OCTOBER 2018

DRAFT FINAL
SITE-SPECIFIC QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER MONITORING AT THE FORMER FIRE TRAINING PIT AND TRACKED VEHICLE REPAIR/OLD MOBILIZATION AND TRAINING EQUIPMENT SITE

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Yakima, Washington

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Site-Specific Quality Assurance Project Plan for Groundwater Monitoring at the Former Fire Training Pit and Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

Joint Base Lewis-McChord Yakima Training Center Yakima, Washington

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
µg/L	Microgram(s) per liter
APP	Accident Prevention Plan
bgs	below ground surface
CA	Corrective Action
CMI(O)	Corrective measures implementation (operations)
cPAH	Total carcinogenic polycyclic aromatic hydrocarbons
DL	Detection limit
DNAPL	Dense non-aqueous phase liquid
DoD	Department of Defense
DOE	Department of Energy
DQO	Data quality objective
EA	EA Engineering, Science, and Technology, Inc., PBC
E&E	Ecology & Environment
EDR	Environmental Data Resources, Inc.
Ecology	Washington State Department of Ecology
ELAP	Environmental Laboratory Accreditation Program
ERP	Environmental Restoration Program
ft	Feet/foot
FTP	Fire training pit
ID	Identification
IDW	Investigation-derived waste
IRP	Installation Restoration Program
JBLM	Joint Base Lewis-McChord
LNAPL	Light non-aqueous phase liquid
LOD	Limit of detection
LOQ	Limit of quantitation
LTM	Long-term management
LUC	Land use control
MATES	Mobilization and Training Equipment Site
mg/kg	Milligram(s) per kilogram

mg/L	Milligram(s) per liter
mL	Milliliter
MMP	Main Motor Pool
MS	Matrix spike
MSD	Matrix spike duplicate
MTCA	Model Toxics Control Act
No.	Number
OSHA	Occupational Safety and Health Administration
PAIC	Pomona Artesian Irrigation Company
PAH	Polycyclic aromatic hydrocarbon
PAL	Project action limit
PCB	Polychlorinated biphenyl
PDB	Passive diffusion bag
Pegasus	Pegasus Environmental Management Services Inc.
PPE	Personal protective equipment
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
SAIC	Science Applications International Corporation
SI	Site Investigation
SOP	Standard operating procedure
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEC	Toxic equivalent concentration
TEF	Toxicity equivalency factor
TPH	Total petroleum hydrocarbons
TPH-D	Total petroleum hydrocarbons – diesel range
TPH-G	Total petroleum hydrocarbons – gasoline range
TPH-O	Total petroleum hydrocarbons – heavy oil range
TtEC	Tetra Tech EC, Inc.
TTEC	Total toxic equivalent concentration
TVR	Tracked vehicle repair

USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UFP	Uniform Federal Policy
UST	Underground storage tank
VOA	Volatile organic analysis
VOC	Volatile organic compound
WAARNG	Washington Army National Guard
WAC	Washington Administrative Code
YTC	Yakima Training Center

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1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has prepared this Site-Specific Quality Assurance Project Plan (QAPP) in support of groundwater monitoring at the Yakima Training Center (YTC) former Fire Training Pit (FTP) site (YFCR-53) and Tracked Vehicle Repair (TVR) / Old Mobilization and Training Equipment Site (MATES) (YFCR-01), herein referenced as the sites. This work is performed under the Environmental Remediation Multiple Award Indefinite Delivery/Indefinite Quantity Contract W912DQ-16-D-3001. This QAPP is prepared in the Uniform Federal Policy (UFP) format and will be referred to herein as "QAPP."

1.1 BACKGROUND

YTC is an active United States Army sub-installation of Joint Base Lewis-McChord (JBLM), Washington located approximately 5 miles northeast of the city of Yakima, Washington (Figure 1). Two sites, the YTC former FTP site and TVR/Old MATES facilities, are undergoing compliance operations that are in the corrective measures implementation (operations) (CMI[O]) phase (Figure 2). Long-term management (LTM) remedies, including land use controls (LUCs) and groundwater monitoring to monitor natural attenuation of site contaminants for the foreseeable future, were selected and are in place at the former FTP site and TVR/Old MATES facilities in accordance with their respective Decision Documents (Fort Lewis Environmental Restoration Program [ERP] 2007a and 2007b).

LUCs at the former FTP and TVR/Old MATES sites were implemented to restrict drinking water well installation (a media-specific restriction). In addition, LUCs at TVR/Old MATES were implemented 1,000 feet (ft) around the TVR/Old MATES boundary for drinking water control and at TVR Building 845 to prohibit or otherwise manage potential excavation.

The sites are undergoing compliance operations in the CMI(O) phase. This includes semiannual groundwater monitoring for site-related contaminants for the foreseeable future until contaminant concentrations fall below Model Toxics Control Act (MTCA) Method A/Standard Method B groundwater cleanup levels (JBLM 2017). Site-related contaminants are petroleum hydrocarbons, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs) at the former FTP site and VOCs at TVR/Old MATES. Detailed background information for the former FTP site and TVR/Old MATES is presented in Worksheet #10.

1.2 DOCUMENT PURPOSE

The purpose of this Site-Specific UFP-QAPP is to outline the policies, organization, and specific quality assurance (QA) and quality control (QC) measures to be implemented during the collection, analysis, and reporting of data associated with monitoring activities at the former FTP site and TVR/Old MATES. This Site-Specific UFP-QAPP includes project-specific data acquisition operations, specifies the data usability requirements to support the decision-making process, and provides a clear, concise, and complete plan for the data collection and evaluation.

1.3 REPORT ORGANIZATION

This Site-Specific UFP-QAPP will be used in conjunction with the Programmatic UFP-QAPP (EA 2018b) and the Accident Prevention Plan (APP) (EA 2018a) to address the elements of the work to be performed. The Programmatic UFP-QAPP has been prepared to consistently address the information applicable to multiple sites at JBLM and YTC and to eliminate the replication of common information. The Site-Specific UFP-QAPP ties to the Programmatic UFP-QAPP (EA 2018b), and only those worksheets that provide information specific to execution of project tasks at the former FTP site and TVR/Old MATES are presented herein.

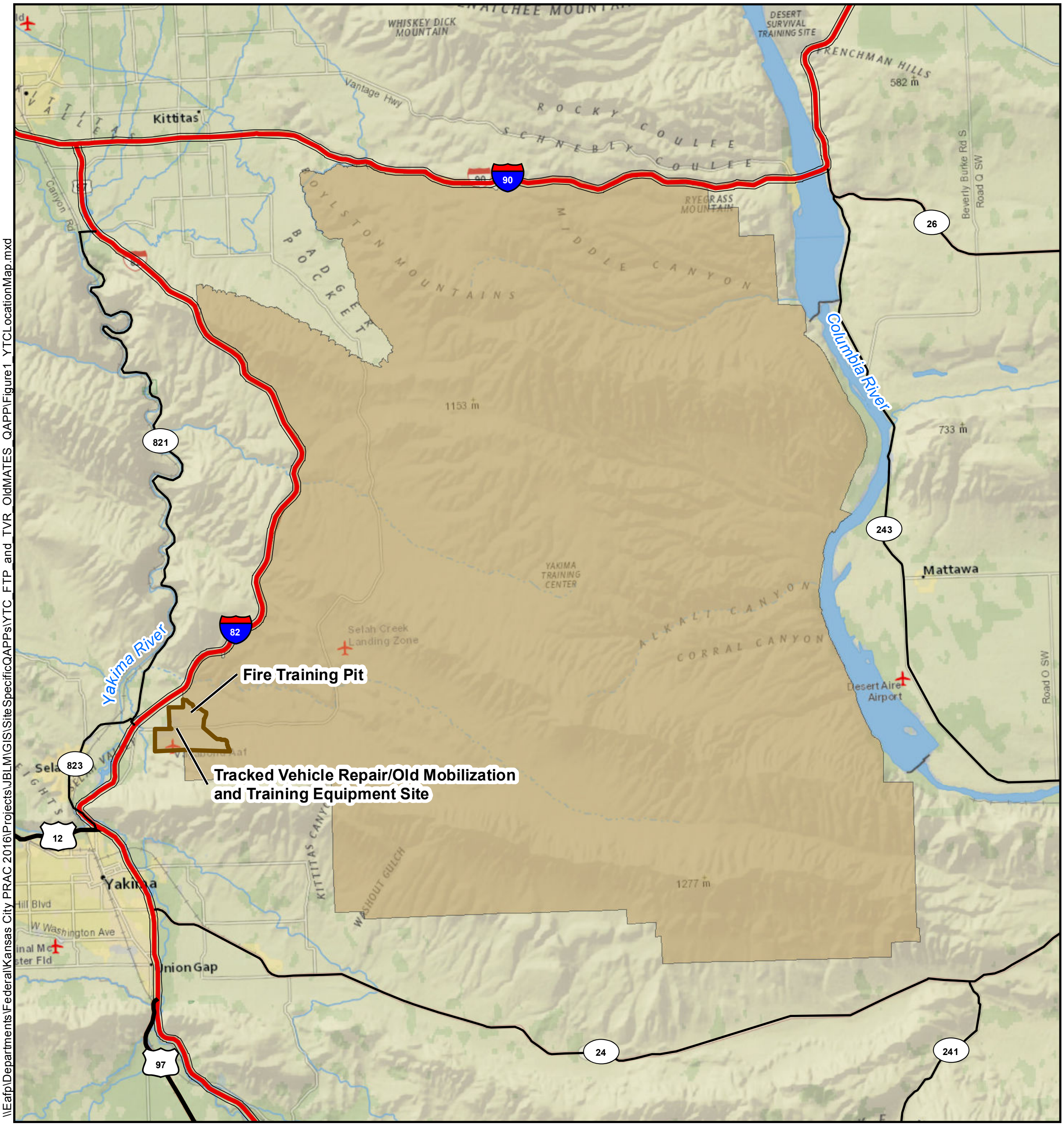
When used in conjunction with the Programmatic UFP-QAPP, this document meets the requirements and elements set forth in the Intergovernmental Data Quality Task Force UFP for QAPPs (U.S. Environmental Protection Agency [USEPA], Department of Defense [DoD], and U.S. Department of Energy [DOE] 2005). The UFP-QAPP Manual integrates the USEPA seven-step data quality objective (DQO) process (USEPA 2006), and the terminology in this UFP-QAPP is consistent with the UFP-QAPP Manual (USEPA, DoD, and DOE 2005). The worksheets in this document follow the Optimized UFP-QAPP format of the UFP-QAPP Workbook (USEPA, DoD, and DOE 2012), as outlined in Table 1.

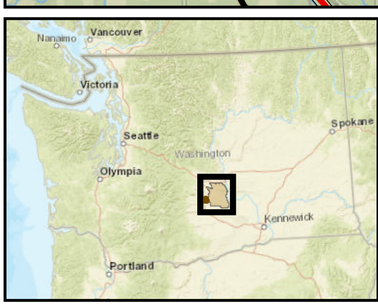
This document is organized as follows:

- ***Section 1, "Introduction"***—Describes the report organization, brief site description, and document purpose.

- ***Section 2, "Worksheets"***—Includes the optimized worksheets specified by the Intergovernmental Data Quality Task Force UFP for QAPPs.

- ***Section 3, "References"***—Provides reference information for the sources cited in the document.





0 2.5 5 10
Miles

1 inch equals 5 miles

N

Legend

- Yakima Training Center
- Cantonment Area Boundary
- Interstate
- State Route
- US Route

FIGURE 1
YAKIMA TRAINING CENTER LOCATION MAP

UNIFORM FEDERAL POLICY-
QUALITY ASSURANCE PROJECT PLAN

Map Date: 6/25/2018
Coordinate System: UTM Zone 10
Horizontal Datus: WGS 84

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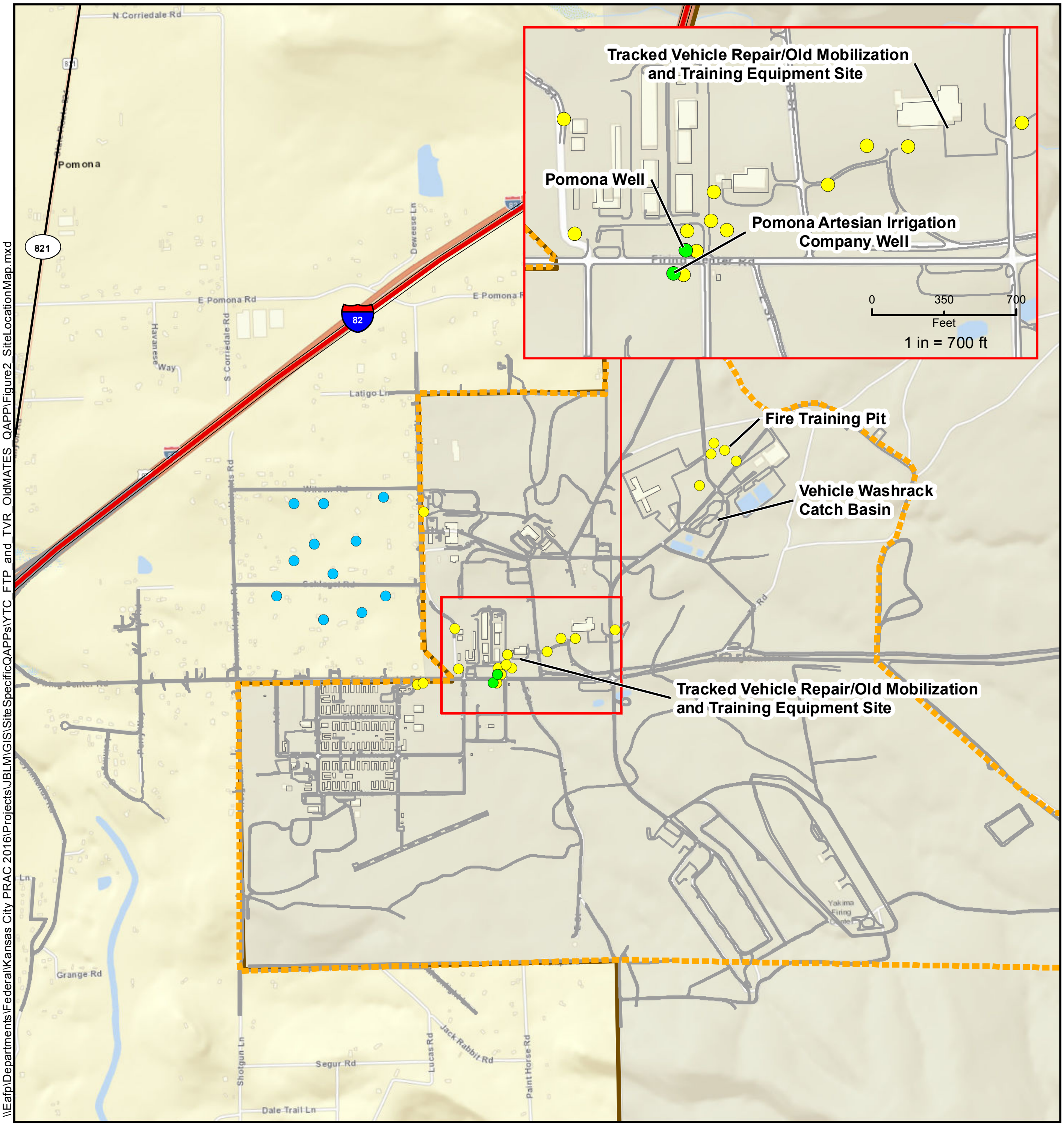

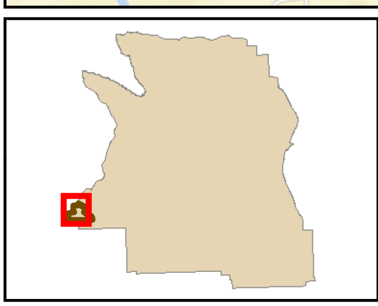

0 1,000 2,000 4,000

Feet

1 in = 2,000 ft

N

Legend

- Yakima Training Center
- Cantonment Area Boundary
- Building
- Monitoring Wells
- Residential Drinking Water Well
- Water Supply Well
- Interstate
- State Route
- US Route

FIGURE 2
SITE LOCATIONS MAP
UNIFORM FEDERAL POLICY-
QUALITY ASSURANCE PROJECT PLAN

Map Date: 8/15/2018
Coordinate System: UTM Zone 10
Horizontal Datus: WGS 84

2. WORKSHEETS

The worksheets presented in this section document the project organization, specific procedures for the execution of the work, QC protocols, and the assessment and oversight planning that will help to ensure the quality of the data collection. This format satisfies the USEPA Requirements for QAPPs (USEPA 2006) and follows the current UFP-QAPP Guidance (USEPA, DoD, and DOE 2005). The original 37 worksheets have been optimized into the 28 worksheets (USEPA, DoD, and DOE 2012) included in this UFP-QAPP and summarized in Table 1.

