ounce |
| PCB | polychlorinated biphenyl |
| PFAS | per- and polyfluoroalkyl substances |
| SOP | standard operating procedure |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TPH | total petroleum hydrocarbons |
| VOA | volatile organic analyte |
| VOC | volatile organic compound |
| ZnAc | zinc acetate |

[a] Sample results will be reported on a dry weight basis.
[b] Metals for TCLP include arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc.

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# Worksheet 23 – IDW Analytical SOP References Table

| Lab SOP Number | Title, Revision Date, and/or Number | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis | Modified for Project Work? (Yes/No) |
|---|---|---|---|---|---|---|
| WI11621 | Determination of Total Cyanide in Water, Wastewater, and Soils (Department of Defense) SW-846 9012B, SW-846 9012A, Rev 4, effective 090/8/2014. | Definitive | Soil, Aqueous/Cyanide | Flow Analyzer | ELLE | No |
| WI10697 | % Moisture Calculation and % Solids Calculation (Gravimetric) by SM 2540 G-1997 and SM 2540 G-2011, Rev 17; effective 3/21/19. | Definitive | Soil, Solids/Total Solids | Oven/Balance | ELLE | No |
| WI11931 | Metals by ICP for Methods SW-846 6010/B/C/D (aqueous, solid, tissue) and EPA 200.7(aqueous) Rev 13, effective 07/17/2019. | Definitive | Soil, solids, aqueous, and TCLP/Metals | ICP | ELLE | No |
| WI7965 | Mercury in Aqueous, Solid, and Tissue Samples by EPA 7471A, 7471B, 7470A, and 245.3 rev 3 by Cold Vapor AA, Rev 19, effective 11/30/2020. | Definitive | Solids, Aqueous/Mercury | CVAA | ELLE | No |
| WI8236 | VOCs and GRO by GC/MS in Soils by Method 8260C/D, Rev 6, effective 4/12/19. | Definitive | Soil, Solids/VOCs | GC/MS | ELLE | No |
| WI36459 | Polyfluorinated Alkyl Substances (PFASs) in Solids by Method 537 Version 1.1 Modified QSM 5.3 Table B-15 Using LC/MS/MS Rev. 1, effective 01/29/2021. | Definitive | Soil, Solids/PFAS | LC/MS/MS | ELLE | No |
| DV-WC-0091 | Acid-Soluble and Acid-Insoluble Sulfides: Distillation and Titration [SW 9030B/SW9034], | Definitive | Solids/Sulfide | N/A | Eurofins TestAmerica Denver | No |
| WI8224 | GRO in Soil and Water by GC using Northwest Gx Method, Rev 12, effective 03/21/2019. | Definitive | Solids, Aqueous/VOCs | GC/FID | ELLE | No |
| WI9781 | TPH by NWTPH-Dx (modified) in Soils using GC-FID. | Definitive | Soil, Solids/DRO | GC/FID | ELLE | No |
| WI10004 | Polychlorinated Biphenyls (PCBs) in Solid Samples by 8082A using GC-ECD, Rev 9, effective 03/29/2018. | Definitive | Soil, Solids/PCBs | GC/ECD | ELLE | No |
| WI11483 | Colorimetric Sulfide in Waters (#0230), Sulfide as H2S (#10293 Calculation), Dissolved Sulfide in Water (#10499) by 4500-S2 D-2011, 4500-S2 F-2011, or EPA 376.2, Rev 17, effective 03/15/2018. | Definitive | Water/Total Sulfide | UV Spec | ELLE | No |
| WI8194 | VOCs and GRO by GC/MS in Waters and Wastewaters by Method 8260C/D, Rev 8, effective 7/18/19. | Definitive | Water/VOCs | GC/MS | ELLE | No |

| Lab SOP Number | Title, Revision Date, and/or Number | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis | Modified for Project Work? (Yes/No) |
|---|---|---|---|---|---|---|
| WI9783 | TPH by NWTPH-Dx (modified) in Waters using GC-FID | Definitive | Water/DRO | GC | ELLE | No |
| WI9238 | Analysis of Polychlorinated Biphenyls (PCBs) by 8082A in Aqueous Samples using GC-ECD, Rev 6, effective 03/29/2018 | Definitive | Water/PCBs | GC | ELLE | No |
| WI36458 | Polyfluorinated Alkyl Substances (PFAS) in Aqueous Samples by Method 537 Revision 1.1 Modified QSM 5.3 Table B-15 Using/LC/MS/MS, Rev 1, effective 01/28/2021. | N/A | Water/PFAS | LC/MS/MS | ELLE | No |

Note: The laboratory SOPs listed in Worksheet #23 are the most current revisions at the time of publication of this QAPP. AECOM will review the laboratory SOPs immediately prior to sample submittal to ensure that the laboratory uses SOPs that are in compliance with the DoD QSM annual review requirement.

| | |
|---|---|
| % | percent |
| CVAA | cold vapor atomic absorption |
| DRO | diesel range organic |
| ELLE | Eurofins Lancaster Laboratories Environmental, LLC |
| GC/ECD | gas chromatography-electron capture detection |
| GC/FID | gas chromatography-flame ionization detector |
| GC/MS | gas chromatography-mass spectrometry |
| GRO | gasoline range organic |
| ICP | inductively coupled plasma |
| LC/MS/MS | liquid chromatography with tandem mass spectrometry |
| N/A | not applicable |
| PCB | polychlorinated biphenyl |
| PFAS | per- and polyfluoroalkyl substances |
| SOP | standard operating procedure |
| Spec | spectrophotometer |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TPH | total petroleum hydrocarbon |
| UV | ultraviolet |
| VOC | volatile organic compound |

# Work Sheet 24 – IDW Analytical Instrument Calibration Table

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| % Moisture | Use at least two Class 1 weights that bracket expected mass typically ranging from 0.01-50.0g | Daily | +/- 0.5 g | Perform balance internal calibration, tag out of operation and contact outside support | ELLE Analyst | WI10697 |
| Total Cyanide: 9012B | Initial calibration with a minimum of 6 points ranging from 0.010 to 0.350 mg/L | Daily | r >0.995. | Perform instrument maintenance and recalibrate. | ELLE Analyst | WI11621 |
| | Initial Calibration Blank | With each initial calibration | No analytes detected > 1/2 LOQ. | Reanalyze or recalibrate. | ELLE Analyst | |
| | LOD | Quarterly | Detect the compound. | Reanalyze the LOD. | ELLE Analyst | |
| | ICV | After each initial calibration | Within +/- 10% of the nominal concentration. | If ICV fails again, do system maintenance and recalibrate. | ELLE Analyst | |
| | CCV | Prior to sample analysis, after every 10 field samples, and at the end of the sequence | Within +/- 10% of the nominal concentration. | Reanalyze the CCV in duplicate. If both pass, continue with analysis. If either fails again, take corrective action and recalibrate. | ELLE Analyst | |
| | CCB | Prior to sample analysis, after every 10 field samples, and at the end of the sequence | No analytes detected > 1/2 LOQ. | Correct problem and reanalyze associated samples. | ELLE Analyst | |
| | Distillation verification | With each initial calibration | Within +/- 10% of the nominal concentration. | Correct problem and reanalyze associated samples or repeat ICAL. | ELLE Analyst | |
| Sulfide | Calibration using at least 5 points ranging from 0.10 to 2.0 mg/L | Every 3 months or when a new reagent is prepared | Correlation coefficient must be ≥0.995. | Correct the problem and recalibrate. | ELLE Analyst | WI11483 (water) |
| | CCV Standard | Beginning of each batch, every 10 samples, and end of batch | ±10% difference. | Correct the problem, recalibrate, and reanalyze affected samples. | ELLE Analyst | |
| Distillation -- iodometric titration | Standardization of titrant | Initial daily standardization prior to sample analysis. | See method SOP for standardization procedure. | N/A. | Eurofins TestAmerica Denver Analyst / Section Supervisor | DV-WC-0091 (soil/solids) |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| ICP Metals: 6010D | Initial Calibration consists of Blank and 1 point: 0 ppm and 50 ppm for Al, Ca, Fe, Mg, K, Na, S, and Si. 0 ppm and 1 ppm for all other metals | Each new run | Passing ICV and ICB. | Recalibrate; perform instrument maintenance if calibration cannot conform to criteria; recalibrate. | ELLE Analyst | WI11931 |
| | ICV | After each calibration | ±10% of true value, RSD must be <5%. | Recalibrate and reanalyze. | ELLE Analyst | |
| | ICB | Immediately after the ICV | No analytes > 1/2 RL. | Positive result: Accept sample results >10× the ICB or < LOD. Negative result: Accept results >10× ICB. All other samples must be reanalyzed with compliant ICB. | ELLE Analyst | |
| | LOD | Quarterly | Analytes detected. | Reprep and reanalyze LOD. | ELLE Analyst | |
| | CCV | Immediately after the ICSAB and every 10 samples | ±10% of true value, RSD must be <5%. | Reanalyze. | ELLE Analyst | |
| | CCB | Immediately after the CCV and at a frequency of every 10 samples | No analytes > 1/2 RL. | Positive result: Accept sample results >10× the ICB or < LOD. Negative result: Accept results >10× ICB. All other samples must be reanalyzed with compliant ICB. | ELLE Analyst | |
| | Interference Check Sample-A | At the beginning of each run, immediately following the LLC | Absolute value of concentration for all non-spiked project analytes <1/2 LOQ. | Recalibrate. | ELLE Analyst | |
| | Interference Check Sample-AB | At the beginning of each run, immediately following the LLC | ± 20% of the true value for each analyte. | Recalibrate. | ELLE Analyst | |
| | Low Level Check (LLC) | Beginning of each sequence and before the interference check samples | ± 20% of true value. | Reanalyze the sample. | ELLE Analyst | |
| | Linear Range | Quarterly | ±10% of true value. | Samples > 90% of the linear range must be reanalyzed as a dilution. | ELLE Analyst | |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| CVAA (Mercury): 7470A | ICAL for all analytes; minimum 5 standards and a calibration blank. | Daily ICAL prior to sample analysis. | $r^2 \geq 0.99$ | Correct the problem, then repeat ICAL. | ELLE Analyst | W17965 |
| | Second source ICV. | Once after each ICAL, prior to sample analysis. | All reported analytes within ± 10% of true value. | Correct the problem. Rerun ICV. If fails, repeat ICAL. | ELLE Analyst | |
| | CCV. | After every 10 field samples and at the end of the analysis sequence. | All reported analytes within ± 10% of the true value. | Recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV; or immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, take corrective action(s) and recalibrate; then re-analyze all affected samples since last acceptable CCV. | ELLE Analyst | |
| | ICB/CCB. | Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence. | No analytes detected > LOD. | Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed. | ELLE Analyst | W17965 |
| GC/MS Volatiles 8260D | GC/MS Tuning | Tune with BFB before an ICAL and every 12 hours | Per ion abundance criteria in SW-846 method. | Retune, injection port maintenance, clean the source, and/or change the column. | ELLE Analyst | WI8194 (water) and WI8236 (soil) |
| | Initial Calibration with minimum 5 points; Solid and 5 mL waters 1 ppb through 300 ppb; 25 mL waters 0.2 ppb through 25 ppb; 5 mL UST waters 0.5 ppb through 200 ppb | After continuing calibration fails | %RSD of ≤15% is required for all analytes using an average relative response factor. 10% of the analytes may fail this criteria. For any analytes with a %RSD >15%, a first-degree linear regression can be used providing that the correlation coefficient (CC) is ≥ 0.99 and a minimum of five levels are used. A quadratic curve fit may be used provided that the coefficient of determination is ≥ 0.99 and a minimum of six levels are used. If >10% of the analytes fail, the calibration is not valid and must be repeated. Minimum response factor criteria must be met for select compounds. | Perform instrument maintenance and recalibrate. | ELLE Analyst | |
| | Retention Time Window Establishment | Once per ICAL and at the beginning of the analytical sequence | Position is set using the midpoint standard of the ICAL curve when ICAL is performed. On days with no ICAL, use the initial CCV. | N/A. | ELLE Analyst | |
| | Evaluation of Relative Retention Times (RRT) | With each sample | RRT of each reported analyte within ±0.06 RRT units. | Correct problem, then recalibrate. | ELLE Analyst | |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| GC/MS Volatiles 8260D (cont'd) | MDL Standard | After each calibration | All compounds must be detected. | Repeat tuning and ICAL procedure prior to analyzing samples. Repeat maintenance if needed. | ELLE Analyst | WI8194 (water) and WI8236 (soil) |
| | ICV Standard | After each calibration | All target analytes ≤20% drift. | Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples. | ELLE Analyst | |
| | LOD standard | Quarterly | All compounds must be detected. | Reprep and reanalyze LOD. | ELLE Analyst | |
| | CCV standard | Every 12 hours and at the end of analytical run | All target analytes ≤20% drift. Ending CCV – All reported analytes and surrogates within ± 50%. | Reanalyze CCV in duplicate immediately. If both pass, samples can be reported. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed, all samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported. | ELLE Analyst | |
| LC/MS/MS PFAS for QSM 5.3 Table B-15 | Mass Calibration | Initially, annually, and after performing major maintenance | Per manufacturer's specifications. | N/A. | ELLE Analyst | W36458 (water) and WI36459 (soil) |
| | Tuning of LC/MS/MS | When masses fall outside of ± 0.5 amu of true masses | Within 0.5 amu of true value. | Retune and verify. If tuning fails acceptance criteria, perform a mass calibration and repeat the tune check. | ELLE Analyst | |
| | Mass Spectral Acquisition Rate | Each analyte, labeled analyte, and injection internal standard | A minimum of 10 spectra scans are acquired across each chromatographic peak. | N/A. | ELLE Analyst | |
| | Initial calibration with a minimum 5 points | After continuing calibration fails | S/N ratio ≥10:1 for all ions used for quantification. % RSD of the RFs for all analytes must be <20%. Linear or non-linear calibrations must have a $r^2$ ≥0.99. Must use at least 6 points for a quadratic. Analytes must be within 70-130% of their true values for each calibration standard. | Perform more aggressive instrument maintenance and recalibrate. | ELLE Analyst | |
| | MDL standard | After each initial calibration | All compounds must be detected. | Repeat ICAL procedure prior to analyzing samples. Repeat maintenance if needed. | ELLE Analyst | |
| | Instrument Sensitivity Check | Prior to analysis and every 12 hours using a standard with analyte concentrations at the LOQ | Recover within ±30% of their true value. | Correct problem and rerun ISC. If problem persist, repeat ICAL. | ELLE Analyst | |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| LC/MS/MS PFAS for QSM 5.3 Table B-15 (cont'd) | ICV Standard | Once with every ICAL | Within ±30% of their true value. | Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples. | ELLE Analyst | W36458 (water) and WI36459 (soil) |
| | LOD standard | Quarterly | All compounds must be detected. | Reprep and reanalyze LOD. | ELLE Analyst | |
| | LOQ Verification | Quarterly | Within 50% of true value. | Reprep and reanalyze LOQ. | ELLE Analyst | |
| | CCV Standard | Every 10 samples and at the end of a sequence | Alternate analyte concentrations range from the LOQ to the mid-level of the calibration curve. Recover within ±30% of their true value. | Reanalyze CCV in duplicate immediately. If both pass, samples can be reported. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed, all samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported. | ELLE Analyst | |
| | Instrument Blanks | Immediately following the highest standard analyzed and daily at start of a sequence | Concentration of each analyte must be ≤1/2 LOQ. | If criteria not met after highest calibration standard, that standard's concentration must be decreased until criteria are met. If criteria are not met for sample, run additional instrument blanks until criteria are met. | ELLE Analyst | |
| Gas Chromatography GRO – NWTPH-Gx | RT Marker | Before every initial calibration and batch | Used to determine the start and stop points for the specific GRO range to be quantitated. The RT should fall within established RT windows. | Update the hydrocarbon(s) midpoint RTs from the standard. If RTs are continuously inconsistent, maintenance may need to be performed. | ELLE Analyst | WI8224 |
| | Initial calibration with minimum 5 points; waters 55 to 5500 ppb; soils 687.5 ppb to 27,500 ppb | After continuing calibration fails | RSD must be ≤20% to assume linearity through the origin and use the average calibration factor (AVGCF) for quantitation. If the %RSD is >20%, a linear calibration may be used in place of the average calibration factor as long as the correlation coefficient is > 0.99. | Perform instrument maintenance and recalibrate. | ELLE Analyst | WI8224 |
| | MDL Standard | After each calibration | GRO must be detected. | Reprep and repeat MDL and ICAL procedure prior to analyzing samples. Maintenance if needed. | ELLE Analyst | WI8224 |
| | ICV Standard | After each calibration | The percent difference for the calculated concentration versus the nominal concentration is ≤20%. | Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples. | ELLE Analyst | WI8224 |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| Gas Chromatography DRO and/or HRO – NWTPH-Dx | Initial calibration with a minimum of 5 points ranging from 12 to 583 mg/kg for soils and 50 to 10,000 µg/l for waters | After continuing calibration fails | %RSD for ICAL RF ≤20%; linear r ≥0.99. | Perform more aggressive instrument maintenance and recalibrate. | ELLE Analyst | WI9781 (soil), W19783 (water) |
|  | MDL Standard | After each initial calibration | All compounds must be detected. | Repeat ICAL procedure prior to analyzing samples. Repeat maintenance if needed. | ELLE Analyst |  |
|  | ICV Standard | After each initial calibration | Target compounds +/- 15% of the nominal concentration and within established retention time windows. | Reanalyze the ICV. If ICV fails again, do system maintenance and recalibrate. | ELLE Analyst |  |
|  | CCV Standard | Prior to sample analysis, after every 10 field samples, and at the end of the sequence | Target compounds +/- 15% of the nominal concentration and within established retention time windows. | All samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported. | ELLE Analyst |  |
| Gas Chromatography PCBs 8082A | Initial calibration with a minimum 5 points; ranges from 2 to 200 µg/L | After continuing calibration fails | % RSD ≤20%; if >20%, then alternate fit linear $r^2$ ≥0.99 or quadratic r2 ≥0.99. Must use 6 points for quadratic curve. | Perform more aggressive instrument maintenance and recalibrate. | ELLE Analyst | WI9238 (water), WI10004 (soil) |
|  | MDL Standard | After each initial calibration | All compounds must be detected. | Repeat ICAL procedure prior to analyzing samples. Repeat maintenance if needed. | ELLE Analyst |  |
|  | ICV Standard | After each initial calibration | Target aroclors +/- 20% of the nominal concentration and within established retention time windows. | Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples. | ELLE Analyst |  |
|  | LOD Standard | Quarterly | All compounds must be detected. | Reprep and reanalyze LOD. | ELLE Analyst |  |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference [a] |
|---|---|---|---|---|---|---|
| Gas Chromatography PCBs 8082A (cont'd) | CCV Standard | Prior to sample analysis, after every 10 field samples, and at the end of the sequence | Target aroclors +/- 20% of the nominal concentration and within established retention time windows. | All samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported. | ELLE Analyst | WI9238 (water), WI10004 (soil) |
|  | Confirmation of positive results | All positive results | Calibration and QC criteria are the same for the confirmation analysis as for primary analysis. RPD for results between primary and confirmation is ≤40%. | Flag outliers. | ELLE Analyst |  |