Table 1 Uniform Federal Policy-Quality Assurance Project Plan Worksheet Summary

Worksheet No.	Worksheet Title	Worksheet Type
1 and 2	Title and Approval Page	Programmatic and Site-Specific
3 and 5	Project Organization and Quality Assurance Project Plan Distribution	Programmatic
4, 7, and 8	Personnel Qualifications and Sign-Off Sheet	Programmatic
6	Communication Pathways	Programmatic
9	Project Planning Session Summary	Programmatic
10	Conceptual Site Model	Site-Specific
11	Project/Data Quality Objectives	Site-Specific
12	Measurement Performance Criteria	Programmatic
13	Secondary Data Uses and Limitations	Site-Specific
14 and 16	Project Tasks and Schedule	Site-Specific
15	Project Screening Levels and Laboratory-Specific Detection Limits	Site-Specific
17	Sample Design and Rationale	Site-Specific
18	Sampling Locations and Methods	Site-Specific
19 and 30	Sample Containers, Preservation, and Hold Times	Programmatic and Site-Specific
20	Field Quality Control Summary	Site-Specific
21	Field Standard Operating Procedures	Programmatic and Site-Specific
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	Programmatic and Site-Specific
23	Analytical Standard Operating Procedures	Programmatic
24	Analytical Instrument Calibration	Programmatic
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	Programmatic
26 and 27	Sample Handling, Custody, and Disposal	Programmatic
28	Analytical Quality Control and Corrective Action	Programmatic
29	Project Documents and Records	Programmatic
31, 32, and 33	Assessments and Corrective Action	Programmatic
34	Data Verification and Validation Inputs	Programmatic
35	Data Verification Procedures	Programmatic
36	Data Validation Procedures	Programmatic
37	Data Usability Assessment	Programmatic

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Worksheets #1 and 2: Title and Approval Page

Site Location: YTC FTP Site and TVR/Old MATES

Contract/Work Assignment: W912DQ-16-D-3001, Delivery Order W912DW-18-F-5012

Document Title: Site-Specific Quality Assurance Project Plan for Groundwater Monitoring at the Yakima Training Center Fire Training Pit and Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

Preparation Date: October 2018

Lead Organization: JBLM Public Works – Environmental Division

Lead Organization Program Manager

Signature:____________________ **Date**:__________

Meseret Ghebresllassie
JBLM Public Works – Environmental Division

Investigative Organization Project Manager

Signature:____________________ **Date**:__________

Timothy McCormack, LHG
EA

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Worksheets #4, 7, and 8: Personnel Qualifications and Sign-Off Sheet

This worksheet is presented in the Programmatic UFP-QAPP (EA 2018b).

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Worksheets #3 and 5: Project Organization and Quality Assurance Project Plan Distribution

This worksheet is presented in the Programmatic UFP-QAPP (EA 2018b).

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Worksheet #6: Communication Pathways

This worksheet is presented in the Programmatic UFP-QAPP (EA 2018b).

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Worksheet #9: Project Planning Session Summaries

This worksheet is presented in the Programmatic UFP-QAPP (EA 2018b).

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Worksheet #10: Conceptual Site Model

This worksheet summarizes the available site information for the former FTP site and TVR/Old MATES as presented in the Calendar Year 2017 Groundwater Monitoring Plan (Tetra Tech EC, Inc. [TtEC] 2017), 2017 Annual Groundwater Monitoring Report (TtEC 2018), the Fiscal Year 2016 YTC Army Defense ERP Installation Action Plan (JBLM 2017), and the 2017 Draft Periodic Review Report (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, US Army Corps of Engineers [USACE] 2017). The information presented in this section includes site background, regulatory framework, history, summaries of previous investigations and remedial actions, natural resource information, nature and extent of contamination, and potential exposure pathways. This information serves as the conceptual site model for the sites.

10.1 Site Background

YTC has been used for training military artillery, infantry, and engineering units since 1941. Expansion of YTC occurred in the early 1950s with the acquisition of additional land and permanent construction of the Cantonment Area in the southwest portion of YTC. An expansion of YTC to the north occurred in the early 1990s. Currently YTC is approximately 327,233 acres and is divided into the Cantonment Area and the Down Range Area. The former FTP site and TVR/Old MATES are located within the Cantonment Area.

10.1.1 Former Fire Training Pit Site

The former FTP site is an approximately 15,000 square foot site located in the northeast portion of the Cantonment Area east/northeast of the New MATES facility / Building 850 (Figure 10-1). The site was identified as SWMU 59 in the September 1995 RFA conducted by the USEPA.

The former FTP was used to practice extinguishing fires two or three times a year from an unknown start date until 1987, with a single training event conducted in 1990 (Shapiro & Associates 1991). Practice events consisted of saturating an open, unlined earthen pit with water, adding and igniting 500 to 1,000 gallons of waste JP-4 aviation fuel, diesel fuel, or motor gasoline, and then extinguishing the fire. During the 1990s, the site was used for storing stockpiles of waste sand filter material and sediments from the adjacent vehicle wash rack treatment system (Ecology & Environment [E&E] 1993) as well as storing fuel bladders (Shannon & Wilson 2001). Currently the site is vacant and not used by YTC.

10.1.2 Tracked Vehicle Repair /Old Mobilization and Training Equipment Site

TVR/Old MATES refers to a site associated with a trichloroethene (TCE) groundwater plume in the area roughly between Old MATES (Building 951) and Building 810 located on the YTC Supply & Maintenance Facility (Figure 10-2). The source of TCE in groundwater appeared to be historical releases due to past use and handling of solvents at both the Old MATES and the former TVR (Building 845) facilities (Fort Lewis ERP 2007b).

The Washington Army National Guard (WAARNG) conducted tracked vehicle maintenance and repair activities and used degreasing solvents, such as TCE, at the TVR facility from 1968 until 1975, when they started using Building 951 on the Old MATES facility for repairs (EHS-International, Inc. 2010 and Science Applications International Corporation [SAIC] 1995). The Old MATES/Building 951 was used for maintenance, repair, and washing of tracked and wheeled military vehicles owned by the WAARNG at YTC until 2008, when vehicle maintenance operations were transferred to the New MATES Facility (Building 960) (EHS-International, Inc. 2010). De-greasing solvents including TCE have been used since about 1968 at Building 845, and since 1975 at Building 951 (Shapiro & Associates 1991). There are no records identifying when TCE use was suspended or when TCE was replaced by other products. No records were identified detailing past use, handling, and storage of TCE at either facility (EHS-International, Inc. 2010). However, a former floor drain at the TVR facility (Building 845) discharged immediately adjacent to the location of monitoring well TVR-1 (Cory 2004). No similar locations of historical discharges at Old MATES have been identified (Fort Lewis ERP 2007b).

Waste oil underground storage tanks (USTs) were considered a possible source of TCE in groundwater at TVR/Old MATES. Four 250-gallon waste oil USTs were in use at the TVR facility (Building 845) from the mid-1970s until 1991 (Shapiro & Associates 1991, Pegasus Environmental Management Services Inc. [Pegasus] 1993, SAIC 1995). A fifth 650-gallon waste oil UST was used at Building 845 from 1980 until 1991. In addition, one 2,000-gallon waste oil UST at the Old MATES was reportedly in operation from 1968 until 1995 (Shapiro & Associates 1991, SAIC 1995, EHS-International, Inc. 2010). These six former waste oil USTs have been removed. Three of the five waste oil tanks at Building 845 and the 2,000-gallon waste oil UST at Building 951 were "clean closed" with either no contaminants detected in soil or contaminant concentrations in confirmation soil samples below MTCA soil cleanup levels (CEcon Corporation 1994, SAIC 1995).

Solid waste management units (SWMU) 43 and 44 referred to former waste oil USTs 845-3 and 845-4 associated with TVR Building 845. During the removal of USTs 845-3 and 845-4 in 1993, the excavations could not be cleaned closed because contamination was present under Building 845 and further excavation would have compromised the structural integrity of the building. Therefore, soil contamination from waste oil USTs 845-3 and 845-4 remains under Building 845. Further information on UST excavation and soil sampling is presented in Section 10.3.2.

Although possible, it is unlikely that the contamination remaining under Building 845 from USTs 845-3 and 845-4 is the source of TCE at TVR. Concentrations of TCE in monitoring well TVR-2, installed immediately downgradient of former USTs 845-3 and 845-4, are relatively low (Fort Lewis ERP 2007a). In addition, the downgradient contamination associated with former USTs 845-3 and 845-4 cannot be the source of TCE located upgradient of the former USTs between Old MATES Building 951 and TVR Building 845.

10.2 Regulatory Framework

YTC is a sub-installation of JBLM. YTC is not on the National Priorities List; however, it is addressed under the Resource Conservation and Recovery Act (RCRA). USEPA completed a RCRA facility assessment (RFA) in 1995 in response to a RCRA permit application for a hazardous waste open burning/open detonation unit. This RFA identified 77 SWMUs and 38 areas of concern and recommended corrective action (CA) for a majority of the SWMUs and areas of concern. In Washington, RCRA CA is addressed in accordance with the MTCA regulations. Since an agreed order or consent decree has not been assigned for the YTC CA sites, the JBLM ERP is addressing the RCRA CA sites at YTC in the MTCA voluntary cleanup program, with consultation from the Washington State Department of Ecology (Ecology) Hazardous Waste and Toxics Reduction Program (JBLM 2017).

Final remedies have been selected at Installation Restoration Program (IRP) sites with concurrence from Ecology. As of March 2014, the status of the YTC IRP sites was remedy-in-place/response complete. The LUC and LTM remedies selected in accordance with their respective Decision Documents are in place at the former FTP site (Fort Lewis ERP 2007a) and TVR/Old MATES (Fort Lewis ERP 2007b).

LUCs were implemented and are maintained at the sites in accordance with the Decision Documents (Fort Lewis ERP 2007a and 2007b) because current MTCA regulations require an institutional control whenever a contaminant concentration is above its MTCA Method A/Standard Method B cleanup level (regardless of actual risk). LUCs are presented in the LUC Plan, which was updated in January 2018 (Sealaksa 2018). LUCs at both sites prevent the installation of new drinking water wells without an approved monitoring plan. In addition, LUCs at TVR/Old MATES were implemented to prevent the installation of on-post water supply wells within 1,000 ft of the site boundary as long as concentrations of contaminants of potential concern in existing monitoring wells are above MTCA Method A/Standard Method B groundwater cleanup levels, and to investigate and address potential soil contamination as necessary in the event that Building 845 is deconstructed in the future (Fort Lewis ERP 2007b). Institutional controls include dig permits and restrictions on land use (JBLM 2017).

Per the YTC LUC Plan, annual inspections are conducted to determine if LUC mechanisms remain in place. Annual LUC inspection checklists are currently included in the annual groundwater monitoring reports. Inspections consist of checking all sites for potential residential land use and/or unplanned construction/excavation. Interviews are also conducted to ensure that GIS layer data are kept current and that Fort Lewis and YTC personnel have appropriate access. Previous checklists were reviewed (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

Semiannual groundwater monitoring is performed to evaluate the natural attenuation of site-related contaminants (petroleum hydrocarbons, VOCs, and SVOCs at the former FTP site and VOCs at TVR/Old MATES) until contaminant concentrations fall below MTCA Method A/Standard Method B groundwater cleanup levels (JBLM 2017).

Army Periodic Five Year Reviews of the IRP sites were conducted in 2012 and 2017 to determine whether the remedial actions implemented are protective of human health, and to identify any problems or concerns that are affecting or may in the future affect the protectiveness of the remedy (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017). The 2017 review concluded that the remedies at the former FTP site and TVR/Old MATES currently protect human health and the environment because LUCs are in place to prevent installation of new water supply wells until MTCA groundwater cleanup levels are met. Groundwater monitoring results will determine when MTCA cleanup levels are attained and groundwater LUCs can be removed.

10.3 Investigative History

A facility-wide preliminary assessment of YTC was completed in the early 1990s (Shapiro & Associates, Inc. 1991). The preliminary assessment documented the former FTP site and TVR/Old MATES usage, identified potential receptors, and concluded that sites such as the two sites addressed in this Site-Specific QAPP could potentially be releasing hazardous substances to groundwater as a result of historical activities.

TCE was detected in groundwater from a domestic drinking water well (former Marie Well) located within the YTC Cantonment Area between ¼ and ½-mile west-southwest of the Old MATES (Building 951) and TVR (Building 845) before the well was decommissioned in the 1990s, which prompted subsequent investigations in 1993 (EHS-International, Inc. 2010). A Site Screening Inspection and Hazard Ranking System Score for YTC was completed in January 1993 (Resource Applications, Inc. 1993) and a Site Investigation (SI) was completed in September 1993 (E&E 1993). A Hazard Ranking System score was calculated; however, it was too low for YTC to be considered for inclusion on the Comprehensive Environmental Response, Compensation, and Liability Act National Priority List.

Yakima Health District collected groundwater samples from 12 private domestic wells located downgradient of YTC and analyzed those samples for VOCs in 1995 (Yakima Health District 1995). The Pomona Artesian Irrigation Company (PAIC) well, located on YTC across the street from YTC's Pomona Well, was one of the 12 wells sampled. No contaminants were detected in the wells with the exception of styrene in a single well at a concentration equal to the detection limit (DL) of 0.1 microgram per liter (μg/L).

The final RFA Report was completed in September 1995 (SAIC 1995). The RFA for the entire installation was a result of a RCRA Part B Permit Application for the Range 14 open burning/open detonation area. Although the 1995 RFA did not explicitly address TCE in groundwater in the TVR/Old MATES area, the RFA recommended a CA for the soil contamination that remained under a building adjacent to waste oil USTs 845-3 (SWMU 43) and 845-4 (SWMU 44). RCRA CAs that were recommended or implied by the RFA need to satisfy MTCA regulations in accordance with Washington Administrative Code (WAC) 173-303-646(3).

10.3.1 Former Fire Training Pit Site

The former FTP site was one of the YTC facilities/sites investigated in the September 1993 SI (E&E 1993). One borehole was advanced approximately 150 ft topographically and hydraulically downgradient/southwest of the former FTP. Significant groundwater was not encountered during the drilling of the borehole to a depth of approximately 140 ft. However, when it came time to decommission the borehole, several gallons of petroleum product were reportedly discovered on top of a column of water. As a result, monitoring well FTP-1 was completed to a depth of approximately 20 ft in the perched groundwater located at the fractured top of the uppermost basalt flow.

The 1995 RFA indicated a high potential for releases to soil and possibly groundwater at the former FTP site (SAIC 1995). Remedial action to remediate contaminated soil and the petroleum product in well FTP-1 was recommended.

A RCRA Facility Investigation was conducted from 1999 through 2001 to further delineate the nature and extent of contamination at the former FTP site (Shannon & Wilson 2001). Nine soil borings were advanced and four monitoring wells (FTP-13 through FTP-16) were installed in 1999 in the perched groundwater located at the fractured top of the uppermost basalt flow as part of the investigation in 1999. Total petroleum hydrocarbon (TPH) indicators in the gasoline range (TPH-G), diesel range (TPH-D), and heavy oil range (TPH-O) were reported in soil samples collected from 2.5 to 6 ft below ground surface (bgs) at concentrations greater than MTCA Method A Soil cleanup levels for unrestricted land use (100 milligrams per kilogram [mg/kg] for TPH-G and 200 mg/kg for TPH-D and TPH-O at the time of the sampling).

Groundwater monitoring was conducted as part of the RCRA Facility Investigation at previously installed well FTP-1 and newly installed wells FTP-13 through FTP-16 in July 1999, November 2000, and May 2001. Analytical results indicated petroleum product constituents (e.g., benzene and 1,3,5-trimethylbenzene), various polycyclic aromatic hydrocarbons (PAHs), and TPH-G, TPH-D, and TPH-O in one onsite monitoring well (FTP-1) at concentrations that exceeded MTCA Method A Groundwater cleanup levels, as presented in Table 10-1 below. Light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) were reportedly encountered at FTP-1 during each event; however, the thicknesses of LNAPL and DNAPL were not accurately quantified.

An interim remedial cleanup action was completed in 2003 to remove the soil contamination that exceeded MTCA Method A/Standard Method B cleanup levels. The cleanup action was documented in a January 2004 Bay West report (Bay West 2004). Soil was excavated during three separate mobilizations in 2003. The total excavation area was approximately 5,000 square feet and extended to the underlying basalt. A total of 1,351 tons of soil was disposed of offsite in November 2003. Contaminant concentrations in confirmation soil samples, including PAHs, were reported to be below MTCA Method A/Standard Method B cleanup levels, with the exception of TPH-G and TPH-D in samples collected from the soil/basalt interface. The excavation was backfilled with clean soil.

Following the interim remedial cleanup action, groundwater monitoring events were conducted by the Fort Lewis ERP in January 2004, March and August 2005, March and August 2006, March and September 2007, and March and September 2008. Analytical results of the ground water sample collected from well FTP-1 reported TPH-G, TPH-D, and TPH-O, as well as benzene and total PAHs at concentrations exceeding MTCA Method A cleanup levels (800, 500, 500, 5, and 0.1 µg/L, respectively; EHS-International, Inc. 2010 and TtEC 2018). Between March 2005 and March 2007, 4-inch diameter socks containing oxygen release compound from Regensis were hung at FTP-1 at depths of 11-18 ft bgs to address elevated contaminant concentrations.

Table 10-1 Contaminant Concentrations at FTP-1 in Monitoring Years 1999 to 2004

Analyte	FTP-1 Concentrations (µg/L) [(a)]				Method A Cleanup Level (µg/L)
	July 1999	November 2000	May 2001	January 2004	
TPH-G	**2,300**	**8,300**	**6,800**	**3,900**	800
TPH-D	**34,000 J**	**140,000 J**	**750,000 J**	**4,400**	500
TPH-O	**7,600 J**	**11,000J**	**46,000**	**48,300**	500
Benzene	**7.5**	**7.7**	3.7 U	**10.6**	5
Toluene	0.074 J	4.7 J	0.77 U	<0.5 U	1,000
Ethylbenzene	4.4	3.0 J	1.6 U	3.8	700
Total Xylenes	16.66 J	41.2 J	52	9.4	1,000
Total Naphthalenes	**1,598 J**	**450**	**3,540 J**	**193**	160
Total cPAHs	**0.243 J**	1.774 U	**5.02 J**	<0.362 U	0.1
Fluorene	140 J	33	450 J	9.1	640
Total Polychlorinated biphenyls	<21.3 U	ND	<0.81 U	Not sampled	0.1
TCE	0.066J	**32 J**	<4 U	<0.5 U	5
cis-DCE	<0.4 U	**70 J**	<4 U	<0.5 U	70
Vinyl chloride	<0.4 U	ND	<4 U	<0.5 U	0.2
Methylene chloride	<0.4 U	3.7 J	<4 U	<12.5 U	5
bis-(2-Ethylhexyl) phthalate	**29 J**	ND	**54 J**	6.0	6

a. Concentrations in bold exceeded Method A cleanup levels.