| | |
|---|---|
| %D | percent difference |
| amu | atomic mass unit |
| BFB | bromofluorobenzene |
| CCB | continued calibration blank |
| CCV | continued calibration verification |
| CVAA | cold vapor atomic absorption |
| DRO | diesel range organic |
| ELLE | Eurofins Lancaster Laboratories Environmental, LLC |
| g | gram |
| GC/MS | gas chromatography-mass spectrometry |
| GRO | gasoline range organic |
| ICAL | initial calibration |
| ICB | initial calibration blank |
| ICP | inductively coupled plasma |
| ICSAB | interference check samples A and B |
| ICV | initial calibration verification |
| LC/MS/MS | liquid chromatography with tandem mass spectrometry |
| LOD | limit of detection |
| LOQ | limit of quantitation |
| MDL | method detection limit |
| mg/kg | milligram per kilogram |
| mg/L | milligram per liter |
| mL | milliliter |
| N/A | not applicable |
| ND | not detected |
| PCB | polychlorinated biphenyl |
| PFAS | per- and polyfluoroalkyl substances |
| ppb | parts per billion |
| ppm | parts per million |
| QC | quality control |
| QSM | Quality Systems Manual |
| RF | response factor |
| RL | reporting limit |
| RRT | relative retention time |
| RSD | relative standard deviation |
| RT | retention time |
| S/N | signal-to-noise ratio |
| SOP | standard operating procedure |

[a] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

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# Worksheet 25 - IDW Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

| Instrument/ Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference [a] |
|---|---|---|---|---|---|---|---|---|
| Analytical balance | Assure the balance is in a vibration-free area, is level, and the interior housing is clean. | Verification with ASTM certified weights | Visual inspection and weight verification | Each day of use | The reading must be ±0.1% or ±0.5mg, whichever is greater. | 1) verify cleanliness of weights 2) remove balance from service and place a call to service firm 3) management must evaluate data generated since last acceptable reading to determine any potential impacts to data quality | ELLE analyst | WI11880 |
| | Annual calibration and maintenance | Annual calibration and maintenance | Annual calibration and maintenance | Annual | Per vendor specification in compliance with ISO certification. | Per vendor specification in compliance with ISO certification. | Professional calibration vendor (ISO 17025 certified) | |
| Thermo 6000 Series ICP-AES | As needed replacement of components. | Calibration checks | Visual inspection of components | As needed maintenance/ calibration checks every 10 injections | 90–110% for the calibration checks. | Recalibration. | ELLE Analyst | WI11931 |
| Leeman Labs Hydra II Mercury Analyzer | As needed, replacement of components. | Calibration checks | Visual inspection of components | As needed maintenance/ calibration checks every 10 injections | 90-110% for the calibration checks | Recalibration | ELLE Analyst | WI7965 |
| UV Spectrophotometer | As needed replacement of components. | Calibration checks | Visual inspection of components | As needed maintenance/ calibration checks every 10 injections | 90-110% for calibration checks. | Recalibration. | ELLE Analyst | WI11483 |
| Agilent 6890 GC/5973 MSD (or equivalent) | As needed, replacement of components. | CCV | Visual inspection of components | As needed | Initial calibration or continuing calibration verification passes method criteria. | Perform additional maintenance prior to instrument calibration or CCV. | ELLE Analyst | WI8236, WI8194 |
| LC/MS/MS | Backflush of column, injection port and pre-columns, cleaning of ion spray cone, adjustment of collision energies, others as needed. | Calibration check | Visual | As needed | Initial calibration or calibration verification passes method specifications. | Perform additional maintenance prior to instrument calibration or calibration verification. | ELLE Analyst | WI36459, WI36458 |
| Flow Analyzer | As needed replacement of components and/or tubing. | Calibration checks | Visual inspection of components | As needed maintenance/ calibration checks every 10 injections | 90-110% for calibration checks. | Recalibration. | ELLE Analyst | WI11621 |

| Instrument/ Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference [a] |
|---|---|---|---|---|---|---|---|---|
| Agilent 6890 GC/PID and/or FID (or equivalent) | As needed, replacement of components. | CCV | Visual inspection of components | As needed | Initial calibration or continuing calibration verification passes method criteria. | Perform additional maintenance prior to instrument calibration or CCV. | Analysts or group leaders | WI8224 |
| HP5890, HP6890, or Agilent 7890 GC with FID | Injection port maintenance; column; FID maintenance. | Continuing Calibration Check | Visual inspection | As needed | Initial calibration within specifications. | Perform maintenance again; recalibrate if necessary. | ELLE Analyst | WI9781, WI9783 |
| Gas Chromatograph, HP5890, HP 6890, and HP7890 with ECD Detector | Injection port maintenance; ECD maintenance. | Calibration Check; all analytes within +/- 20% of the nominal concentration and within established retention time windows | Visual Inspection | As needed | Initial calibration after maintenance is within specifications. | Perform maintenance again. | GC analyst | WI10004, WI9238 |

| | |
|---|---|
| % | percent |
| ASTM | American Society for Testing and Materials |
| CCV | continuing calibration verification |
| ECD | electron capture detector |
| ELLE | Eurofins Lancaster Laboratories Environmental, LLC |
| FID | flame ionization detector |
| GC | gas chromatograph |
| ICP-AES | inductively coupled plasma-atomic emission spectroscopy |
| ISO | International Organization for Standardization |
| LC/MS/MS | liquid chromatography with tandem mass spectrometry |
| mg | milligram |
| MS | mass spectrometer |
| MSD | mass spectrometer detector |
| PID | photoionization detector |
| SOP | standard operating procedure |

[a] Specifies the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

# Worksheet #28 – IDW Laboratory QC Samples Table

| | |
|---|---|
| **Matrix:** | Soil/Solids |
| **Analytical Group:** | Total Solids |
| **Analytical Method/SOP Reference:** | Analytical Methods: SM 2540-G<br>Preparation Methods: SM 2540-G<br>Laboratory SOPs: WI10697 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Duplicate | 1 per 10 samples | Laboratory statistical RPD | Flag data. | ELLE Analyst | Precision | Results within acceptance limits |
| LCS | 1 per prep batch of up to 20 samples | Laboratory statistical limits | Correct problem, reprepare and reanalyze the LCS and all sample associated | ELLE Analyst | Accuracy/Bias | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| QC | quality control |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Soil |
| **Analytical Group:** | Metals |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 6010D<br>Preparation Methods: EPA 3050B<br>Laboratory SOPs: WI8636, WI11931 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method Blank | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 RL or >1/20 the amount measured in any sample. | Reanalyze blank to confirm detections. If detects confirm, redigest samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 RL or >1/20 the amount measured in any sample |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3 ±25% for elements not in QSM 5.1.1; RPD ≤20%. | Analyze post digestion spike and serial dilution. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3 ±20% for elements not in QSM 5.1.1; RPD ≤20%. | Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Duplicate | 1 per prep batch of up to 20 samples | RPD must be ≤20%. | Flag data. | ELLE Analyst | Precision | Results within acceptance limits |
| Serial Dilutions | Must be prepared with each background sample, evaluated only when analyte concentrations are >50x the LOQ | The percent difference must be ≤10%. | Flag data. | ELLE Analyst | Precision | Results within acceptance limits |
| Post Digestion Spike | Prepare with each background sample | ± 20% True Value. | No specific action needed unless required by the project. PDS is reported in data package. | ELLE Analyst | Accuracy/Bias | Results within acceptance criteria |
| Internal Standard | Every sample and QC | Must be 50%-130% of the calibration blank. | Reanalyze at a dilution. | ELLE Analyst | Precision | Results within acceptance criteria |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| PDS | post digestion spike |
| QC | quality control |
| QSM | Quality Systems Manual |
| RL | reporting limit |
| RPD | relative percent difference |
| SOP | standard operating procedure |

**Matrix:** Soil\Solids\Water

**Analytical Group:** Mercury

**Analytical Method/SOP Reference:** Analytical Methods: EPA 7470A, EPA 7471B
Preparation Methods: TCLP 1311, EPA 7470A, EPA 7471B
Laboratory SOPs: WI7965