NOTES: J = Value is estimated.
ND = Not detected, no reporting limit presented.
U = Not reported above the reporting limit.

Semiannual groundwater monitoring events have been conducted during the first and third quarters since 2005 in accordance with the 2007 Decision Document (Fort Lewis ERP 2007a). Sampling events are conducted in the first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., August/September) each year. TPH-G, TPH-D, and TPH-O have continuously been reported in samples from well FTP-1 at concentrations above MTCA cleanup levels (800, 500, and 500 µg/L, respectively) (TtEC 2018). Benzene has historically been reported at concentrations both above and below above MTCA Method A cleanup level of 5 µg/L, with higher concentrations typically reported in the third quarter sampling event and lower concentrations (below cleanup criteria) reported in the first quarter sampling event. In addition, toluene, ethylbenzene, and total xylenes have continuously been reported in groundwater at FTP-1 at concentrations below MTCA Method A cleanup levels (1,000, 700, and 1,000 µg/L, respectively). The groundwater results from 2017 are presented in Table 10-2 below. Concentrations in downgradient wells either continue to be not detected or have been below cleanup levels. This has been consistent during the 15 years of monitoring at the FTP site, suggesting that the petroleum hydrocarbons in groundwater are localized near well FTP-1, and are not migrating in any significant manner.

Table 10-2 Former Fire Training Pit Site 2017 Groundwater Analytical Results

Analyte	FTP-1		FTP-14		FTP-15		FTP-16		Method A Cleanup Level
	March 2017	September 2017	March 2017	September 2017	March 2017	September 2017	March 2017	September 2017	
TPH-G	**930**	**1,000**	50 J	37 J	14 J	15 J	<250 U	<250 U	800
TPH-D	**17,000**	**35,000**	170 J	220	130 J	210	120 J	190	500
TPH-O	**2,400**	**4,000**	90 J	110	120 J	130	100 J	160	500
Benzene	1.3	4.1	NS	NS	NS	NS	NS	NS	5
Toluene	0.14 J	0.54	NS	NS	NS	NS	NS	NS	1,000
Ethylbenzene	2.5	6.4	NS	NS	NS	NS	NS	NS	700
Total Xylenes	0.36 J	0.78 J	NS	NS	NS	NS	NS	NS	1,000

NOTES: J = Value is estimated.
NS = Not sampled.
U = Not reported above the reporting limit.

Concentrations are reported in micrograms per liter (µg/L). Concentrations in bold exceeded Method A cleanup levels.

10.3.2 Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

In October 1991, five waste oil USTs at the TVR (Building 845) were evacuated, excavated, removed, cleaned, and disposed of (Pegasus 1993). The contractor performing the work (Pegasus) noted visible surface contamination associated with three of the UST excavations. Soil samples from each excavation were analyzed for TPH, benzene, ethylbenzene, toluene, xylenes, Toxicity Characteristic Leaching Procedure (TCLP) VOCs, and TCLP metals. TPH concentrations exceeding 10,000 mg/kg were detected in samples collected from the five UST excavations. TCLP TCE was detected at 20 milligrams per liter (mg/L) in samples collected from the UST 845-5 excavation, and TCLP tetrachloroethene was detected at 17 mg/L in samples collected from the UST 845-6 excavation. No TCLP VOCs were detected in samples collected from the UST 845-3 (SWMU 43) and UST 845-4 (SWMU 44) excavations. No additional CA was taken at that time due to contract limitations.

CEcon Corporation was contracted to excavate and remove contaminated soil left in place following the tank removal activities by Pegasus (CEcon 1994). In October 1993, CEcon Corporation removed approximately 1,000 cubic yards of soil during the excavation of contaminated soil from the five waste oil tank sites at Building 845. Confirmation samples collected by CEcon Corporation verified that no further action was required for USTs

845-2 (SWMU 42), 845-5 (SWMU 45), and 845-6 (SWMU 46). However, some TPH-contaminated soil was left in place on the north and east sidewalls of the UST 845-3/UST 845-4 (SWMUs 43 and 44) excavation due to the presence of existing structures (Building 845 lube rack and oil-water separator). These structures prevented further excavation in the north and east directions. Although confirmation samples collected by CEcon Corporation were analyzed for potential contaminants suspected at the time, no confirmation samples were analyzed for VOCs.

TVR, Old MATES, and the Main Motor Pool (MMP) were among the facilities/sites investigated in the September 1993 SI (E&E 1993). Monitoring wells TVR-1 and TVR-2 were installed near the TVR facility (Building 845), wells MTS-1 and MTS-2 were installed near the Old MATES (Building 951), and wells MMP-1 and MMP-2 were installed near the former Marie Well southwest of both Buildings 845 and 951. Soil samples were collected from each monitoring well borehole during drilling and were analyzed for VOCs, SVOCs, pesticides/polychlorinated biphenyls (PCBs), metals, and TPH. Groundwater samples were collected from newly installed monitoring wells, the decommissioned Marie Well, two MMP monitoring wells located adjacent to the Marie Well, and two drinking water wells (Pomona Well and PAIC Well) located approximately 250 ft southwest of monitoring well TVR-1. TCE was reported in groundwater at concentrations above the MTCA Method A cleanup level of 5.0 µg/L at TVR-1 (35 µg/L), TVR-2 (14 µg/L), MTS-1 (7.90 µg/L), and MTS-2 (7.4 µg/L). TCE at the Marie well was reported at a concentration of 1.2 µg/L. Based on the presence of TCE in groundwater at TVR and Old MATES wells, and the absence of contamination in corresponding soil samples, the SI Report concluded that TCE contamination in groundwater may indicate migration from an unidentified source.

A subsequent groundwater sampling event was conducted at the TVR wells (TVR-1 and TVR-2) and Old MATES wells (MTS-1 and MTS-2) in 2004. TCE was reported at concentrations ranging from 3.6 µg/L (TVR-2) to 12 µg/L (MTS-2 and TVR-1) in samples collected during this event. Monitoring wells TVR-3, TVR-4, MTS-3, and MTS-4, were installed in October and November 2004, and subsequent groundwater monitoring events were conducted in March 2005 and August 2006. Samples could not be collected from TVR-4, which was dry. TCE concentrations were reported in samples from wells TVR-1, TVR-2, MTS-1, MTS-2, TVR-3, and MTS-4. Concentrations in March 2005 ranged from 4.4 µg/L (TVR-2) to 25 µg/L (MTS-2), and concentrations in August 2005 ranged from 3.4 µg/L (TVR-2) to 38 µg/L (MTS-2) (TtEC 2018).

The extent of TCE in groundwater had not been determined as of August 2005; therefore, monitoring wells TVR-5, TVR-6, TVR-7, and 815-2 were installed in October 2005 (TtEC 2018) to further delineate the contamination. TCE concentrations were reported at wells TVR-1, TVR-2, TVR-3, MTS-1, MTS-2, MTS-4, TVR-5 through TVR-7, and 815-2. Concentrations ranged from 1.6 µg/L (TVR-5) to 38 µg/L (TVR-7).

Groundwater monitoring has been conducted semiannually since 2005, with sampling events conducted in the first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., August/September) each year (TtEC 2018). TCE has continuously been detected at ten monitoring wells: 815-2 (with the exception of March 2010), MTS-1, MTS-2, MTS-4, TVR-1, TVR-2 (last sampled in March 2016), TVR-3, TVR-5, TVR-6, and TVR-7. Concentrations were reported above the MTCA Method A cleanup level of 5 µg/L continuously or nearly continuously at five monitoring wells: MTS-4, TVR-1, TVR-3, TVR-6, and TVR-7. TCE concentrations have been trending downward in most of the monitoring wells at the site over time. Overall, the TCE concentrations reported in groundwater in the latest sampling events conducted in 2017 were not significantly elevated. The highest concentration of TCE detected in 2017 was reported in well TVR-1 at 8.3 µg/L (fall).

TCE has not been detected at the PAIC or Pomona wells, which have been sampled continuously since 2005. In addition, TCE was not reported at wells MMP-1 (last sampled in March 2014), MMP-2 (last sampled in March 2007), MRC-2 (last sampled in March 2012), and MTS-3 (last sampled in March 2007).

10.4 Physical Profile Information

YTC is located within the Yakima Fold Belt sub-province of the Columbia Plateau physiographic province east of the Cascade Mountain Range in south-central Washington. Terrain is undulating and dominated by at least four parallel northwest-southeast trending anticlinal ridges with large intervening synclinal valleys (Fort Lewis 2010). North-south trending drainages dissect the ridges. The YTC Cantonment Area is located just south of Selah Canyon which cuts through the valley falling between Umtanum Ridge and Yakima Ridge. The Selah Canyon area runs east-west on the northern portion and contains steep slopes. While still quite variable, the land area south of the Selah Canyon is the most level, and thus, the most developable areas within the cantonment area (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, US Army Corps of Engineers [USACE] 2017).

YTC and the surrounding area supports a shrub-steppe habitat; natural vegetation primarily consists of sagebrush, bitterbrush, and various species of bunch grasses (Fort Lewis 2010, National Archives and Records Administration 2010). Further information for YTC and the IRP sites, including local climate, geology, hydrology, and surface water features, is presented below.

10.4.1 Climate

The climate of the Yakima Valley, including the YTC Military Reservation, is mild and dry, having characteristics of both maritime and continental climates modified by the Cascade Mountains to the west and Rocky Mountains to the east (Fort Lewis 2010). Since YTC lies in the rain shadow of the Cascade Mountains, YTC is sheltered from large accumulations of precipitation (Potomac-Hudson Engineering, Inc. 2012 and Western Regional Climate Center 2011). The area experiences an average annual precipitation of 8 inches of rainfall and 23 inches of snowfall per year (TerranearPMC, LLC 2017), with precipitation occurring mostly in the late fall and early winter. Evapotranspiration is estimated at 25-57 inches per year for Yakima (Tomlinson 1997). Because of the low precipitation and high evapotranspiration rates, surface drainages are not sustained year-round.

Summers are typically dry and hot, with July being the warmest and driest month (Potomac-Hudson Engineering, Inc. 2012 and Western Regional Climate Center 2011). Diurnal temperature variations in June and July average to approximately 34 degrees Fahrenheit (°F), with maximum temperatures in the upper 80s and minimum temperatures in the low 50s. On average, July accumulates the least amount of monthly precipitation (0.19 inches).

Winter temperatures are cold and diurnal temperature variations are less extreme (approximately 17°F). Minimum temperatures average 20.9°F in January. December accounts for the highest average monthly precipitation of 1.34 inches. Occasional light snowfall contributes to an average snow depth of 3 inches in January (Potomac-Hudson Engineering, Inc. 2012 and Western Regional Climate Center 2011).

10.4.2 Hydrology

The Yakima and Columbia rivers border YTC to the west and east, respectively, and flow from north to south (Kurtz 2010). Drainage of natural surface waters, including streams and creeks, on YTC are defined by a series of ridges and valleys; numerous small gullies dissect the valleys. Surface waters flow along these gullies from numerous springs into several streams, which eventually flow into the Yakima or Columbia River. Major streams on YTC predominantly flow to the west and discharge into the Yakima River, or to the east and discharge into the Columbia River. Streams on YTC are fed by direct precipitation runoff and in some cases by discharge of groundwater (springs and seeps). Due to the arid and semi-arid climate of the region and occasional high volume precipitation and snowmelt events, streams at YTC have high variation in flows.

There are no perennial surface water bodies located at the former FTP site or TVR/Old MATES (EHS-International, Inc. 2010). The closest perennial surface water is Selah Creek, approximately 1.7 miles north of the TVR/Old MATES and 1.1 miles north of the former FTP site. Selah Creek flows from east to west and drains into the Yakima River.

No naturally-occurring streams or other surface water features, such as lakes, ponds, or marshes exist at the sites or on adjoining properties (EHS-International, Inc. 2010). The sites and adjoining properties are located outside of the U.S. FEMA 100-year and 500-year flood zones (Environmental Data Resources, Inc. [EDR] 2010a and 2010b).

A man-made water irrigation canal, identified as the High Line Canal (Archives 2010), lies between the Old MATES and New MATES Facilities. There are two wetlands classified in the National Wetlands Inventory that are located approximately 213 meters (700 ft) southeast of the Old MATES Facility (EDR 2010b), one of which is a freshwater pond known as the Kiddie Pond.

10.4.3 Geology

YTC is located within the Yakima Fold Belt, which is characterized by southeast-trending anticlines and synclines. The anticlines are expressed as ridges and intervening synclines form valleys. Most of the YTC Cantonment Area is located within the synclinal valley between the anticlinal Yakima Ridge and Umtanum Ridge. In general, YTC is underlain by a thick sequence of basalt flows known as the Columbia River Basalt Group. From youngest to oldest, the four formations that comprise the Columbia River Basalt Group are the Saddle Mountain Basalt, Wanapum Basalt, Grande Ronde Basalt, and Imnaha Basalt (Schuster et. al. 1997).

The Columbia River Basalt Group lava flows have a total thickness greater than 10,000 feet in parts of eastern Washington. Individual flows range from a few feet to more than 100 feet thick. Each flow typically consists of a vesicular or rubbly flow top, a relatively thick internal zone that has a hackly texture of random cooling joints, and lower zone that is characterized by columnar jointing perpendicular to the base of the flow (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

Portions of the YTC Cantonment Area have sedimentary rocks/deposits of the Ellensburg Formation and/or quaternary deposits on top of the basalt flows. The Ellensburg Formation is comprised of partially consolidated sand and gravel, and sediments ranging from unconsolidated sand, silt, and clay to weakly indurated sandstone, siltstone, and claystone. These sediments range from a few feet to several hundred feet thick, and are generally thickest underlying lowland areas. Younger quaternary deposits that locally overlie the Ellensburg Formation and the Columbia River Basalt in the YTC area include unconsolidated alluvial sand and gravel along the stream channels and floodplains, alluvial fan deposits of silty sand and gravel along the flanks of the ridges, and windblown silt deposits (loess) (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

10.4.3.1 Former Fire Training Pit Site

The uppermost materials underlying the former FTP site consist of localized fill material and up to 12 ft of alluvium comprised primarily of unconsolidated silty sand (Shannon & Wilson 2001). The uppermost bedrock geologic unit at the former FTP site is the Pomona Flow of the Saddle Mountain Basalt Formation (E&E 1993, Schuster et al. 1997, Shannon & Wilson 2001). In general, this unit is present at a depth of approximately 5-10 ft bgs at the former FTP site (E&E 1993, Shannon & Wilson 2001). Basalt apparently extends to an approximate depth of 150 ft bgs without significant interbeds at the site.

10.4.3.2 Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

The uppermost bedrock unit underneath the overburden in the TVR/Old MATES area is the Pomona Flow of the Saddle Mountain Basalt Formation (E&E 1993, Shannon & Wilson 2001). In general, this unit was encountered at depths between 10 and 45 ft bgs in the six monitoring wells at TVR, MTS, and MMP (E&E 1993). Saddle Mountain Basalt extends beneath the site without significant interbeds to a depth of greater than 100 ft bgs.

10.4.4 Hydrogeology

Groundwater in the region occurs principally within (1) the alluvial sand and gravel, (2) the sand and gravel deposits within the Ellensburg Formation, and (3) the basalt flows and interbedded sediments of the Columbia River Basalt sequence (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

The alluvial deposits are typically moderately to highly permeable, and groundwater within them generally is unconfined. The water table in these deposits is typically at or near the elevation of the nearby streams. Groundwater within the Ellensburg Formation typically occurs within the sand and gravel units and can be either confined or unconfined, depending on the local thickness and composition of the formation. The basalt flows and associated sedimentary interbeds form the most productive aquifer system in the region. Groundwater within this system occurs principally within fracture and rubble zones of the basalt flows and in the sand and gravel layers that occur between some of the flows. The water-yielding zones within this sequence range from a few feet to over 50 feet thick. Their lateral extent ranges from short distances to several miles, depending on the stratigraphic continuity of the water-bearing unit.

The uppermost groundwater in the YTC cantonment occurs in the basaltic bedrock and interbedded sediments at depths ranging from 70 to 105 feet below ground surface (bgs), based on the geologic profile from the 1993 monitoring wells installed during the Site Inspection (SI) in the central and western portions of the cantonment. This aquifer is confined, has a piezometric surface at about 60 to 70 feet bgs and has a westward flow gradient of about 30 feet per mile. The groundwater flow direction in any given area is strongly influenced by the distribution of the stratigraphic units. Flow in the flanks of the valley has a northerly or southerly component, toward the axis of the valley and away from the flanking anticlinal ridges.

10.4.4.1 Former Fire Training Pit Site

The former FTP site has perched groundwater located in vesiculated, fractured basalt near the top of the Pomona Basalt flow (E&E 1993, Shannon & Wilson 2001). Depth to water at the site is approximately 10-25 ft bgs (Shannon & Wilson 2001). The direction of perched groundwater flow is southwest and generally mirrors the surface topography. Seasonal fluctuation in groundwater elevation appears to be slight based on limited data. The next deepest groundwater-bearing unit is at approximately 150 ft below the site.