**Analytical Organization:** Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| MS/MSD pair | One per analytical method for each batch of at most 20 samples. | Per DoD QSM Appendix C Limits, Methods SW-846 6010C/7471B and Lab SOPs<br>MSD or Matrix Duplicate: RPD of all analytes ≤20%. | Examine the PQOs. Notify Lab QA officer and project chemist about additional measures to be taken. | Analyst<br>Lab QA Officer<br>Project Chemist | Accuracy/Precision | For matrix evaluation, use QC acceptance criteria at least as stringent as specified by DoD QSM 5.3 (DoD and DOE 2019) (update to lab's most recent accreditation [e.g., QSM 5.2] as applicable). |
| Dilution test | One per preparatory batch if MS or MSD fails. Only applicable to samples with concentrations >50× the LOQ prior to dilution. | Five-fold dilution must agree within ±10% of the original measurement. | Perform PDS addition. | Analyst<br>Lab QA Officer<br>Project Chemist | Accuracy/ Representativeness | QC acceptance criteria specified by DoD QSM 5.2 (DoD and DOE 2019) (update to lab's most recent accreditation [e.g., QSM 5.3] as applicable). Diluted result is within ±10% of the original measurement. |
| PDS (ICP only) | One per preparatory batch when dilution test fails or analyte concentration in all samples <50 × LOQ prior to dilution. Use the same sample as used for the MS/MSD, if possible. | Recovery within 80–120%. | Run all associate samples in the preparatory batch by MSA. | Analyst<br>Lab QA Officer<br>Project Chemist | Accuracy/ Representativeness | QC acceptance criteria specified by DoD QSM 5.2 (DoD and DOE 2019) (update to lab's most recent accreditation [e.g., QSM 5.2] as applicable).<br>Recovery within 80–120%. |
| MSA | When dilution test or post digestion spike fails. | N/A. | N/A. | Analyst<br>Lab QA Officer<br>Project Chemist | Confirmation | N/A. |

| | |
|---|---|
| DoD | Department of Defense |
| DOE | Department of Energy |
| ICP | inductively coupled plasma |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSA | method of standard additions |
| MSD | matrix spike duplicate |
| N/A | not applicable |
| PDS | post digestion spike |
| PQO | project quality objective |
| QA | quality assurance |
| QC | quality control |
| QSM | Quality Systems Manual |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Soil |
| **Analytical Group:** | VOCs |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 8260D<br>Preparation Methods: EPA 5035/5035A<br>Laboratory SOPs: WI11170/WI8236 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per sample (including MS/MSD, LCS, and Blanks) | Recovery limits per QSM 5.3. | If obvious matrix interference report data with a comment. Otherwise, re-analyze. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method blanks | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. | Reanalyze to confirm detections. If detects confirm reanalyze samples that are not ND or not >10x the blank value or regulatory limit. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3.; RPD ≤20%. | Flag outliers. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3.; RPD ≤20%. | Analytes in the LCS that fail high and are ND in the samples can be reported. For all others reanalyze LCS and samples. If it still fails, perform instrument maintenance, restart the tune period and reanalyze all QC and samples. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Internal standards | Per sample (including MS/MSD, LCS, and blanks) | -50% to + 100% of internal standard area of 12 hour STD. RT change. | Check the instrument for possible problems and then reanalyze samples. If reinject confirms, report with a comment. | ELLE Analyst | Precision | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| RPD | relative percent difference |
| RT | retention time |
| SOP | standard operating procedure |
| STD | standard |
| VOC | volatile organic compound |

| | |
|---|---|
| **Matrix:** | Soil |
| **Analytical Group:** | PFAS |
| **Analytical Method/SOP Reference:** | Analytical Methods: DoD QSM v5.3, Table B-15<br>Preparation Methods: DoD QSM v5.3, Table B-15<br>Laboratory SOPs: WI36459 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blanks | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. | Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater |
| MS/MSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits if in-house limits do not exist use 70-130%; RPD ≤30%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits, if in-house limits do not exist use 70-130%; RPD ≤30%. | Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Isotopically Labeled Extraction Standards [1] | Per sample (including MS/MSD, LCS, and blanks) prior to preparation | Within 50% of true value. | If fails for QC sample, but the native compounds are within specification, report data. If fails for sample, reextract and reanalyze and/or consult a supervisor for course of action. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Post Spike Sample | Aqueous samples prepared by serial dilution instead of SPE that have reported values <LOQ | 70-130% recovery. | Reanalyze sample, sample duplicate and post spike sample at higher dilutions until criteria is met. | ELLE Analyst | Accuracy | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| PFAS | per- and polyfluoroalkyl substances |
| QC | quality control |
| RPD | relative percent difference |
| SOP | standard operating procedure |
| SPE | solid phase extraction |

[1] For NMePFOSA, NMePFOSAE, NEtPFOSA, NEtPFOSAE, and HFPODA, an exception will be made to the QSM 5.3 Table B-15 criteria as these compounds typically recover <50%. For all other PFAS compounds if EIS recovery is <50%, the laboratory will check for laboratory error and correct if identified. If no laboratory error is identified, additional corrective action will be performed if EIS recovery is <10%. If EIS recovery is >10% and samples have detections above the reporting limit, no additional corrective action will be performed. If EIS recovery is >10% and samples have no detections for associated native analytes, the native analyte response will be evaluated to confirm the validity of the reporting limit. Reporting limits will be proportionately increased as necessary and appropriate to ensure that reported values accurately reflect the sensitivity of the analysis. For all PFAS compounds, if EIS recovery is >150%, the laboratory will check for error and correct if identified. If no laboratory error is identified, additional corrective action will be performed only when field samples have detections above the reporting limits for the associated native target analytes and EIS recovery is >200%.

| | |
|---|---|
| **Matrix:** | Soil/Solids/Water |
| **Analytical Group:** | Total Cyanide |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 9012B<br>Preparation Methods: EPA 9012B<br>Laboratory SOPs: WI11621 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample. | Reanalyze blank to confirm detections. If detects confirm, reprep samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample |
| MS | 1 per 10 samples | Recovery limits per QSM 5.3; RPD ≤20%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3; RPD ≤20%. | Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Duplicate | 1 per 10 samples | RPD ≤20%. | Flag data | ELLE Analyst | Precision | Results within acceptance limits |
| Post Digestions Spike (PDS) | When MS fails | Recovery limits per QSM 5.3; RPD ≤20%. | Perform MSA | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Method of Standard Addition (MSA) | When MS &PDS fails | N/A. | Include MSA information with data. | ELLE Analyst | Accuracy/Bias/Precision | N/A |