10.4.4.2 Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

The E&E monitoring wells (TVR-1, TVR-2, MTS-1, MTS-2, MMP-1, and MMP-2) were completed within a fractured basalt zone confined aquifer, identified as the Selah Interbed (of the Ellensburg Formation) beneath the Pomona basalt flow (E&E 1993). The Selah Interbed Aquifer is a fractured basalt zone confined aquifer and is the shallowest groundwater underneath the site, at depths on the order of 100-150 ft bgs. The direction of groundwater flow is to the west/southwest. The Selah Interbed Aquifer is underlain by a thick sequence of basalt flows within the Columbia River Basalt Group (JBLM 2010).

10.5 Current and Potential Future Land and Resource Use

The former FTP site and TVR/Old MATES are located within the Cantonment Area, which is within the general use zone of YTC (JBLM 2010). Land use within the Cantonment Area includes transient residential, administrative, commercial, and light industrial facilities and open space (USACE 2007). The YTC population is predominantly transient soldiers performing maneuvers with a few permanent adult residents, onsite workers, and no children (JBLM 2017). The principal users of YTC are active-duty U.S. Army units and units of the WAARNG. YTC is also used by units of the U.S. Army Reserve, U.S. National Guard, U.S. Marine Corps, U.S. Air Force, U.S. Navy, U.S. Coast Guard, U.S. Special Operations Command, local and federal law enforcement, and forces from Canada, Japan, and other allied nations (USACE 2007). The only significant adjacent population center is Selah, to the west (population 6,300) (JBLM 2017).

The former FTP site is currently vacant and not being used by YTC. The TVR/Old MATES TCE plume is bounded by the Old MATES Building 951 and Old MATES facility with its gravel parking lot for wheeled and tracked vehicles to the northeast; the former TVR/Building 845 with gravel parking/staging areas and tracked vehicle gravel road to the north; the U.S. Army Garrison YTC Supply and Maintenance Facility to the northwest; 7th Avenue/Firing Center Road, vegetated and undeveloped land, gravel parking/staging areas, and tracked vehicle gravel road to the south; and a paved parking area to the southwest.

The Pomona and PAIC wells are public water supply wells located on either side of Fire Training Center Road near D Street, approximately 1 mile southwest of the former FTP site and approximately 250 ft southwest of monitoring well TVR-1 (Figure 2). Public Water Supply Wells require well head protection from any potential source of contamination for a 100 foot radius around the wells, per WAC 246-290-135 Source water protection. There are no plans or need for an additional water supply well to serve the YTC Cantonment Area Water System (Fort Lewis ERP 2007b). Over the past decade, residential drinking water wells have been installed west of the YTC boundary, approximately 1,500 to 3,000 ft northwest of the TVR/Old MATES TCE plume.

The Pomona Well is an artesian well used by YTC as a primary production source for the Cantonment Area Water System. The USEPA Website lists this well as serving a population of 1,378 individuals and gives the address as - Yakima Training Center 970 Firing Center Rd Bldg. 810 Yakima, WA 98901. Washington State classifies this as Type A Community System. The well was reported to be completed in the Wanapum and/or Grande Ronde Formation (Hong West and Associates 1996). Well logs generated during pump tests conducted in 1940 identify that the well was constructed with a 10-inch diameter casing to a depth of 60 ft bgs and a 6 and 5/8-inch diameter casing from 60 to 430 ft bgs. However, a down-hole video survey conducted by YTC in 1995 identified open borehole construction completed to between approximately 353 and 407 ft bgs (Fain 2000, Cory 2004). The video survey also identified that water was entering the Pomona Well apparently along a sedimentary interbedded or fracture zone at approximately 401 ft bgs (Fain 2000). With the exception of the 1995 down-hole video survey, available sources of information regarding construction of the Pomona Well have presented incorrect data, including a typographical error in Table 2-1 of the Water System Plan (Cory 2004). The 1995 video survey of the Pomona Well is therefore considered to be the most accurate source of well construction information available to date.

The Pomona Well reportedly flows at 250 gallons per minute. The high artesian pressure in this well is interpreted to indicate that groundwater flow to this well is due largely to the structural down-warp in which the YTC is located. The groundwater at depth in this area occurs in basalt fractures and interbedded sediments. This flow system is presumably recharged from a considerably higher area farther up slope, and is confined under pressure beneath less permeable strata consisting of basalt or fine-grained sediment (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

The PAIC Well is an artesian well used as the sole production well for the PAIC Water System that serves approximately 60 homes and businesses located west of YTC (Wilson 2004). The USEPA Website lists this well as serving a population of 150 individuals and gives the address as - 731 Firing Center Rd Yakima, WA 98901. Washington State classifies this as a Type A Community System. Well logs from pump tests conducted in 1940 indicate identical (although very generic) well construction details as those presented for the Pomona Well (Fain 2000). However, because the 1995 video survey of the Pomona Well showed that the 1940 well log and other sources of post-drilling anecdotal information were incorrect, it is reasonable to assume that the 1940 well log for the PAIC Well may also be inaccurate, and that construction of the PAIC Well may match that of the Pomona Well (open borehole). The basis for assuming similar or identical well construction for the Pomona Well and PAIC Well are: both wells are artesian, both wells have similar production capacities, both wells were installed at the same time and location by the same well driller working for the same water system, and both wells were given identical 1940 well logs.

Institutional controls at both the former YTC site and TVR/Old MATES include dig permits and restrictions on land use (JBLM 2017). LUCs were implemented in March 2007 Decision Documents for the former FTP site (Fort Lewis ERP 2007a) and TVR/Old MATES (Fort Lewis ERP 2007b) to ensure that a new drinking water well is not installed within the former FTP site boundary or 1,000 ft of the TVR/Old MATES site boundary without an approved monitoring plan (Bussey 2007b). In addition, a LUC for Building 845 at the TVR/Old MATES was implemented to address, as necessary, potential contamination under the building if the building is deconstructed.

10.6 Sources of Known or Suspected Contamination

The source of contamination at the former FTP site was fire training practices involving the use and burning of petroleum fuel (e.g., aviation fuel, diesel fuel, gasoline) in an open, unlined earthen pit at the site, resulting in petroleum contamination of soil and groundwater. Source control that included the removal of petroleum-contaminated soil was completed in 2003 (EHS-International, Inc. 2010).

The source of TCE in groundwater under TVR/Old MATES appears to be historical discharges of TCE at both the TVR facility (Building 845) and Old MATES (Building 951) due to past use and handling of solvents at both facilities. Although there were five waste oil USTs at TVR and one waste oil UST at Old MATES, these six USTs were clean-closed with contaminant concentrations in confirmation soil samples below MTCA soil cleanup levels, with the exception of a small portion from the excavation for TVR USTs 845-3 and 845-4. Although possible, it is unlikely that the contamination remaining under Building 845 from USTs 845-3 and 845-4 is the source of TCE at the TVR facility since concentrations of TCE in monitoring well TVR-2, which is installed immediately downgradient of former USTs 845-3 and 845-4, are relatively low. Moreover, the former TVR facility USTs cannot be the source of TCE upgradient from the USTs between Old MATES Building 951 and TVR Building 845.

10.7 Known or Suspected Contaminants or Classes of Contaminants

Contaminants of concern at the former FTP site are TPH-G, TPH-D, and TPH-O, which have continuously been reported above MTCA Method A cleanup levels (800, 500, and 500 μg/L) at FTP-1. Benzene, toluene, ethylbenzene, and total xylenes have also been reported in groundwater, with benzene reported above the MTCA Method A cleanup level of 5 μg/L.

The contaminant of concern at TVR/Old MATES is TCE, which has been reported in monitoring wells at concentrations above the MTCA Method A cleanup level of 5 μg/L. No other VOC has been detected at the site with the exception of cis-l,2-dichloroethene, a degradation product of TCE, in three monitoring wells at concentrations below its MTCA Standard Method B groundwater cleanup level of 16 μg/L.

10.8 Primary Release Mechanism

Although the reported histories of the releases at the former FTP site differ slightly (E&E 1993, SAIC 1995), a significant release of petroleum products to site soil occurred as a result of past fire training practices. Leaking and leaching of petroleum products led to the contamination of subsurface soil and groundwater.

Vehicle maintenance has been conducted and de-greasing solvents have been used at both the TVR facility and Old MATES facility. A former floor drain at the TVR facility discharged immediately adjacent to monitoring well TVR-1. There are no similar identified locations of historical discharges at Old MATES. Leaching and infiltration of TCE led to contamination of groundwater.

10.9 Nature and Extent of Contamination

FTP-1 is the most impacted well at the former FTP site, with concentrations of TPH-G, TPH-D, and TPH-O reported above Method A cleanup levels of 800, 500, and 500 µg/L, respectively. Contamination is confined to shallow, perched groundwater encountered at depths of 10-25 ft bgs in vesiculated fractured basalt near the top of the Pomona Basalt flow. TPH has been reported at concentrations below MTCA Method A cleanup levels in the farthest downgradient well FTP-16, located at the east-southeast portion of the New MATES facility, approximately 600 ft west-southwest of FTP-1.

TCE is the contaminant of concern at TVR/Old MATES. Cis-l,2-dichloroethene, a degradation product of TCE, is also detected at two wells at low concentrations. The TCE plume at the TVR/Old MATES is present within the Selah Interbed Aquifer, a fractured basalt zone confined aquifer. It is the shallowest groundwater underneath the site at depths on the order of 100 to 150 feet below ground surface. The TCE plume extends southwest from the Old MATES facility to beyond Firing Center Road. VOCs have not been detected in either of the currently active water supply wells (the YTC Pomona and the PAIC supply wells) located in the vicinity of the TVR facility.

10.10 Fate and Transport Considerations

The migration of contaminated groundwater at the former FTP site as based on previous groundwater elevation data presented in previous groundwater monitoring reports is southwest towards the New MATES facility (TtEC 2018). While trend analyses suggest that TPH-G concentrations have been decreasing over time in FTP-1, the decrease has not been statistically significant. In addition, while the overall trend in TPH-D concentrations in FTP-1 is increasing, the increase has not been statistically significant. Since 2012, the TPH-D concentrations have been on a generally decreasing trend (TtEC 2018).

Concentrations of TPH-G, TPH-D, and TPH-O continue to be detected above MTCA cleanup levels of 800, 500, and 500 µg/L, respectively in samples from well FTP-1 as based on the 2017 groundwater analytical results (TtEC 2018). TPH-G, TPH-D, and TPH-O continue to either not be detected or be detected at relatively low concentrations that are below MTCA cleanup levels at downgradient wells, consistently over 15 years of monitoring at the FTP site, suggesting that the petroleum hydrocarbons in groundwater are localized near well FTP-1, and are not migrating in a significant manner.

The groundwater flow direction beneath the Old MATES and TVR facilities is to the west-southwest as based on groundwater elevation data presented in the 2017 annual report (TtEC 2018). Groundwater contamination beneath the Old MATES and TVR facilities is present in the Selah Interbed Aquifer at depths on the order of 100 to 150 feet below ground surface. The Selah Interbed Aquifer is underlain by a thick sequence of basalt flows within the Columbia River Basalt Group. TCE and other VOCs, including the TCE breakdown products cis-1,2-dichloroethylene and vinyl chloride, have not been detected in either of the currently active water supply wells (the

YTC Pomona and the PAIC supply wells) located in the vicinity of the TVR Facility and screened at about 400 ft.

Overall, the TCE concentrations reported in groundwater are not significantly elevated. The highest TCE concentration detected in 2017 was 8.3 µg/L in groundwater samples from well TVR-1 during the fall sampling event). Statistical analyses conducted for the 2017 annual report showed statistically significant downward trends for TCE concentrations in seven TVR/Old MATES wells (815-2, MTS-1, MTS-2, MTS-4, TVR-1, TVR-3, and TVR-7) (TtEC 2018). An overall downward trend for TCE concentrations was observed in TVR/Old MATES wells TVR-2 and TVR-5; however, the trends were not considered statistically significant. An overall upward trend for TCE was seen in one TVR/Old MATES well (TVR-6); however, the trend was not considered statistically significant.

Based on annual groundwater monitoring reports, the TVR/Old MATES TCE plume does not appear to be migrating off YTC. However, since the groundwater flow frequently shifts from west to south downgradient near TVR-6 and TVR-7, the 2017 Periodic Five Year Review recommended that installation of one or two downgradient wells should be considered to better define the downgradient plume extent and confirm that TCE is not migrating off of YTC (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

10.11 Potential Receptors and Exposure Pathways

The nearest potential groundwater receptors to the FTP and TVR/Old MATES sites are the Pomona and PAIC drinking water wells. The YTC Pomona Well and PAIC Well are artesian wells completed in a deep basalt aquifer with an open interval of approximately 353 and 407 ft bgs. A third well, the Marie drinking water well, was decommissioned in the 1990s and is no longer a potential receptor. While residential wells have been installed west of the YTC boundary, these wells are located approximately 1,500-3,000 ft northwest/cross-gradient of the TVR/Old MATES TCE plume. LUCs are in place to prevent exposure to contaminated groundwater by restricting drinking water well installation at the former FTP site and within 1,000 ft of the TVR/Old MATES site boundary.

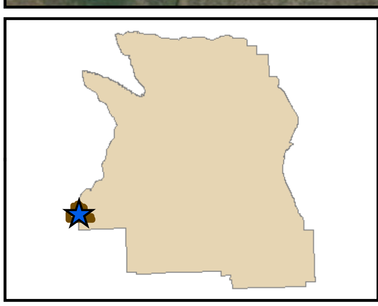
A risk-based screening evaluation for human and ecological receptors was conducted for the former FTP site (Fort Lewis ERP 2002). Based on the evaluation, potential receptors that could be exposed to TPH-contaminated soil included current and future onsite workers as well as residents under an assumed future residential land use scenario. Soil was subsequently excavated in 2003. The site is currently undeveloped and is not actively being used or expected to be used in the future. LUCs have been implemented for this site and include media specific restrictions (restrict drinking water well installation and land use), and institutional controls (dig permits and restrictions on land use) (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

The potential groundwater ingestion/inhalation pathway at the former FTP site is incomplete since groundwater impacts in shallow, perched groundwater immediately down-gradient of the former pit do not pose a potential risk or hazard to current or future potential receptors (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017). Monitoring well FTP-1 is located 100 ft southwest (the assumed direction of groundwater flow) of the FTP site. All existing water supply wells are located a considerable distance from the site. In addition, contamination is within a shallow, perched groundwater bearing zone and not within a regionally important aquifer. Given the distance of both the Pomona Well and PAIC Well from the former FTP site and the hydraulic separation between the perched groundwater and the aquifer(s) the water supply wells are completed in, it is considered unlikely that these wells are being impacted by the former FTP site.

The terrestrial ecological pathway for the former FTP site was considered incomplete in the April 2006 terrestrial ecological evaluation by Pacific Northwest National Laboratory (2006).

The only potentially complete exposure pathways at the TVR/Old MATES site are the potential direct contact and groundwater ingestion/inhalation pathways due to the presence of TCE in the Selah Interbed Aquifer. LUCs have been implemented 1,000 ft around the TVR/Old MATES site boundary (drinking water control) and at Building 843 (excavation control). In addition, media specific restrictions (prohibit, or otherwise manage excavation, and restrict drinking water well installation) and institutional controls (permits and restrictions on land use) have been implemented for the site (Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, USACE 2017).

The potential direct contact and groundwater ingestion/inhalation pathways at TVR/Old MATES do not pose an unacceptable risk or hazard given the current and anticipated future land use. While the Pomona and PAIC wells are located within the TVR/Old MATES plume boundary, it is unlikely that the water supply wells would be impacted by TCE contamination in the TVR/Old MATES area given the relatively low TCE concentrations in monitoring wells and the hydraulic separation between the Selah Interbed Aquifer and the deeper aquifer(s) in which the water supply wells are completed. Numerous analytical results have confirmed that no TCE is present in either the Pomona Well or the PAIC Well. The nearest off-post residential well is located approximately ¼ mile northwest/cross-gradient of the most downgradient monitoring well and is likely completed within the Selah Interbed Aquifer. Further, it is unlikely that off-post wells would be impacted with TCE as the plume has not expanded beyond the YTC boundary.



Legend

- Cantonment Area Boundary
- Monitoring Well
- Fall 2017 10-ft Groundwater Contour
- Groundwater Flow Direction

0 200 400 800
Feet

1 in = 400 ft

N

FIGURE 10-1
FORMER FIRE TRAINING PIT
SITE LAYOUT
UNIFORM FEDERAL POLICY-
QUALITY ASSURANCE PROJECT PLAN

Map Date: 6/25/2018
Coordinate System: UTM Zone 10
Horizontal Datus: WGS 84

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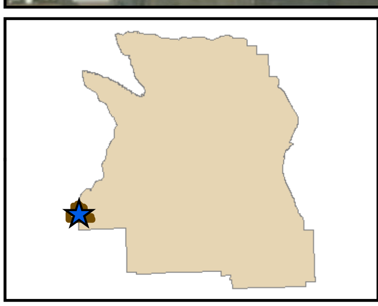


Legend

- Cantonment Area Boundary
- Monitoring Well
- Water Supply Well
- Residential Drinking Water Well
- Fall 2017 TCE Contour

0 300 600 1,200
Feet

1 in = 600 ft

N

Note: TCE concentrations are in micrograms per liter (µg/L)

FIGURE 10-2
TVR/Old MATES SITE LAYOUT AND FALL 2017 TCE CONCENTRATIONS

UNIFORM FEDERAL POLICY-
QUALITY ASSURANCE PROJECT PLAN

Map Date: 6/25/2018
Coordinate System: UTM Zone 10
Horizontal Datus: WGS 84

Worksheet #11: Project/Data Quality Objectives

This worksheet is used to develop the project DQOs using a systematic planning process that documents the environmental decisions that need to be made and the level of data quality needed to support them. The DQO process is outlined in the USEPA 2006 guidance document (USEPA 2006). The specific QA/QC requirements developed for the sites are consistent with those presented in the DoD Quality Systems Manual, Version 5.1 (DoD and DOE 2017).

DQOs are both qualitative and quantitative statements that define the type, quality, and quantity of data necessary to support the decision-making process during project activities. The objective of this UFP-QAPP is to establish standard procedures so that the integrity, accuracy, precision, completeness, and representativeness of collected samples are maintained, and the required DQOs are achieved.

The DQO process provides a systematic procedure for defining the criteria that a data collection design should satisfy. The DQO process established by the USEPA and incorporated into the 2012 UFP-QAPP guidance consists of seven steps; these steps are used during the planning of the data collection process to ensure that field and analytical activities, and the resulting data, meet the project objectives. The DQO process is designed to: (1) clarify study objectives and decisions to be made based on the data collected, (2) define the most appropriate type of data to collect, (3) determine the most appropriate conditions for collecting the data, and (4) specify acceptable decision error limits based on the consequences of making an incorrect decision.

The seven steps in the DQO process are as follows: (1) state the problem; (2) identify the goals of the study; (3) identify information inputs; (4) define the boundaries of the study; (5) develop the analytic approach; (6) specify performance or acceptance criteria; and (7) develop the detailed plan for data collection.

Step 1: State the Problem

Groundwater contaminants are present at the former FTP site and TVR/Old MATES at concentrations above MTCA Method A or Standard Method B cleanup levels. Groundwater contamination has the potential to impact downgradient drinking water wells. Continued LTM, including groundwater monitoring, is required in accordance with the final Decision Documents to evaluate groundwater conditions and assess concentration trends at designated monitoring wells.

Step 2: Identify the Goals of the Data Collection

The goals of the study are to:

1. Evaluate the groundwater contaminant concentrations at select monitoring wells.

2. Determine if contaminant concentration trends are increasing, decreasing, or otherwise show evidence of offsite migration.

Principal Study Question

Does the existing monitoring program adequately characterize the extent of contamination at the former FTP site and TVR/Old MATES?

- Alternative Actions

  — No action.
  — Optimize the monitoring network and/or modify sampling frequency.

Decision Statement

Determine if the existing groundwater monitoring program is adequate to characterize the extent of groundwater contamination or if changes to the monitoring network and/or monitoring frequency are required to support the decision making process.

Step 3: Identify the Information Inputs

Information inputs include the following:

- Collection and analysis of semiannual water level data.

- Semiannual groundwater sampling and analysis of site-related contaminants

  — TPH-G, TPH-D, and TPH-O at each former FTP site well scheduled for sampling
  — VOCs, SVOCs, TPH-G, TPH-D, and TPH-O at former FTP site well FTP-1
  — VOCs at each at TVR/Old MATES well scheduled for sampling.

- Historical groundwater monitoring data with analytical results from 1993 through the present.

Analytical results from groundwater monitoring efforts will be compared to the project screening levels presented in Worksheet #15. Data generated from the groundwater monitoring effort will be used to perform statistical analysis.

Data Users

The data users include JBLM, USACE, the regulatory authorities (Ecology), and the Contractor.

Step 4: Define the Boundaries of the Study

The current monitoring program includes collection of water levels from 5 monitoring wells at the former FTP site and 12 monitoring wells at the TVR/Old MATES, as well as collection of groundwater samples from 4 monitoring wells at the former FTP site, and 10 monitoring wells and 2 currently active water supply wells at the TVR/Old MATES. Groundwater monitoring events are scheduled to occur on a semiannual basis. The current monitoring locations and monitoring schedule is summarized in Worksheet #18. Monitoring locations are presented in Figures 11-1 and 11-2.

Step 5: Develop the Analytic Approach

The data generated by the monitoring program will be evaluated in accordance with the following "if/then" statements to support decision making at the sites:

- If groundwater monitoring data indicate that the current monitoring program is inadequate to characterize the extent of contamination, then modifications to the monitoring network and/or monitoring frequency will be implemented to ensure accurate tracking of contaminant concentrations.

- If contaminant concentrations demonstrate decreasing trends or are below cleanup levels in a specific monitoring well or series of wells, then the monitoring program will be evaluated to determine if the sampling frequency at certain wells may be reduced or eliminated, or if changes to the target analyte list are appropriate.

- If the TVR/Old MATES TCE plume expands in the future such that TCE concentrations in monitoring wells installed adjacent to the YTC boundary (i.e., MMP-1, TVR-5, and 815-2) exceed the MTCA Method A/Standard Method B groundwater cleanup level for two consecutive monitoring events, then the selected remedy (LUCs and groundwater monitoring) will be re-evaluated in consultation with JBLM, USACE, and Ecology.

Additional details regarding statistical analysis to support trend analysis and evaluation of monitoring data are presented in Worksheet #14.

Step 6: Specify Performance or Acceptance Criteria

This section evaluates the consequences of making incorrect decisions and considerations and/or actions taken to mitigate decision error.

Decision Error and Potential Consequences

The acceptable limits for false positive or false negative decision errors will be based on evaluating the potential consequences of these decision errors (such as risks to human health and the environment or unnecessary expenditures for additional sampling) if specific contaminants are detected or are not detected above action levels. Two potential decision errors could be made based upon interpreting sampling and analytical data:

1. Concluding that the concentration of a specific chemical at a sample location within an area is below the action level when it truly is above the action level.

2. Concluding that the concentration of a specific chemical at a sample location within an area is greater than the action level when it truly is below the action level.

The consequences of the first error would have severe implications because the contamination would be left undetected and leave risk at the site due to contaminant concentrations. The consequences of the second error would result in unnecessary expenditure, and diversion of resources that could be used for cleanup of other contaminated areas.

The consequences of the first error are deemed more serious because of the potential risk. The baseline condition, therefore, is established such that the contaminant concentration is truly greater than or equal to the action level. The baseline condition is defined as the null hypothesis (H_0). The alternative is defined as the alternative hypothesis (H_a). This may be summarized as follows:

$$H_0\text{: [concentration]} \geq \text{ action level}$$
$$H_a\text{: [concentration]} < \text{ action level}$$

A false positive error, also known as a Type I error, occurs when the null hypothesis is falsely rejected (i.e., the sample data show that the concentration of a chemical is below the action level when it actually exceeds the action level). The measurement of the size of this error is called alpha (α), the level of significance. Alpha is expressed numerically as a probability or the tolerance for uncertainty.

A false negative error, also known as a Type II error, occurs when the null hypothesis is falsely accepted (i.e., the sample data show that the concentration of the chemical is above the action level when it actually is below the action level). The measurement of the size of this error is called beta (β), or the complement of the power of the hypothesis test.

The tolerance limits for decision error have been established at α=5 percent or 0.05 for false positives and β=20 percent or 0.2 for false negatives.

The analytical data and sampling design performance will be statistically evaluated based on the detected contaminant concentrations at the project sites.

Sources of Error

Total study error potential is equally attributable to sampling and measurement error because of the steps and sample volume associated with the planned sample collection and analysis. Successfully managing the magnitude of total study error is the result of understanding the error sources, generating an appropriate sampling design, and choosing accurate measurement techniques. The approach used to manage study error for the planned sampling and analysis is discussed below.

- *Groundwater Monitoring Data—*The sources of decision error for these results are equally attributable to sampling or measurement error. This conclusion is based upon review of the sampling and analysis strategy. The sampling design is straightforward, and the analysis will be performed using the services of a DoD Environmental Laboratory Accreditation Program (ELAP)-accredited laboratory with standard methods.

The quality of sampling and analysis must be at a level that results in representative, precise, and reproducible data. The data generated will be sufficient for the intended use. “Good” data will be defined as data that are produced following the specified standard operating procedures (SOPs) and meeting the established criteria in this UFP-QAPP, including precision, accuracy, comparability, representativeness, completeness, and sensitivity.

The data need to be of adequate quality to make the decisions established for these sites. The purpose of this is to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels. Worksheet #12 of the Programmatic UFP-QAPP (EA 2018b) presents the measurement performance criteria applicable to this effort.

Step 7: Develop the Detailed Plan for Data Collection

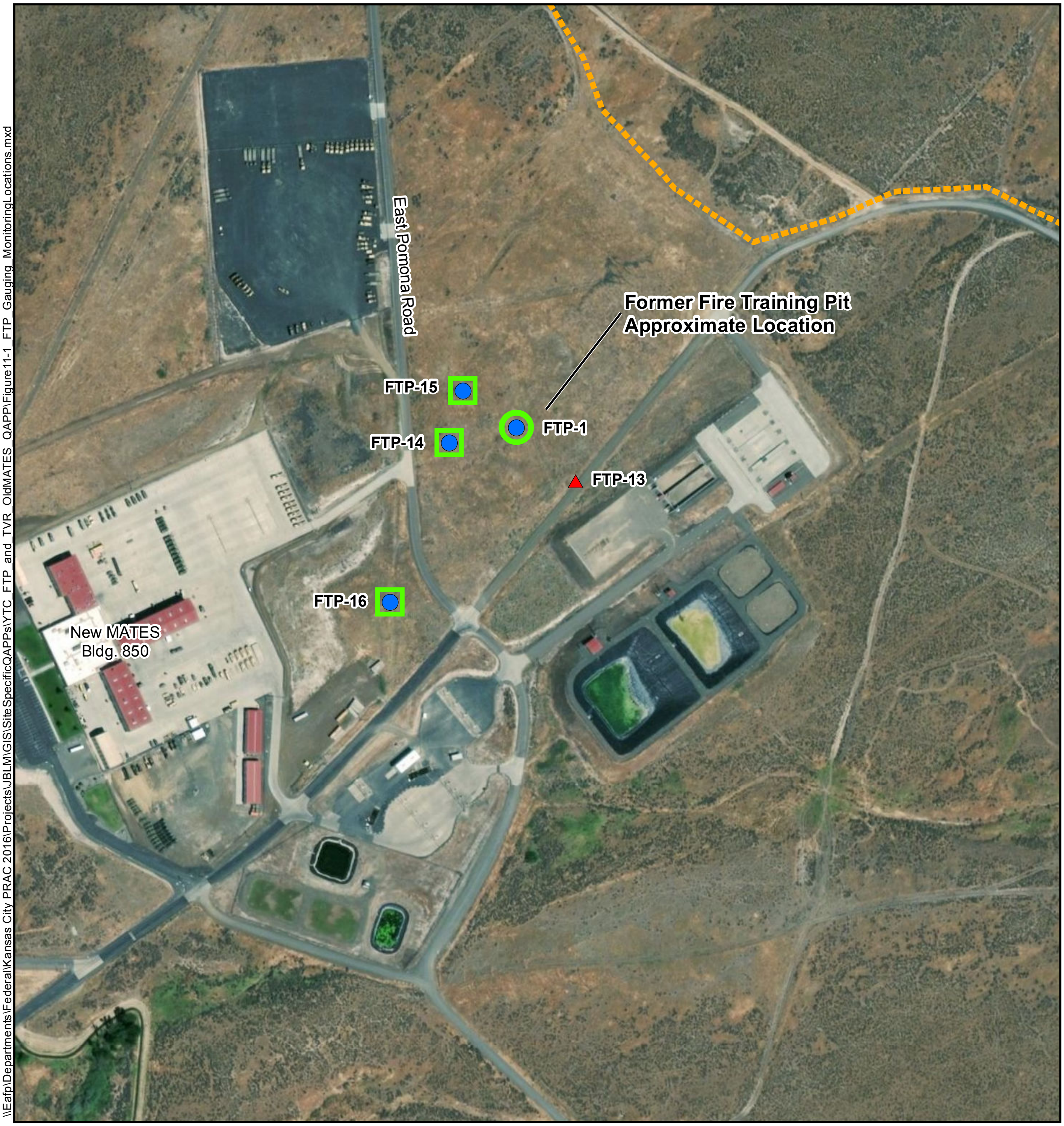
The plan for data collection is described below.

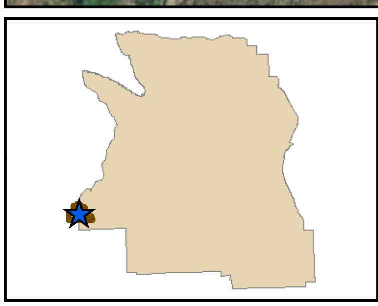
- Depth to water measurements will be collected using electronic water level indicator.

- Groundwater samples at the former FTP site will be collected using disposable Teflon bailers and shipped offsite for laboratory analysis of TPH-G, TPH-D, TPH-O, VOCs, and SVOCs.

- Groundwater samples at the TVR/Old MATES will be collected using disposable passive diffusion bags (PDBs) and shipped offsite for laboratory analysis of VOCs.

Additional details pertaining to the sampling plan are provided in Worksheets #14, #16, #17, and #18. Worksheet #20 details the field sample count and QC sample requirements.





0 200 400 800
Feet
1 in = 400 ft

N

Legend

- Cantonment Area Boundary
- Semiannual Gauging Only
- Semiannual Gauging and Groundwater Sampling
- Sampling for Total Petroleum Hydrocarbon Analysis Only
- Sampling for Volatile Organic Compounds, Semivolatile Organic Compounds, and Total Petroleum Hydrocarbons

FIGURE 11-1
FORMER FIRE TRAINING PIT MONITORING LOCATIONS
UNIFORM FEDERAL POLICY-
QUALITY ASSURANCE PROJECT PLAN

Map Date: 8/15/2018
Coordinate System: UTM Zone 10
Horizontal Datus: WGS 84

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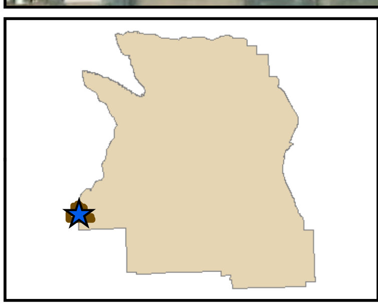

0 300 600 1,200
Feet
1 in = 600 ft

N

Legend

- Cantonment Area Boundary
- Semiannual Gauging Only
- Semiannual Gauging and Sampling First and Third Quarters
- Semiannual Gauging First and Third Quarters and Semiannual Sampling First Quarter Only
- Semiannual Groundwater Sample Only
- Monitoring Well Removed From Program
- Dry Monitoring Well

FIGURE 11-2
TVR/Old MATES
MONITORING LOCATIONS

UNIFORM FEDERAL POLICY-
QUALITY ASSURANCE PROJECT PLAN

Map Date: 9/13/2018
Coordinate System: UTM Zone 10
Horizontal Datus: WGS 84

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Worksheet #12: Measurement Performance Criteria for Analytical Testing

This worksheet is presented in the Programmatic UFP-QAPP (EA 2018b).

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Worksheet #13: Secondary Data Uses and Limitations

Sources of secondary data that may be used for this task order are included below. Note this is not an exhaustive list, as additional documents may be identified later that provide use to the current effort.

Data Type	Data Source (originating organization, report title, and date)	Data Generator(s) (data types, data generation/collection dates)	How data may be used (if deemed usable during data assessment stage)	Factors affecting reliability of data and limitations on data use
Planning Document	Tetra Tech EC, Inc., CY 2017 Groundwater Monitoring Plan, Fire Training Pit (FTP) and Tracked Vehicle Repair/Old Mobilization and Training Equipment Site (TVR/Old MATES), June 2017.	Previous guidance for groundwater monitoring.	Guidance for sampling locations, frequencies, and methods used during previous monitoring events. Detailed information on site background, site history, and physical profile information.	These data are valid and usable for comparison.
Report	Tetra Tech EC, Inc., 2017 Annual Groundwater Monitoring Report, Fire Training Pit (FTP) and Tracked Vehicle Repair/Old Mobilization and Training Equipment Site (TVR/Old MATES), January 2018.	Previous groundwater monitoring report and analytical data.	Detailed information on current site conditions and groundwater concentrations. Analytical data and statistical analysis/trends.	These data are valid and usable for comparison.
Report	EHS-International, Inc. Final Report Environmental Baseline Surveys Washington Army National Guard Yakima Sites 1 and 2 Yakima Training Center, Yakima and Kittitas Counties, Washington, September 2010.	Investigation report presenting site background information.	Detailed information on site history, geology/hydrogeology, and nature and extent of contamination.	These data are valid and usable for comparison.
Report	Yakima Training Center Army Defense Environmental Restoration Program Installation Action Plan, JBLM 2017, June 2017.	Report presenting site background information.	Detailed information on regulatory framework, site history, and contaminants of concern.	These data are valid and usable for comparison.

Data Type	Data Source (originating organization, report title, and date)	Data Generator(s) (data types, data generation/collection dates)	How data may be used (if deemed usable during data assessment stage)	Factors affecting reliability of data and limitations on data use
Review Report	Regional Planning and Environmental Center, Fort Worth District, Southwestern Division, US Army Corps of Engineers, Draft Periodic Review Report Yakima Training Center, Yakima, Washington, March 2017.	Review report for remedies at IRP sites conducted from 2007-2012. Summary of previous investigative and remedial activities and data.	Detailed information on regional and site history, geology/hydrogeology, water supplies, nature and extent of contamination, exposure pathways/receptors, and site remedies. Presents recommendations for future monitoring activities.	These data are valid and usable for comparison.
Decision Document	Fort Lewis ERP, Decision Document for Selected Remedy at Former Fire Training Pit (SWMU 59), March 2007.	Decision Document for former FTP site including selected remedy and remedial goals.	To describe site history and site remedy.	These data are valid and usable for comparison.
Decision Document	Fort Lewis ERP, Decision Document for Selected Remedy at Tracked Vehicle Repair/Old MATES Area, March 2007.	Decision Document for TVR/Old MATES including selected remedy.	To describe site history, site remedy, potential receptors/risk.	These data are valid and usable for comparison.
Decision Document	Fort Lewis ERP, Decision Document for a Remedial Action, Fire Training Pit, Yakima Training Center, WA. September 2002.	Decision Document for soil excavation remedial action at former FTP site.	To describe site history, site remedy, potential receptors/risk.	These data are valid and usable for comparison.
Guidance Document	Sealaska, 2017 Comprehensive Land Use Controls Plan, Joint Base Lewis-McChord, Pierce County, Washington, January 2018.	Land Use Control Plan for YTC.	To describe land use controls and institutional controls.	These data are valid and usable for comparison.