| | |
|---|---|
| LCS | laboratory control sample |
| LOQ | limit of quantitation |
| MS | matrix spike |
| N/A | not applicable |
| ND | non-detect |
| QC | quality control |
| QSM | Quality Systems Manual |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Soil/Solids |
| **Analytical Group:** | Total Sulfide |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 9034<br>Preparation Methods: EPA 9030B<br>Laboratory SOPs: DV-WC-0091 |
| **Analytical Organization:** | Eurofins Laboratories Environmental, LLC - Denver |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method Blank | One per preparation batch (20 samples) | No Target Compounds>1/2 LOQ | If sufficient sample is available, re-prepare and reanalyze samples. | Analyst / Section Supervisor | Contamination | No Target Compounds>1/2 LOQ |
| Laboratory Control Sample | One per preparation batch (20 samples) | Laboratory statistical limits | Reanalyze LCS once. If acceptable, report. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available. | Analyst / Section Supervisor | Accuracy/Bias | Laboratory % Recovery Control Limits |
| Matrix Spike/Matrix Spike Duplicate | One per preparation batch (20 samples) | Laboratory statistical limits | If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error. For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. Explain in the case narrative. | Analyst / Section Supervisor | Accuracy/Bias/ Precision | Laboratory % Recovery / RPD Control Limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LOQ | limit of quantitation |
| MS | matrix spike |
| QC | quality control |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Soil/Solids/Water |
| **Analytical Group:** | TPH - GRO |
| **Analytical Method/SOP Reference:** | Analytical Methods: Ecology NWTPH-Gx<br>Preparation Methods: EPA 5035<br>Laboratory SOPs: WI8224 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per sample (including MS/MSD, LCS, and Blanks) | Laboratory statistical limits | If obvious matrix interference report data with a comment. Otherwise, re-analyze. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method blanks | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 Reporting Limit or >1/10 the amount measured in any sample. | Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 Reporting Limit or >1/10 the amount measured in any sample |
| MS/MSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits; RPD ≤30%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits; RPD ≤30%. | Analytes in the LCS that fail high and are ND in the samples can be reported. For all others reanalyze LCS and samples. If it still fails, perform instrument maintenance reanalyze all QC and samples. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |

| | |
|---|---|
| GRO | gasoline range organics |
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| RPD | relative percent difference |
| SOP | standard operating procedure |
| TPH | total petroleum hydrocarbon |

| | |
|---|---|
| **Matrix:** | Soil/Solids |
| **Analytical Group:** | TPH - DRO |
| **Analytical Method/SOP Reference:** | Analytical Methods: Ecology NWTPH-Dx<br>Preparation Methods: EPA 3550C<br>Laboratory SOPs: WI10913/WI9781 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per Sample (including Blanks, LCS/LCSD, MS/MSD) | 50–150% | Reanalyze if outside limits, if confirmed, report. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method Blanks | 1 per prep batch of up to 20 samples | No analytes detected > RL or >1/10 the amount measured in any sample. | Reanalyze to confirm detections; Rx if needed. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > RL or >1/10 the amount measured in any sample |
| MS/MSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits, RPD ≤20%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits, RPD ≤20%. | Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |

| | |
|---|---|
| DRO | diesel range organics |
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| RL | reporting limit |
| RPD | relative percent difference |
| SOP | standard operating procedure |
| TPH | total petroleum hydrocarbon |

| | |
|---|---|
| **Matrix:** | Soil/Solids |
| **Analytical Group:** | PCBs |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 8082A<br>Preparation Methods: EPA 3546<br>Laboratory SOPs: WI10927/WI10004 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per sample (including MS/MSD, LCS, and Blanks) | Recovery limits per QSM 5.3. Laboratory statistical limits for surrogates not in QSM 5.3. | If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method blanks | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. | Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3; RPD ≤30%. | Flag outliers. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤30%. | Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| PCB | polychlorinated biphenyl |
| QC | quality control |
| QSM | Quality Systems Manual |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | Sulfide |
| **Analytical Method/SOP Reference:** | Analytical Methods: SM4500 S2D<br>Preparation Methods: SM4500 S2D<br>Laboratory SOPs: WI11483 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample. | Reanalyze blank to confirm detections. If detections confirmed, reanalyze samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample. |
| MS/MSD | 1 per 20 samples | Laboratory statistical window and RPD | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS | 1 per prep batch of up to 20 samples | Method specified window | Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-analyzed. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Duplicate | 1 per 20 samples | Laboratory statistical RPD | Flag data | ELLE Analyst | Precision | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| RPD | relative percent difference |
| SOP | standard operating procedure |

|  |  |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | Metals (Total Fraction) |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 6010D<br>Preparation Methods: EPA 3005A<br>Laboratory SOPs: WI8639, WI11931 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method Blank | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 RL or >1/20 the amount measured in any sample. | Reanalyze blank to confirm detections. If detections confirmed, redigest samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 RL or >1/20 the amount measured in any sample |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3 ±25% for elements not in QSM 5.1.1; RPD ≤20%. | Analyze post digestion spike and serial dilution | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3 ±20% for elements not in QSM 5.1.1; RPD ≤20%. | Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Duplicate | 1 per prep batch of up to 20 samples | RPD must be ≤20%. | Flag data | ELLE Analyst | Precision | Results within acceptance limits |
| Serial Dilutions | Must be prepared with each background sample, evaluated only when analyte concentrations are >50x the LOQ | The percent difference must be ≤10%. | Flag data | ELLE Analyst | Precision | Results within acceptance limits |
| Post Digestion Spike | Prepare with each background sample | ± 20% True Value. | No specific action needed unless required by the project. PDS is reported in data package. | ELLE Analyst | Accuracy/Bias | Results within acceptance criteria |
| Internal Standard | Every sample and QC | Must be 50%-130% of the calibration blank. | Reanalyze at a dilution. | ELLE Analyst | Precision | Results within acceptance criteria |

|  |  |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| QSM | Quality Systems Manual |
| RL | reporting limit |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | Mercury |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 7470A<br>Preparation Methods: TCLP 1311, EPA7470A<br>Laboratory SOPs: WI7965 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method Blank | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 RL or >1/20 the amount measured in any sample | Reanalyze blank to confirm detections. If detects confirm, redigest samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 RL or >1/20 the amount measured in any sample |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3; RPD ≤20% | Flag outliers | ELLE Analyst | Accuracy/Bias/ Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3; RPD ≤20% | Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed. | ELLE Analyst | Accuracy/Bias/ Precision | Results within acceptance limits |
| Duplicate | 1 per prep batch of up to 20 samples | RPD must be ≤20% | Flag data | ELLE Analyst | Precision | Results within acceptance limits |
| Method of Standard Addition (MSA) | When dilution fails or project requires it | N/A | N/A | ELLE Analyst | N/A | Document in data package |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| N/A | not applicable |
| ND | non-detect |
| QC | quality control |
| QSM | Quality Systems Manual |
| RL | reporting limit |
| RPD | relative percent difference |
| SOP | standard operating procedure |