Worksheets #14 and 16: Project Tasks and Schedule

This worksheet provides an overview of the project tasks, describes the procedures to be followed, and presents a summary of the project deliverables to be prepared in support of the groundwater monitoring program at the former FTP site and TVR/Old MATES. Field tasks will be conducted in accordance with applicable Ecology regulations, WAC Chapters 173-340-820 and 173-340-810, and USEPA guidance. The sampling design and rationale are discussed further in Worksheet #17. Worksheet #18 presents a comprehensive list of the current monitoring locations and sampling frequency. Field SOPs are listed in Worksheet #21 of this Site-Specific UFP-QAPP and are provided in Appendix A of the Programmatic UFP-QAPP (EA 2018b). Field forms detailed in the sections below are presented in Appendix B of the Programmatic UFP-QAPP. A general project schedule detailing the specific tasks and planned start and end dates is presented at the end of this worksheet.

14.1 Mobilization/Demobilization Tasks

Mobilization includes procurement of field equipment and supplies and mobilization of field staff. The following tasks will be conducted prior to mobilization:

- Notify the YTC point-of-contact at least 1 week before the scheduled sampling day(s)
- Obtain the necessary information from field personnel to meet installation access requirements
- Coordinate with field personnel and subcontractors as needed
- Obtain necessary access and escorts
- Determine staging areas for equipment, if necessary
- Order sample bottles and field monitoring equipment.

Sample bottle requirements are presented in Worksheet #19 and 30. The equipment necessary to execute the field work and complete the project tasks is detailed below and in the SOPs identified in Worksheet #21.

Entrance briefing and safety meetings will be conducted prior to the start of fieldwork to familiarize the team personnel with site health and safety requirements, the objectives and scope of field activities, and chain-of-command. Personnel mobilized to the site will meet requirements for Occupational Safety and Health Administration (OSHA) hazardous waste operations training and medical surveillance requirements as specified in the APP, which has been submitted as a separate document (EA 2018a). Site personnel will also be trained to perform the specific tasks to which they are assigned. At no time will site personnel be tasked with performing an operation or duty for which they do not have appropriate training. The field team will be familiar with sample locations and will identify related field support areas and requirements.

Demobilization includes removing field equipment and supplies, returning rented equipment, managing investigation-derived waste (IDW) as described in Section 14.5, performing general cleanup, and organizing and finalizing field documentation.

14.2 Groundwater Elevations

Static water level and well depth measurements will be taken with an electronic water level indicator at each well location listed in Worksheet #18 in accordance with SOP 010. An interface probe will be used to determine the presence and thickness of LNAPL, if any, prior to measurement of the groundwater levels. Each measurement will be recorded to the nearest 0.01 ft from the measuring point on the top of the polyvinyl chloride casing (notch, mark, or north end).

Monitoring well inspection forms presented Appendix B of the Programmatic UFP-QAPP (EA 2018b) will be completed for each well during gauging activities. Well repairs will be completed if necessary to comply with Washington State and US Army regulations/guidance. All monitoring wells will be locked to protect against vandalism.

The electronic water level indicator and/or interface probe will be decontaminated before use, between wells, and at the end of the day. Measurements will be recorded in the field logbook.

14.3 Groundwater Sampling Tasks

Groundwater sampling will be conducted at the sites semiannually during the first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., September). The monitoring well locations and sample collection frequency is presented in Worksheet #18. Sample containers will be provided by the analytical laboratory prior to sampling. Required sample containers, preservation methods, volumes, and holding times are provided in Worksheets #19 and 30.

Field forms and field logbook documentation will be completed during the planned sampling activities as detailed in Section 14.7 below.

Additional details for the planned groundwater sampling at the former FTP and TVR/Old MATES sites are presented below.

14.3.1 Former Fire Training Pit Site

The equipment to be used during groundwater sampling at the former FTP site will include a sounding tape (water level meter or interface probe), and disposable Teflon™ bailers. Requirements for maintenance, testing, and inspection of field equipment are summarized in

Worksheet #22 and related forms are provided in Appendix B of the Programmatic UFP-QAPP (EA 2018b).

Each monitoring well will be bailed until three well volumes are removed or until the monitoring well is bailed dry, whichever occurs first. Water quality parameters will not be monitored or recorded during bailing operations. Pertinent sampling information will be recorded on purge forms (Well Purging and Sampling Record; Appendix B of the Programmatic UFP-QAPP; EA 2018b). Unusual conditions (colors, odors, surface sheens, etc.) observed during well purging or sampling will be recorded and reported. Sampling information will also be recorded in the field logbook.

Groundwater samples will be collected once the wells have recharged to at least 80 percent of the initial depth of water. Wells FTP-14, FTP-15, and FTP-16 will be sampled for TPH-G, TPH-D, and TPH-O. Well FTP-1 will be sampled for VOCs, SVOCs, TPH-G, TPH-D, and TPH-O. Samples aliquots for the analysis of volatile analytes (VOCs and TPH-G) will be collected before the others.

14.3.2 Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

Monitoring wells at the TVR/Old MATES will be sampled using PDBs in accordance with SOP 013A. Samples from the Pomona Well and the PAIC Well will be collected from taps on each well while the pumps are running. Samples will be collected for VOC analysis. Water quality parameters will not be collected during sampling.

PDB samplers in wells sampled semiannually will be installed prior to sampling during the previous semiannual sampling event. PDB samplers in wells sampled annually during the first quarter will be installed during in the previous third quarter. A dedicated string/harness will be used to position the PDB sampler at 2-5 ft above the bottom of the monitoring well screen. PDB samplers will be deployed for approximately six months. During each semiannual sampling event, PDB samplers will be extracted and samples will be collected. PDB samplers for the following sampling event will then be installed.

PDB installation dates and sampling information will be recorded on sample forms provided in Appendix B of the Programmatic UFP-QAPP (EA 2018b).

14.4 Equipment Decontamination Tasks

Non-disposable equipment that may directly or indirectly contact samples, including electronic water level indicators and/or interface probes, will be decontaminated between well/sampling locations in accordance with SOP 005. Non-disposable personal protective equipment (PPE) or clothing that becomes contaminated during site work will be appropriately cleaned before reuse or will be disposed of and replaced.

14.5 Investigation-Derived Waste

IDW generated during sampling activities is anticipated to be limited to purge water at the former FTP site, decontamination fluids, and PPE (e.g., nitrile gloves). IDW will be handled and disposed of as described below.

Purge water and decontamination water will be collected in 5-gallon buckets and discharged to the oil water separator at the main Vehicle Washrack catch basin (Figure 2). IDW discharge will be coordinated with YTC Wastewater Treatment Plant Operator prior to disposal.

Non-investigative waste, such as litter and garbage, will be collected on an as-needed basis to maintain each site in a clean and orderly manner. This waste will be containerized and transported to the designated sanitary landfill or collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

14.6 Field Quality Control Tasks

QC tasks will be overseen by EA's Field Team Leader and/or QC Manager. Requirements for calibration, maintenance, testing, and inspection of field equipment are summarized in Worksheet #22 and related forms are provided in Appendix B of the Programmatic UFP-QAPP (EA 2018b).

Field QC samples are intended to provide an indication of how consistent sample collection and analyses are over the course of the program. The analytical laboratory will analyze QC samples in accordance with the documents and procedures listed in Worksheet #28 of the Programmatic UFP-QAPP (EA 2018b). Field and laboratory QC samples are listed on Worksheet #20 and will include the following:

- ***Field Duplicates*****—**One field duplicate sample will be collected annually at the FTP site. One field duplicate sample will be collected per sampling event at TVR/Old MATES. Duplicate samples will be taken at the same time as the primary samples, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The purpose of these samples is to check the reproducibility of laboratory and field procedures, and indicate non-homogeneity.

- ***Matrix spike (MS)/matrix spike duplicate (MSD***)—MS/MSD samples will be collected at each site at a rate of 5 percent of project samples (1 set per 20 field samples). MS/MSD sample locations will be selected by the field staff, and up to three times the normal sample volume will be collected to accommodate the extra volume required to prepare the MS/MSD samples at the laboratory. The results of MS/MSD samples are used to evaluate the matrix effect of the sample upon the analytical methodology.

- ***Trip blanks*****—**A minimum of one, laboratory-supplied, trip blank will accompany each cooler containing samples sent to the laboratory for VOC analysis. Trip blanks will be supplied by the laboratory in unopened, 40-milliliter (mL) volatile organic analysis (VOA) vials filled with laboratory grade, analyte-free water.

14.7 Documentation and Records

A bound field logbook will be used to record information about each field activity, including field personnel at the site, daily weather conditions, site conditions, tasks completed, general field notes, samples collected, field screening results, and deviations from this QAPP and other plans as detailed in SOP 059. Field activities will be recorded daily with black or blue waterproof ballpoint pens. Each page of field notes will be numbered and dated, and initials of crew members will be defined. Errors will be crossed out with a single line, initialed, and dated, and correct data entered adjacent to the error.

Pertinent information will be logged in the field logbook as follows:

- Date and time of sample collection
- Weather conditions
- Location number and name
- Location of sampling point
- Sample identification number
- Type of sample
- Condition of monitoring well
- Field observations, especially those such as floating immiscible layer or sheen on water surfaces
- References, such as maps or photographs of the sampling site
- Collection of QA/QC samples.

The following field logbook procedures will be followed to ensure that:

- The cover of each field logbook lists the project name, location, activities, name of contact and phone number, start/end date, and time of logbook entries.
- The date and start/end time of activities, personnel onsite, site conditions (including presence of airborne particulates [soot, dust, etc. from heavy truck traffic], and presence

of unusual odors) and visitors onsite (as well as arrival and departure times) for each day are recorded.

- The weather entry for each day includes cloud cover (partly cloudy, full sun, etc.), precipitation (type and intensity), wind direction, temperature, wind speed, and humidity.

- The well condition, including signs of damage or vandalism, is recorded.

- Information such as the type of PPE, identification of contract documents, serial numbers of equipment utilized, serial/tracking number of shipments, deviances from the site plan, and times onsite and offsite are listed in field logbooks and/or appropriate field forms.

- No pages are removed from the field logbooks.

- Specific times are listed for each activity observed at the site in the field logbook.

- When the author releases a specific field logbook that the new author prints his/her name, and signs the field logbook prior to making any entries in the field logbook.

Field sheets will be maintained by the sampling team to provide a daily record of significant events, observations, and measurements taken during the field investigation. The field log sheets are intended to provide sufficient data and observations to enable the field team to reconstruct events that occur during the project. Field sheets will include daily field logs, daily calibration forms and checklists, groundwater purge forms, and sample collection checklists. Additional field forms including health and safety forms (provided in the APP) and contractor QC forms/checklists (provided in Appendix B of the Programmatic UFP-QAPP, EA 2018b) will be completed for this project.

Photographs will be used to document unusual conditions observed during field activities. Before taking photographs, a camera pass or other appropriate approval will be obtained from YTC, if required.

Hardcopy data (field notebooks, photographs, hard copies of chain-of-custody forms, air bills, etc.) will be kept in the project files.

14.8 Sample Management Tasks

Sample management is the process by which field samples are handled once collected. This process encompasses sample labeling, preservation, documentation, and shipment to the laboratory. Sample containers will be provided by the analytical laboratory, and will be pre-preserved for those constituents that require chemical preservation, as detailed in Worksheet #19 and #30. Samples will be placed in an iced cooler and maintained at less than 6 degrees Celsius (°C) (but not frozen) immediately upon collection.

14.8.1 Sample Identification

Samples will be uniquely identified, labeled, and documented in the field at the time of collection. Weatherproof sample labels with sample identification numbers will be affixed to each sample container. Sample labels will indicate the site location, sample name, date, time, sampler's initials, parameters to be analyzed, preservative, and pertinent comments.

The sample identification number will uniquely identify the sample in relation to a specified sampling location. A sample identification system has been developed to provide uniform classification and to assist project personnel with interpretation of data reports and field notes.

Each sample will be named with the site name (FTP for former FTP site and TVR for TVR/Old MATES) followed by a unique identification code for sample location (well identification [ID] followed by an eight-digit date code corresponding to year-month-date of sampling). For example, for TVR well MMP-1 samples collected on 23 September 2018, sample IDs would be denoted as TVR-MMP-1-20180923.

Field duplicate samples will be given a unique sample ID and sample time independent of the primary sample to disguise the duplicate sample from the analytical lab, as presented in Worksheet #18. Samples will be named using the same convention for monitoring well samples.

Trip blank samples will be denoted with the prefix TB.

14.8.2 Sample Custody

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

Sample custody documentation provides a written record of sample collection and analysis, and sample custody procedures provide for specific identification of samples associated with an exact location, the recording of pertinent information associated with the sample, and a chain-of-custody record that serves as physical evidence of sample custody. Samples will be labeled, packed, and shipped to the analytical laboratory, and tracked by secure chain-of-custody protocol in accordance with SOP 001 and SOP 004 as detailed in Worksheet #26 and #27 of the Programmatic UFP-QAPP (EA 2018b).

Additional guidelines for sample handling, custody, and disposal are presented in Worksheet #26 and #27 of the Programmatic UFP-QAPP (EA 2018b).

14.9 Laboratory Analysis Tasks

Samples will be submitted to ALS Environmental of Kelso, Washington, a DoD ELAP and State of Washington accredited laboratory. Groundwater samples collected from each former FTP well scheduled for sampling will be analyzed for TPH-G by Method NWTPH-Gx, and TPH-D and TPH-O by Method NWTPH-Dx. In addition, samples collected from FTP-1 will be analyzed for VOCs by USEPA Method SW8260C and SVOCs by USEPA Method SW8270C. Samples collected at the TVR/Old MATES will be analyzed for VOCs by USEPA Method SW8260C.

Project quantitation limits, action limits, and the selected screening criteria for each of the methods, matrices, and analytes that will be evaluated are presented in Worksheet #15. The analytical laboratory will process and analyze samples according to the sample chain-of-custody records and the requirements of the Programmatic UFP-QAPP (EA 2018b). The analytical SOPs are provided in Worksheet #23 of the Programmatic UFP-QAPP.

Following the receipt at the laboratory, samples will be tracked using laboratory sample logs. Air bills for overnight shipping will be retained.

The analytical laboratory will generate portable document format reports and electronic data deliverables of the sample analysis, as specified in the Programmatic QAPP (EA 2018b).

14.10 Laboratory Quality Control Tasks

The project laboratory will be responsible for conducting laboratory QC procedures and reporting laboratory QC results in accordance with laboratory SOPs. Laboratory QC samples will be prepared and analyzed according to the analytical method requirements, the laboratory's QA Plan, as well as the Site-Specific and Programmatic UFP-QAPP documents. Laboratories that perform analytical work under this project must adhere to a QA program that is used to monitor and control laboratory QC activities. Each laboratory must have a written QA manual that describes the QA program in detail. The laboratory QA Manager is responsible for ensuring that laboratory internal QC checks are conducted in accordance with applicable methods and protocols, the laboratory's QA manual (Appendix C of the Programmatic UFP-QAPP, EA 2018b), and the requirements of this QAPP.

Details regarding analytical QC are provided in Worksheet #28 of the Programmatic UFP-QAPP (EA 2018b). Internal and continuing calibration verification will be conducted for applicable equipment as summarized in Worksheets #24 and #25 of the Programmatic UFP-QAPP. Measurement performance criteria are specified in Worksheets #12 and #28 of the Programmatic QAPP (EA 2018b).

Worksheet #15 presents project screening levels and laboratory reference limits for analytes included in the monitoring program.

14.11 Data Review and Validation Tasks

Review activities for analytical data and other project inputs are summarized in Worksheets #34, #35, and #36 of the Programmatic UFP-QAPP (EA 2018b). Analytical data will be verified by the laboratory QC Manager prior to providing the data to EA; the data will then be reviewed by the EA Data Manager for completeness upon receipt. Overall data quality will be reviewed to determine if the data are suitable for use, as described in Worksheets #35 and #36 of the Programmatic UFP-QAPP (EA 2018b). Results of this evaluation will be summarized in the project report. CA for field or laboratory procedures will be taken as needed in consultation with USEPA.

14.12 Data Management Tasks

Project files will be maintained in the EA Seattle, Washington office. Examples of documents in the project file include project correspondence, field records and the field logbook(s), laboratory data packages, and deliverables. Hard copy and electronic data will be archived in project files for the duration of the project or a minimum of 5 years, whichever is longer.

Worksheet #29 of the Programmatic UFP-QAPP (EA 2018b) discusses data management.

14.13 Data Evaluation Tasks

Groundwater data will be verified, validated, and assessed as described in Worksheets #34 through #37 of the Programmatic UFP QAPP (EA 2018a).

The TPH-G, TPH-D, and TPH-O data at the former FTP site and TCE data at TVR/Old MATES will be statistically evaluated as described below. Summary statistics will be calculated using Microsoft Excel's Descriptive Statistics tool. The Shapiro-Wilk test for normality and linear regression analysis will be performed on the data using a Microsoft Excel add-in, Analyse-It®, or other appropriate software. The Mann-Kendall correlation test will be performed on non-parametric data using Analyse-It®, or other appropriate software.

Concentration measurements not known to be in error will be considered valid; suspect "outliers" will not be removed from the data set and will be included in the analyses. Non-detect data, which represent concentration measurements below the limit of detection (LOD) but above the DL for each constituent, will be evaluated at the LOD value (e.g., if the LOD is 0.5 μg/L, the concentration value is set at 0.5 μg/L). Non-detect data will be labeled with a U qualifier in the data table. Limits of quantitation (LOQ), LODs, and DLs for target analytes are presented in Worksheet #15 and are below or equal to project screening levels per WAC Chapter 173-200 with the exception of 1,2-dibromoethane and vinyl chloride. However, 1,2-dibromoethane and vinyl chloride are not considered contaminants of concern at the sites and have not been previously detected in groundwater at the former FTP site or TVR Old MATES.

14.13.1 Shapiro-Wilk Test for Normality

Prior to analyzing the data for trends, the data will be tested for normal distribution using the Shapiro-Wilk Test for normality. The null and alternate hypotheses are a summary of the objectives of a test, which in this case is to test for the distribution of the data. The null hypothesis, or what is assumed to be true before given evidence that it may be false, for tests for normality is that a dataset is normally distributed. The alternate hypothesis, then, is that a dataset is not normally distributed (Helsel and Hirsch 2002). A significance level, or alpha level, of 0.05 will be used when determining whether or not historical data from monitoring wells are normally distributed. P values, generated using the Shapiro-Wilk Test for Normality, will then be compared to the alpha level. The alpha level is the "cutoff" point for the test statistic in deciding whether the data were normally distributed or not. P values show the strength of the test in determining whether the data was normally distributed or not. P values range from 0 to 1; the closer a P value is to 1 the better the dataset is normally distributed. P values equal to or below 0.05 (alpha level) are not considered normally distributed.

Datasets that are not considered normally distributed will then be transformed by taking the natural log of the original values. This approach is generally the most common transformation of water resources data. The Shapiro-Wilk Test for normality will be run on the transformed data with the same criteria as the datasets above.

14.13.2 Linear Regression and Mann-Kendall Correlation Analyses

Linear regression trend analyses will be conducted on concentration data that are found to be normally or log normally distributed from the Shapiro-Wilk Test. In this instance the null hypothesis for the test is that there is no trend in the data (Helsel and Hirsch 2002). The alpha level for the linear regression analysis is set at 0.05. P values generated by the analysis are then compared to the alpha level. P values less than the alpha value suggest a trend in the data.

The Mann-Kendall test for correlation is performed on data that are not normally or log-normally distributed. No assumptions need to be made about the distribution of the data in order to perform the Mann-Kendall test (Helsel and Hirsch 2002). The null hypothesis is the same as the linear regression test above in that there is no trend in the data. The alpha level will be kept the same at 0.05 although the Mann-Kendall test computes a P value for a two-tailed prediction interval. As such, the alpha levels are actually 0.025 or 0.975. A P value that is smaller than 0.025 or larger than 0.975 suggests a correlation between the change in constituent concentration and time.

14.13.3 Total Toxic Equivalent Concentrations of cPAHs

During YTC's 5-year review conducted by USACE in 2011, it was noted that the updated 2007 Groundwater Monitoring Plan stated that total carcinogenic PAHs (cPAHs) would be evaluated for the FTP using the total toxic equivalent concentrations of benzo(a)pyrene, as outlined in WAC Chapter 173-340-708(8)(e). Concentrations of cPAHs, which include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, are to be reported by the analytical laboratory. The measured concentration of each cPAH is then multiplied by its corresponding toxicity equivalency factor (TEF), provided in Table 708-2 (WAC Chapter 173-340-900), to obtain the toxic equivalent concentration (TEC) of benzo(a)pyrene for that cPAH. For each sample analyzed, the TECs for each cPAH are then summed to obtain the total toxic equivalent concentration (TTEC) of benzo(a)pyrene for that sample. If a cPAH result is not detected, a TEC is not calculated.

The TTEC result is compared to the applicable compliance monitoring requirements in WAC Chapter 173-340-720, Groundwater Cleanup Standards, to determine if the TTEC of the samples comply with the cleanup level for the mixture. If the TTEC for the six cPAHs listed above is equal to or greater than MTCA Method A cleanup of 0.1 µg/L for benzo(a)pyrene, then the results for cPAHs are above the MTCA Method A cleanup level of 0.1 µg/L.

14.14 Assessment/Audit Tasks

SOPs will be reviewed prior to the performance of tasks. Technical system audits will be performed as required (Worksheets #31, #32, and #33 of the Programmatic UFP-QAPP, EA 2018b). Independent technical review and deliverable checks will be performed to assess the quality of field and reporting tasks. The project development team will perform interdisciplinary checks to ensure minimal interference between tasks. The EA Project Manager will be responsible for responding to the assessment findings, including CAs.

The Laboratory QA Manager will conduct assessments of the laboratory procedures and data as described in the laboratory's QA Manual.

14.15 Reporting and Evaluation Tasks

A data package will be generated for this project by the analytical laboratory and will include a case narrative, chain-of-custody record, QC summary data, sample results, standards data, raw QC data, and bench sheets for each analytical method.

Annual groundwater monitoring reports will be prepared to document groundwater monitoring activities and summarize analytical data for the former FTP site and TVR/Old MATES. The reports will be consistent in content and format with prior summary reports. Each report will include:

- Brief site chronology
- Brief discussion of sampling methodology including any deviations from the planning documents
- Site maps for each groundwater sampling event showing relevant surface features, sampling locations, the estimated potentiometric surface contours based on measurements

obtained during each sampling event, and contaminant concentrations obtained during the groundwater monitoring event

- A summary table of historical and recent contaminant concentrations and comparison with screening criteria presented in Worksheet #15
- Statistical summary of key analytes detected in monitoring well FTP-1 and multiple monitoring wells for TVR Old/MATES
- Plots showing key contaminant concentrations over time. Previous reports have only included plots for FTP-1, as this the most impacted well at the site and the only well with TPH-G, TPH-D, and TPH-O concentrations above the MTCA cleanup levels of 800, 500, and 500 µg/L, respectively.
- Copies of original field forms
- Laboratory reports of analysis with chain-of-custody records
- A brief discussion of the QA/QC review and verification process including implications for project data
- A summary of the results and conclusions.

14.16 Project Schedule

The project schedule for the first year of sampling is presented in Table 14-1 below.

Table 14-1 Project Schedule

Activity	Responsible Party	Frequency	Deliverable(s)	Completion Date
PDB installation (TVR/Old MATES only)	EA	Semiannually during the first quarter and third quarter[a]	Not applicable	Not applicable
Groundwater monitoring (former FTP and TVR/Old MATES)	EA	Semiannually first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., September)	Draft Annual Groundwater Monitoring Report	45 days after receipt of analytical data
			Draft Final Annual Groundwater Monitoring Report	14 days after receipt of comments on the Draft Annual Groundwater Monitoring Report
			Final Annual Groundwater Monitoring Report	14 days after receipt of comments on the Draft Final Annual Groundwater Monitoring Report

a. PDB samplers in wells sampled semiannually will be installed during each sampling event to be sampled at the following semiannual sampling event. PDB samplers in wells sampled annually during the first quarter will be installed during in the previous third quarter.

Worksheet #15: Project Screening Levels and Laboratory-Specific Detection Limits

Analytical methods, analytes, screening criteria, and achievable laboratory limits including LOQs, LODs, and DLs are presented in Table 15-1. Matrix effects or necessary dilutions may affect the laboratory limits actually reported for project samples. Project Action Limits (PALs) that have been shaded are less than the associated LOQ, LOD, and DL.

The DL is the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99 percent level of confidence. Although a result at or above the DL indicates that the analyte is present, the absence of a result at or above the DL is inconclusive (i.e., one cannot confidently state whether the analyte is present or absent), because the false negative rate at the DL is 50 percent. The DL shall be used to determine the LOD for each analyte and matrix as well as for all preparatory and cleanup methods routinely used on samples.

The LOD is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a 99 percent confidence level. If a sample has a true concentration at the LOD, there is a minimum probability of 99 percent of reporting a “detection” (a measured value greater than or equal to the DL) and a 1 percent chance of reporting a non-detect (a false negative). Due to the false negative rate at the LOD (1 percent), the laboratory will report non-detectable values as less than the LOD.

The LOQ is the lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias. The LOQ is typically larger than the LOD (but may be equal to the LOD, depending upon the acceptance limits for precision and bias). Quantitative concentration results within specified limits of precision and bias can only be achieved at or above the LOQ; however, the analytical laboratory may identify analytes between the DL and the LOQ. In these instances, the laboratory will report concentration values between the DL and the LOQ as estimated values.

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Table 15-1 Reference Limits and Project Screening Levels

Analyte	Analytical Method	CASRN	Units	MTCA Method A MCL [(a)]	PAL [(b)]	Laboratory Limits		
						LOQ	LOD	DL
Total Petroleum Hydrocarbons								
TPH as Gasoline Range (TPH-G)	NWTPH-Gx	NS	µg/L	800	800	250	25	12
TPH as Diesel Range (TPH-D)	NWTPH-Dx	NS	µg/L	500	500	110	22	12
TPH as Heavy Oil Range (TPH-O)	NWTPH-Dx	NS	µg/L	500	500	110	55	21
Volatile Organic Compounds								
Acetone	SW8260C	67-64-1	µg/L	NS	NS	20	10	3.3
Benzene	SW8260C	71-43-2	µg/L	5.0	5.0	0.50	0.10	0.062
Bromobenzene	SW8260C	108-86-1	µg/L	NS	NS	2.0	0.20	0.12
Bromochloromethane	SW8260C	74-97-5	µg/L	NS	NS	0.50	0.20	0.16
Bromodichloromethane	SW8260C	75-27-4	µg/L	NS	NS	0.50	0.30	0.091
Bromoform	SW8260C	75-25-2	µg/L	NS	NS	0.50	0.50	0.16
Bromomethane (Methyl bromide)	SW8260C	74-83-9	µg/L	NS	NS	0.50	0.30	0.10
2-Butanone (Methyl ethyl ketone)	SW8260C	78-93-3	µg/L	NS	NS	20	4.0	1.9
n-Butylbenzene	SW8260C	104-51-8	µg/L	NS	NS	2.0	0.10	0.054
sec-Butylbenzene	SW8260C	135-98-8	µg/L	NS	NS	2.0	0.10	0.062
t-Butylbenzene	SW8260C	98-06-6	µg/L	NS	NS	2.0	0.20	0.059
Carbon disulfide	SW8260C	75-15-0	µg/L	NS	NS	0.50	0.20	0.069
Carbon tetrachloride	SW8260C	56-23-5	µg/L	NS	NS	0.50	0.20	0.10
Chlorobenzene	SW8260C	108-90-7	µg/L	NS	NS	0.50	0.20	0.11
Chloroethane (Ethyl chloride)	SW8260C	75-00-3	µg/L	NS	NS	0.50	0.20	0.16
Chloroform	SW8260C	67-66-3	µg/L	NS	NS	0.50	0.20	0.072
Chloromethane (Methyl chloride)	SW8260C	74-87-3	µg/L	NS	NS	0.50	0.20	0.068
2-Chlorotoluene	SW8260C	95-49-8	µg/L	NS	NS	2.0	0.20	0.10
4-Chlorotoluene	SW8260C	106-43-4	µg/L	NS	NS	2.0	0.30	0.13
1,2-Dibromo-3-chloropropane (DBCP)	SW8260C	96-12-8	µg/L	NS	NS	2.0	0.80	0.20
Dibromochloromethane (Chlorodibromomethane)	SW8260C	124-48-1	µg/L	NS	NS	0.50	0.50	0.14
1,2-Dibromoethane (Ethylene dibromide [EDB])	SW8260C	106-93-4	µg/L	0.010	0.010	2.0	0.20	0.10
Dibromomethane (Methylene bromide)	SW8260C	74-95-3	µg/L	NS	NS	0.50	0.50	0.15
1,2-Dichlorobenzene	SW8260C	95-50-1	µg/L	NS	NS	0.50	0.20	0.12
1,3-Dichlorobenzene	SW8260C	541-73-1	µg/L	NS	NS	0.50	0.20	0.10

Analyte	Analytical Method	CASRN	Units	MTCA Method A MCL [(a)]	PAL [(b)]	Laboratory Limits		
						LOQ	LOD	DL
1,4-Dichlorobenzene	SW8260C	106-46-7	µg/L	NS	NS	0.50	0.20	0.12
Dichlorodifluoromethane	SW8260C	75-71-8	µg/L	NS	NS	0.50	0.20	0.13
1,1-Dichloroethane	SW8260C	75-34-3	µg/L	NS	NS	0.50	0.20	0.077
1,2-Dichloroethane	SW8260C	107-06-2	µg/L	5.0	5.0	0.50	0.15	0.080
1,1-Dichloroethene	SW8260C	75-35-4	µg/L	NS	NS	0.50	0.20	0.080
1,2-Dichloroethene (cis)	SW8260C	156-59-2	µg/L	NS	NS	0.50	0.20	0.067
1,2-Dichloroethene (trans)	SW8260C	156-60-5	µg/L	NS	NS	0.50	0.20	0.072
1,2-Dichloropropane	SW8260C	78-87-5	µg/L	NS	NS	0.50	0.20	0.10
1,3-Dichloropropane	SW8260C	142-28-9	µg/L	NS	NS	0.50	0.30	0.14
2,2-Dichloropropane	SW8260C	594-20-7	µg/L	NS	NS	0.50	0.20	0.060
1,1-Dichloropropene	SW8260C	563-58-6	µg/L	NS	NS	0.50	0.20	0.089
1,3-Dichloropropene (cis)	SW8260C	10061-01-5	µg/L	NS	NS	0.50	0.20	0.18
1,3-Dichloropropene (trans)	SW8260C	10061-02-6	µg/L	NS	NS	0.50	0.20	0.068
1,3-Dichloropropene (total)	SW8260C	542-75-6	µg/L	NS	NS	1.0	0.40	0.25
Ethylbenzene	SW8260C	100-41-4	µg/L	700	700	0.50	0.10	0.050
Hexachlorobutadiene	SW8260C	87-68-3	µg/L	NS	NS	2.0	0.30	0.11
2-Hexanone	SW8260C	591-78-6	µg/L	NS	NS	20	10	2.7
Isopropylbenzene (Cumene)	SW8260C	98-82-8	µg/L	NS	NS	2.0	0.20	0.051
4-Methyl-2-pentanone (Methyl isobutyl ketone)	SW8260C	108-10-1	µg/L	NS	NS	20	10	2.6
Methylene chloride	SW8260C	75-09-2	µg/L	5.0	5.0	2.0	0.20	0.10
n-Propylbenzene	SW8260C	103-65-1	µg/L	NS	NS	2.0	0.20	0.054
Styrene	SW8260C	100-42-5	µg/L	NS	NS	0.50	0.20	0.089
1,1,1,2-Tetrachloroethane	SW8260C	630-20-6	µg/L	NS	NS	0.50	0.20	0.11
1,1,2,2-Tetrachloroethane	SW8260C	79-34-5	µg/L	NS	NS	0.50	0.20	0.16
Tetrachloroethene (PCE)	SW8260C	127-18-4	µg/L	5.0	5.0	0.50	0.20	0.10
Toluene	SW8260C	108-88-3	µg/L	1,000	1,000	0.50	0.10	0.054
1,2,3-Trichlorobenzene	SW8260C	87-61-6	µg/L	NS	NS	2.0	0.40	0.11
1,2,4-Trichlorobenzene	SW8260C	120-82-1	µg/L	NS	NS	2.0	0.30	0.10
1,1,1-Trichloroethane	SW8260C	71-55-6	µg/L	200	200	0.50	0.20	0.075
1,1,2-Trichloroethane	SW8260C	79-00-5	µg/L	NS	NS	0.50	0.40	0.14
Trichloroethene (TCE)	SW8260C	79-01-6	µg/L	5.0	5.0	0.50	0.10	0.10
Trichlorofluoromethane	SW8260C	75-69-4	µg/L	NS	NS	0.50	0.20	0.12
1,2,3-Trichloropropane	SW8260C	96-18-4	µg/L	NS	NS	0.50	0.50	0.20