| | |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | VOCs |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 8260D<br>Preparation Methods: EPA 8260D<br>Laboratory SOPs: WI8194 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per sample (including MS/MSD, LCS, and Blanks) | Recovery limits per QSM 5.3. Laboratory statistical limits for surrogates not in QSM 5.3. | If obvious matrix interference report data with a comment. Otherwise, re-analyze. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method blank | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. | Reanalyze to confirm detections. If detections confirmed, reanalyze samples that are not ND or not >10x the blank value or regulatory limit. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3; RPD ≤20%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3; RPD ≤20%. | Analytes in the LCS that fail high and are ND in the samples can be reported. For all others, reanalyze LCS and samples. If it still fails, perform instrument maintenance, restart the tune period and reanalyze all QC and samples. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Internal standards | Per sample (including MS/MSD, LCS, and blanks) | -50% to + 100% of internal standard area of 12 hour STD. RT change. | Check the instrument for possible problems and then reanalyze samples. If reinject confirms, report with a comment. | ELLE Analyst | Precision | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| QSM | Quality Systems Manual |
| RPD | relative percent difference |
| RT | retention time |
| SOP | standard operating procedure |
| STD | standard |
| VOC | volatile organic compound |

| | |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | PFAS |
| **Analytical Method/SOP Reference:** | Analytical Methods: DoD QSM v5.3, Table B-15<br>Preparation Methods: DoD QSM v5.3, Table B-15<br>Laboratory SOPs: WI36458 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blanks | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. | Reanalyze to confirm detections. If detections confirmed, reextract samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater |
| MS/MSD | 1 per prep batch of up to 20 samples | Appendix C QSM 5.3. If analytes aren't listed use in-house limits; RPD 30%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Appendix C QSM 5.3. If analytes aren't listed use in-house limits; RPD 30%. | Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| Isotopically Labeled Extraction Standards [1] | Per sample (including MS/MSD, LCS, and blanks) prior to preparation | Within 50% of true value. | If fails for QC sample, but the native compounds are within specification, report data. If fails for sample, reextract and reanalyze and/or consult a supervisor for course of action. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Post Spike Sample | Aqueous samples prepared by serial dilution instead of SPE that have reported values <LOQ | 70–130% recovery. | Reanalyze sample, sample duplicate and post spike sample at higher dilutions until criteria is met. | ELLE Analyst | Accuracy | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| PFAS | per- and polyfluoroalkyl substances |
| QC | quality control |
| QSM | Quality Systems Manual |
| RPD | relative percent difference |
| SOP | standard operating procedure |
| SPE | Solid Phase Extraction |

[1] For NMePFOSA, NMePFOSAE, NEtPFOSA, NEtPFOSAE, and HFPODA, an exception will be made to the QSM 5.3 Table B-15 criteria as these compounds typically recover <50%. For all other PFAS compounds if EIS recovery is <50%, the laboratory will check for error and correct if identified. If no laboratory error is identified, additional corrective action will be performed if EIS recovery is <10%. If EIS recovery is >10% and samples have detections above the reporting limit, no additional corrective action will be performed. If EIS recovery is >10% and samples have no detections for associated native analytes, the native analyte response will be evaluated to confirm the validity of the reporting limit. Reporting limits will be proportionately increased as necessary and appropriate to ensure that reported values accurately reflect the sensitivity of the analysis. For all PFAS compounds, if EIS recovery is >150%, the laboratory will check for error and correct if identified. If no laboratory error is identified, additional corrective action will be performed only when field samples have detections above the reporting limits for the associated native target analytes and EIS recovery is >200%.

| | |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | TPH - DRO |
| **Analytical Method/SOP Reference:** | Analytical Methods: Ecology NWTPH-Dx<br>Preparation Methods: EPA 3510C<br>Laboratory SOPs: WI10908/WI9783 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per Sample (including Blanks, LCS/LCSD, MS/MSD) | 50–150% | Reanalyze if outside limits, if confirmed, report. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method Blanks | 1 per prep batch of up to 20 samples | No analytes detected > RL or >1/10 the amount measured in any sample. | Reanalyze to confirm detections; Rx if needed. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > RL or >1/10 the amount measured in any sample |
| MS/MSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits, RPD ≤20%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Laboratory statistical limits, RPD ≤20%. | Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |

| | |
|---|---|
| DRO | diesel range organics |
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| QC | quality control |
| RL | reporting limit |
| RPD | relative percent difference |
| SOP | standard operating procedure |
| TPH | total petroleum hydrocarbon |

| | |
|---|---|
| **Matrix:** | Water |
| **Analytical Group:** | PCBs |
| **Analytical Method/SOP Reference:** | Analytical Methods: EPA 8082A<br>Preparation Methods: EPA 3510C-LVI<br>Laboratory SOPs: WI10927/WI9238 |
| **Analytical Organization:** | Eurofins Lancaster Laboratories Environmental, LLC (ELLE) |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Surrogate Spike | Per sample (including MS/MSD, LCS, and Blanks) | Recovery limits per QSM 5.3. Laboratory statistical limits for surrogates not in QSM 5.3. | If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze. | ELLE Analyst | Accuracy | Results within acceptance limits |
| Method blanks | 1 per prep batch of up to 20 samples | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. | Reanalyze to confirm detections. If detections confirmed, reextract samples that are not ND or not >10x the blank value. | ELLE Analyst | Accuracy/Laboratory Contamination | No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater |
| MS/MSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3; RPD ≤30%. | Flag outliers | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |
| LCS/LCSD | 1 per prep batch of up to 20 samples | Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤30%. | Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted. | ELLE Analyst | Accuracy/Bias/Precision | Results within acceptance limits |

| | |
|---|---|
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LOQ | limit of quantitation |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ND | non-detect |
| PCB | polychlorinated biphenyl |
| QC | quality control |
| QSM | Quality Systems Manual |
| RPD | relative percent difference |
| SOP | standard operating procedure |

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# Worksheet #30 – IDW Analytical Services Table

| Matrix | Analytical Group | Sampling Locations/ ID Numbers | Analytical SOP | Data Package Turnaround Time | Laboratory/Organization [a] (name and address, contact person, and phone number) |
|---|---|---|---|---|---|
| IDW Solids | Cyanide, Total | All IDW Solids Samples | WI11621 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | Sulfide, Total | All IDW Solids Samples | DV-WC-0091 | 30 calendar days | EurofinsTestAmerica – Denver, 4955 Yarrow Street, Arvada, CO, Amanda Barnhart (primary contact), 717-556-3860 |
| IDW Solids | Total Solids | All IDW Solids Samples | WI10697 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | Metals | All IDW Solids Samples | WI11931/WI7965 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | NWTPH-Gx | All IDW Solids Samples | WI8224 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | NWTPH-Dx | All IDW Solids Samples | WI9781 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | PCBs | All IDW Solids Samples | WI10004 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | VOCs | All IDW Solids Samples | WI8236 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Solids | PFAS | All IDW Solids Samples | WI36459 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | Cyanide, Total | All IDW Aqueous Samples | WI11621 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | Sulfide, Total | All IDW Aqueous Samples | WI11483 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | Metals | All IDW Aqueous Samples | WI11931/WI7965 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | NWTPH-Gx | All IDW Aqueous Samples | WI8224 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | NWTPH-Dx | All IDW Aqueous Samples | WI9783 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |

| Matrix | Analytical Group | Sampling Locations/ ID Numbers | Analytical SOP | Data Package Turnaround Time | Laboratory/Organization [a] (name and address, contact person, and phone number) |
|---|---|---|---|---|---|
| IDW Aqueous | PCBs | All IDW Aqueous Samples | WI9238 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | VOCs | All IDW Aqueous Samples | WI8194 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |
| IDW Aqueous | PFAS | All IDW Aqueous Samples | WI36458 | 30 calendar days | Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860 |

[a] Laboratory meets accreditation requirements to support project needs.

Data packages will be due 30 days after samples are received at the laboratory.

Data packages must include, at a minimum, the following sections:

1. Cover sheet
2. Table of contents
3. Case narrative
4. Analytical results
5. Sample management records
6. QA/QC information

For complete details of report, EDD and data package requirements, see Appendix G of the QAPP document.

# Appendix G:
# Analytical Data Package Requirements

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# Appendix A: Reporting Requirements

In the absence of client specified reporting criteria, the reporting requirements outlined in this appendix shall be used for hard-copy data reports or electronic versions of hard-copy data (such as pdf). They include mandatory requirements for all printed data reports and requirements for data reports requiring third party data review or validation. Optional reporting requirements are those that may be required by a specific project depending upon their needs. The following elements are required: 1) cover sheet, 2) table of contents, 3) Case Narrative, 4) analytical results, 5) sample management records, and 6) Quality Control (QC) information. Information for third-party review may be required depending on project-specific requirements or the method being used.

## 1.0 COVER SHEET

The cover sheet shall specify the following information:

a) title of report (i.e., test report, test certificate);

b) name and location of laboratory (to include a point of contact, phone and facsimile numbers, and e-mail address);

c) name and location of any subcontractor laboratories and appropriate test method performed (information can also be located in the Case Narrative as an alternative);

d) unique identification of the report (such as serial number);

e) client name and address;

f) project name and site location;

g) statement of data authenticity and official signature and title of person authorizing report release, date of issuance;

h) amendments to previously released reports that clearly identify the serial number for the previous report and state the reason(s) for reissuance of the report; and

i) total number of pages.

## 2.0 TABLE OF CONTENTS

Laboratory data packages shall be organized in a format that allows for easy identification and retrieval of information. An index or table of contents shall be included for this purpose.

## 3.0 CASE NARRATIVE

A Case Narrative shall be included in each report. The purpose of the Case Narrative is to:

1) Describe any abnormalities, deviations, and failures that may affect the analytical results;
2) Summarize any issues in the data package that need to be highlighted for the data user to help them assess the usability of the data; and
3) Provide a summary of samples included in the report with the methods employed in order to assist the user in interpretation.

The Case Narrative shall provide:

- a) a table(s) summarizing samples received, providing a correlation between field sample numbers and laboratory sample numbers, and identifying which analytical, preparation, and clean-up methods were performed. If multiple laboratories performed analyses, the name and location of each laboratory shall be associated with each sample;
- b) a list of samples that were received but not analyzed;
- c) date of samples received;
- d) sample preservation and condition at receipt;
- e) a description of extractions or analyses that were performed out of holding times;
- f) a definition of all data qualifiers or flags used;
- g) identification of deviations of any calibration standards or QC sample results from appropriate acceptance limits and a discussion of the associated corrective actions taken by the laboratory;
- h) identification of multiple sample runs with reason(s) identified (e.g., dilutions or multiple cleanups);

i) identification of instances where manual integration was performed including the technical justification; and

j) appropriate notation of any other factors that could affect the sample results (e.g., air bubbles in volatile organic compounds (VOC) sample vials, excess headspace in soil VOC containers, the presence of multiple phases, sample temperature or pH excursions, and container type or volume).

## 4.0 ANALYTICAL RESULTS

The results for each sample shall contain the following information at a minimum:

a) project name and site location;

b) field sample ID number as written on custody form;

c) laboratory sample ID number;

d) preparation batch number(s);

e) matrix (soil, water, oil, air, etc.);

f) date and time sample collected;

g) date and time sample prepared;

h) date and time sample analyzed;

i) method numbers for all preparation, cleanup, and analysis procedures employed;

j) analyte or parameter with the Chemical Abstracts Service (CAS) Registry Number if available;

k) sample aliquot analyzed;

l) final extract volume;

m) identification of analytes for which manual integration occurred, including the cause and justification;

n) analytical results with correct number of significant figures;

o) Detection Limit, Limit of Detection, and Limit of Quantitation associated with sample results and adjusted for sample-specific factors (e.g., aliquot size, dilution/concentration factors, and moisture content);

p) any data qualifiers assigned;

q) concentration units;

r) dilution factors;

s) all multiple sample run results shall be reported;

t) percent moisture or percent solids (all soils are to be reported on a dry weight basis); and

u) statements of the estimated uncertainty of test results (optional).

## 5.0 SAMPLE MANAGEMENT RECORDS

Sample Management records shall include the documentation accompanying the samples, such as:

a) chain of custody records;

b) shipping documents;

c) records generated by the laboratory which detail the condition of the samples upon receipt at the laboratory (e.g., sample cooler receipt forms, cooler temperature, and sample pH);

d) telephone conversation or e-mail records associated with actions taken or quality issues; and

e) records of sample compositing done by the laboratory.

# 6.0 QC INFORMATION

The minimum laboratory internal QC data package shall include:

a) Method Blank results;

b) percent recoveries for Laboratory Control Samples (LCS), Laboratory Control Sample Duplicates (LCSD), Matrix Spikes (MS), and Matrix Spike Duplicates (MSD);

c) MSD or Matrix Duplicate relative percent differences (RPD);

d) surrogate percent recoveries;

e) tracer recoveries;

f) spike concentrations for LCS, MS, surrogates;

g) QC acceptance criteria for LCS, MS, surrogates;

h) Post-Digestion Spike (PDS) recoveries;

i) serial dilutions percent difference; and

j) batch numbers (preparation, analysis, and cleanup).

# 7.0 DATA REPORTS FOR THIRD PARTY REVIEW OR VALIDATION

The data validation guidelines established in other DoD/DOE guidance or project-specific guidelines may have distinct reporting formats. The appropriate QAPP should be consulted to determine what type (stage) of data package is required.

Data validation guidelines define the minimum reporting requirements for each stage (formerly called “level”) of data package as outlined below:

> A cover sheet, table of contents, and Case Narrative including all of the information specified in the previous sections are required for all stages of data reports.
>
> Stage 1: Sample results forms, chain of custody, laboratory receipt checklist.
>
> Stage 2A: Sample results forms, chain of custody, laboratory receipt checklist, method QC forms.

Stage 2B: Sample results forms, chain of custody, laboratory receipt checklist, method QC forms, instrument QC forms, instrument and preparation logs.

Stage 3: Sample results forms, chain of custody, laboratory receipt checklist, method QC forms, instrument QC forms, instrument and preparation logs, instrument quantitation forms (raw data), standards traceability.

Stage 4: Sample results forms, chain of custody, laboratory receipt checklist, sample related method QC forms, instrument QC forms, instrument and preparation logs, instrument quantitation forms (raw data), instrument chromatograms and spectra, standards traceability.