Analyte	Analytical Method	CASRN	Units	MTCA Method A MCL [(a)]	PAL [(b)]	Laboratory Limits		
						LOQ	LOD	DL
1,2,4-Trimethylbenzene	SW8260C	95-63-6	µg/L	NS	NS	2.0	0.20	0.069
1,3,5-Trimethylbenzene	SW8260C	108-67-8	µg/L	NS	NS	2.0	0.20	0.089
Vinyl chloride	SW8260C	75-01-4	µg/L	0.020	0.020	0.50	0.10	0.075
m- & p-Xylenes	SW8260C	179601-23-1	µg/L	NS	NS	0.50	0.20	0.11
o-Xylene	SW8260C	95-47-6	µg/L	NS	NS	0.50	0.20	0.074
Xylenes (total)	SW8260C	1330-20-7	µg/L	1,000	1,000	1.0	0.40	0.18
Polycyclic Aromatic Hydrocarbons								
Acenaphthene	SW8270D SIM	83-32-9	µg/L	NS	NS	0.020	0.0050	0.0044
Acenaphthylene	SW8270D SIM	208-96-8	µg/L	NS	NS	0.020	0.0050	0.0034
Anthracene	SW8270D SIM	120-12-7	µg/L	NS	NS	0.020	0.0050	0.0036
Benzo(a)anthracene	SW8270D SIM	56-55-3	µg/L	NS	NS	0.020	0.0050	0.0026
Benzo(b)fluoranthene	SW8270D SIM	205-99-2	µg/L	NS	NS	0.020	0.0050	0.0041
Benzo(k)fluoranthene	SW8270D SIM	207-08-9	µg/L	NS	NS	0.020	0.0050	0.0030
Benzo(g,h,i)perylene	SW8270D SIM	191-24-2	µg/L	NS	NS	0.020	0.0050	0.0029
Benzo(a)pyrene	SW8270D SIM	50-32-8	µg/L	0.10	0.10	0.020	0.0050	0.0043
Chrysene	SW8270D SIM	218-01-9	µg/L	NS	NS	0.020	0.0050	0.0034
Dibenz(a,h)anthracene	SW8270D SIM	53-70-3	µg/L	NS	NS	0.020	0.0050	0.0025
Fluoranthene	SW8270D SIM	206-44-0	µg/L	NS	NS	0.020	0.020	0.010
Fluorene	SW8270D SIM	86-73-7	µg/L	NS	NS	0.020	0.0050	0.0038
Indeno(1,2,3-cd)pyrene	SW8270D SIM	193-39-5	µg/L	NS	NS	0.020	0.0050	0.0026
1-Methylnaphthalene	SW8270D SIM	90-12-0	µg/L	160	160	0.020	0.0050	0.0035
2-Methylnaphthalene	SW8270D SIM	91-57-6	µg/L	160	160	0.020	0.0050	0.0023
Naphthalene	SW8270D SIM	91-20-3	µg/L	160	160	0.020	0.0050	0.0038
Phenanthrene	SW8270D SIM	85-01-8	µg/L	NS	NS	0.020	0.0050	0.0050
Pyrene	SW8270D SIM	129-00-0	µg/L	NS	NS	0.020	0.010	0.0053
Semivolatile Organic Compounds								
Benzoic acid	SW8270C	65-85-0	µg/L	NS	NS	25	25	5.8
Benzyl alcohol	SW8270C	100-51-6	µg/L	NS	NS	10	0.50	0.38
Bis(2-chloroethoxy)methane	SW8270C	111-91-1	µg/L	NS	NS	10	0.50	0.28
Bis(2-chloroethyl)ether	SW8270C	111-44-4	µg/L	NS	NS	10	0.50	0.33
Bis(2-chloroisopropyl) ether	SW8270C	108-60-1	µg/L	NS	NS	10	0.50	0.31
Bis(2-ethylhexyl) phthalate	SW8270C	117-81-7	µg/L	NS	NS	10	2.0	1.9

Analyte	Analytical Method	CASRN	Units	MTCA Method A MCL [(a)]	PAL [(b)]	Laboratory Limits		
						LOQ	LOD	DL
4-Bromophenyl phenyl ether	SW8270C	101-55-3	µg/L	NS	NS	10	0.50	0.27
Butyl benzyl phthalate	SW8270C	85-68-7	µg/L	NS	NS	10	0.50	0.47
Carbazole	SW8270C	86-74-8	µg/L	NS	NS	10	0.50	0.29
4-Chloro-3-methylphenol	SW8270C	59-50-7	µg/L	NS	NS	10	0.50	0.49
4-Chloroaniline	SW8270C	106-47-8	µg/L	NS	NS	10	2.0	0.38
2-Chloronaphthalene	SW8270C	91-58-7	µg/L	NS	NS	10	0.50	0.29
2-Chlorophenol	SW8270C	95-57-8	µg/L	NS	NS	10	0.50	0.31
4-Chlorophenyl phenyl ether	SW8270C	7005-72-3	µg/L	NS	NS	10	0.50	0.28
Dibenzofuran	SW8270C	132-64-9	µg/L	NS	NS	10	0.50	0.33
3,3'-Dichlorobenzidine	SW8270C	91-94-1	µg/L	NS	NS	25	2.0	0.27
2,4-Dichlorophenol	SW8270C	120-83-2	µg/L	NS	NS	10	0.50	0.27
Diethyl phthalate	SW8270C	84-66-2	µg/L	NS	NS	10	0.50	0.29
2,4-Dimethylphenol	SW8270C	105-67-9	µg/L	NS	NS	25	25	0.26
4,6-Dinitro-2-methylphenol	SW8270C	534-52-1	µg/L	NS	NS	25	10	2.1
2,4-Dinitrophenol	SW8270C	51-28-5	µg/L	NS	NS	10	2.2	1.0
2,4-Dinitrotoluene	SW8270C	121-14-2	µg/L	NS	NS	10	0.50	0.51
2,6-Dinitrotoluene	SW8270C	606-20-2	µg/L	NS	NS	10	0.50	0.35
Dimethyl phthalate	SW8270C	131-11-3	µg/L	NS	NS	10	2.0	0.25
Di-n-butyl phthalate	SW8270C	84-74-2	µg/L	NS	NS	10	0.65	0.65
Di-n-octyl phthalate	SW8270C	117-84-0	µg/L	NS	NS	10	0.63	0.63
Hexachlorobenzene	SW8270C	118-74-1	µg/L	NS	NS	10	0.50	0.36
Hexachlorocyclopentadiene	SW8270C	77-47-4	µg/L	NS	NS	10	25	1.2
Hexachloroethane	SW8270C	67-72-1	µg/L	NS	NS	10	2.0	0.29
Isophorone	SW8270C	78-59-1	µg/L	NS	NS	10	1.0	0.25
2-Methylphenol	SW8270C	95-48-7	µg/L	NS	NS	10	0.50	0.33
3- & 4-Methylphenols	SW8270C	15831-10-4	µg/L	NS	NS	10	0.50	0.48
2-Nitroaniline	SW8270C	88-74-4	µg/L	NS	NS	25	0.50	0.34
4-Nitroaniline	SW8270C	100-01-6	µg/L	NS	NS	25	4.0	4.0
Nitrobenzene	SW8270C	98-95-3	µg/L	NS	NS	10	1.0	0.57
2-Nitrophenol	SW8270C	88-75-5	µg/L	NS	NS	10	0.50	0.37
4-Nitrophenol	SW8270C	100-02-7	µg/L	NS	NS	25	10	1.9
N-Nitrosodimethylamine	SW8270C	62-75-9	µg/L	NS	NS	25	5.0	0.48
N-Nitrosodi-n-propylamine	SW8270C	621-64-7	µg/L	NS	NS	10	2.0	0.50

Analyte	Analytical Method	CASRN	Units	MTCA Method A MCL [(a)]	PAL [(b)]	Laboratory Limits		
						LOQ	LOD	DL
N-Nitrosodiphenylamine	SW8270C	86-30-6	µg/L	NS	NS	10	0.50	0.48
Pentachlorophenol	SW8270C	87-86-5	µg/L	NS	NS	25	5.0	2.4
Phenol	SW8270C	108-95-2	µg/L	NS	NS	10	0.50	0.32
1,2,4-Trichlorobenzene	SW8270C	120-82-1	µg/L	NS	NS	10	2.0	0.30
2,4,5-Trichlorophenol	SW8270C	95-95-4	µg/L	NS	NS	15	7.5	0.38
2,4,6-Trichlorophenol	SW8270C	88-06-2	µg/L	NS	NS	10	0.50	0.20
3-Nitroaniline	SW8270C	99-09-2	µg/L	NS	NS	25	3.3	1.0

a. MTCA Method A MCL from Washington Administrative Code Chapter 173-340-900, Table 720-1 Method A Cleanup Levels for Groundwater (Washington State Legislature October 2007).

b. PALs refer to the lowest applicable screening level.

NOTES:
- µg/L = Microgram(s) per liter.
- CASRN = Chemical Abstracts Service Registry Number.
- DL = Detection limit.
- LOD = Limit of detection.
- LOQ = Limit of quantitation.
- MCL = Maximum Contaminant Level.
- MTCA = Model Toxics Control Act.
- PAL = Project action level.

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Worksheet #17: Sample Design and Rationale

This worksheet documents the overall process for the design and rationale of the field testing, analytical sampling, and field monitoring to be conducted for data collection and data evaluation purposes.

Describe and provide a rationale for choosing the sampling approach:

The groundwater monitoring is conducted under the LUC and LTM remedies for the former FTP site and TVR/Old MATES. Groundwater monitoring activities include the collection and laboratory analysis of groundwater samples from existing monitoring wells and currently active water supply wells.

Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations, numbers of samples to be taken, and sampling frequency.

The number of samples to be taken, sampling frequencies, and rationale are described below. Sampling data needs are presented in Tables 17-1 and 17-2. Sampling locations and frequencies are presented in Worksheet #18.

- Groundwater elevations in the first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., September) at five monitoring wells at the former FTP site (FTP-1, FTP-13, FTP-14, FTP-15, and FTP-16)

- Semiannual sampling in the first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., September) at four monitoring wells at the former FTP site (FTP-1, FTP-14, FTP-15, and FTP-16). Each monitoring well scheduled for sampling will be analyzed for TPH-G, TPH-D, and TPH-O. In addition, well FTP-1 will be analyzed for VOCs and SVOCs.

- Groundwater elevations in the first quarter (spring/wet season i.e., March) and third quarter (fall/dry season i.e., September) at 12 monitoring wells at the TVR/Old MATES (MTS-1, MTS-2, MTS-3, MTS-4, TVR-1, TVR-2, TVR-3, TVR-5, TVR-6, TVR-7, 815-2, and MMP-1)

- Semiannual sampling in the first quarter (spring/wet season i.e., March) at 11 monitoring wells at the TVR/Old MATES (MTS-1, MTS-2, MTS-4, TVR-1, TVR-2, TVR-3, TVR-5, TVR-6, TVR-7, 815-2, and MMP-1) and two currently active water supply wells (Pomona Well and PAIC Well). Samples will be analyzed for VOCs.

- Semiannual sampling in the third quarter (fall/dry season i.e., September) at nine monitoring wells at TVR/Old MATES (MTS-1, MTS-2, MTS-4, TVR-1, TVR-3, TVR-5, TVR-6, TVR-7, and 815-2) and two currently active water supply wells (Pomona Well and PAIC Well). Samples will be analyzed for VOCs.

Field methodologies will be consistent with the SOPs listed in Worksheet #21 and included in Appendix A of the Programmatic UFP-QAPP (EA 2018b). Field activities will be conducted in accordance with the APP (EA 2018a). A dedicated field logbook will be maintained for site activities in accordance with SOP 059. Field forms will be used during onsite work (Appendix B of the Programmatic UFP-QAPP). Photographs will be taken to document field activities, as appropriate.

If the field conditions encountered during the environmental remediation program services warrant changes to the field tasks or monitoring plans, the EA Field Team Leader and/or QC Manager will notify the EA Project Manager immediately upon discovery. Field changes will be communicated as presented in Worksheet #6 of the Programmatic UFP-QAPP (EA 2018b). Specifically, once notified, the EA Project Manager will notify the USACE-Seattle City District Project Manager within 24 hours verbally or via email. Based on a review of the proposed change, and if required by the USACE, a field change request memorandum will be submitted within 1 week to the USACE Project Manager for review and approval. It should be noted that unanticipated field changes may require a UFP-QAPP addendum, amendment, and/or revision. This requirement will be determined in consultation with the USACE Project Manager following notification of the proposed change. If required, the UFP-QAPP addendum, amendment, and/or revision will be submitted to the USACE, JBLM, and regulators for review, comment, and approval.

Table 17-1 Data Needs for Monitoring: Former Fire Training Pit

Well ID	Location	Parameter	Equipment and/or Method	Rationale for Analysis and Data Use
FTP-1	150 ft topographically and hydraulically downgradient/southwest of the former FTP	Groundwater elevations	Electronic water level indicator	Long-term monitoring in accordance with the 2007 Decision Document (Fort Lewis Environmental Restoration Program 2007a).
		VOCs, SVOCs, TPH-G, TPH-D, and TPH-O	Grundfos® Redi-Flo2 pump with variable frequency drive controller; USEPA Method 8260C, USEPA Method 8270C, Method NWTPH-Gx, Method NWTPH-Dx	
FTP-13	Approximately 230 ft southeast of the former FTP	Groundwater elevations	Electronic water level indicator	
FTP-14	Approximately 190 ft west-southwest of FTP-1 and 150 ft south-southwest of FTP-15	Groundwater elevations	Electronic water level indicator	
		TPH-G, TPH-D, and TPH-O	Grundfos® Redi-Flo2 pump with variable frequency drive controller; USEPA Method 8260C, USEPA Method 8270C, Method MWTPH-G, Method NWTPH-Dx	
FTP-15	Approximately 220 ft west of the former FTP	Groundwater elevations	Electronic water level indicator	
		TPH-G, TPH-D, and TPH-O	Grundfos® Redi-Flo2 pump with variable frequency drive controller; USEPA Method 8260C, USEPA Method 8270C, Method MWTPH-G, Method NWTPH-Dx	
FTP-16	Downgradient of the former FTP approximately 600 ft southwest of FTP-1. Within the east-southeast corner of the New MATES Facility.	Groundwater elevations	Electronic water level indicator	
		TPH-G, TPH-D, and TPH-O	Grundfos® Redi-Flo2 pump with variable frequency drive controller; USEPA Method 8260C, USEPA Method 7270C, Method MWTPH-G, Method NWTPH-Dx	

NOTES:
ft = Feet.
FTP = Fire training pit.
MATES = Mobilization and Training Equipment Site.
NWTPH-Dx = Northwest total petroleum hydrocarbon for diesel range organics.
NWTPH-Gx = Northwest total petroleum hydrocarbon for gasoline range organics.
SOP = Standard operating procedure.
SVOC = Semivolatile organic compound.
TPH-D = Total petroleum hydrocarbons – diesel range.
TPH-G = Total petroleum hydrocarbons – gasoline range.
TPH-O = Total petroleum hydrocarbons – heavy oil range.
USEPA = United States Environmental Protection Agency.
VOCs = Volatile organic compounds.

Table 17-2 Data Needs for Monitoring: Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

Well ID	Location	Parameter	Equipment and/or Method	Rationale for Analysis and Data Use
MTS-1	Within the southern portion of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	Long-term monitoring in accordance with the 2007 Decision Document (Fort Lewis Environmental Restoration Program 2007b).
		VOCs	USEPA Method 8260C	
MTS-2	Within the southern portion of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
MTS-3	East and topographically upgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
MTS-4	South-southwest and adjacent to the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
TVR-1	South-southwest and adjacent to the TVR (Building 845); hydraulically downgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
TVR-2	West and adjacent to the TVR (Building 845); hydraulically downgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
TVR-3	Approximately 300 ft southwest of the TVR (Building 845); hydraulically downgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
TVR-5	Approximately 800 ft west-southwest of the TVR (Building 845); hydraulically downgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
TVR-6	Approximately 500 ft south-southwest of the TVR (Building 845); hydraulically downgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
TVR-7	Approximately 250 ft southwest of the TVR (Building 845); hydraulically downgradient of the Old MATES Facility	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
815-2	Approximately 900 ft northeast of the TVR (Building 845)	Groundwater elevations	Electronic water level indicator	
		VOCs	USEPA Method 8260C	
MMP-1	Northeast and east of Buildings T271, T204, and T205; topographically downgradient of the Old MATES Facility; near the vicinity of the former Marie Well	Groundwater elevations	Electronic water level indicator	
Pomona Well	Adjacent to Cold Creek Road, southwest of the TVR (Building 845) Facility	VOCs	USEPA Method 8260C	
PAIC Well	Adjacent to Cold Creek Road, southwest of the TVR (Building 845) Facility	VOCs	USEPA Method 8260C	

NOTES:
ft = Feet.
MATES = Mobilization and Training Equipment Site.
USEPA = United States Environmental Protection Agency.
TVR = Tracked vehicle repair.
VOCs = Volatile organic compounds.

Worksheet #18: Sample Locations and Methods

Table 18-1 Former Fire Training Pit

Well ID	Date Installed	Northing[(a)]	Easting[(a)]	Ground Surface Elevation (ft AMSL)[(b)]	Elevation at TOC (ft AMSL)[(b)]	Total Depth (ft)	Screen Interval (ft bgs)	First quarter (spring/wet season i.e., March) Sampling Event					Second Quarter (fall/dry season i.e., September) Sampling Event					Methods
								Depth to Water Measured	VOCs	SVOCs	TPH-G	TPH-D and TPH-O	Depth to Water Measured	VOCs	SVOCs	TPH-G	TPH-D and TPH-O	
FTP 1	March 1993	5173198.0	695828.3	1464.59	1467.72	21.0	8-18	X	X	X	X	X	X	X	X	X	X	Water level meter, SOP 010, Bailer, SOP 048
FTP 13	7-Sep-99	5173153.0	695878.5	1470.96	1473.07	25.0	10-20	X	---	---	---	---	X	---	---	---	---	
FTP 14	8-Sep-99	5173185.2	695771.4	1455.35	1457.48	22.0	12-22	X	---	---	X	X	X	---	---	X	X	
FTP 15	9-Sep-99	5173228.9	695783.1	1458.72	1460.88	20.0	10-20	X	---	---	X	X	X	---	---	X	X	
FTP 16	22-Sep-99	5173050.7	695722.0	1442.68	1444.81	30.0	20-30	X	---	---	X	X	X	---	---	X	X	

a. Northing and easting coordinates are in Universal Transverse Mercator (UTM) World Geodetic System of 1984 (WGS84), meters.
b. Vertical values are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

NOTES:
AMSL = Above mean sea level.
bgs = Below ground surface.
ft = feet.
SOP = Standard operating procedure.
SVOC = Semivolatile organic compound.
TOC = Top of casing.
TPH-D = Total petroleum hydrocarbons – diesel range.
TPH-G = Total petroleum hydrocarbons – gasoline range.
TPH-O = Total petroleum hydrocarbons – heavy oil range.
VOC = Volatile organic compounds.

Table 18-2 Tracked Vehicle Repair/Old Mobilization and Training Equipment Site

Well ID	Date Installed	Northing[(a)]	Easting[(a)]	Ground Surface Elevation (ft AMSL)[(b)]	Elevation at TOC (ft AMSL)[(b)]	Total Depth (ft)	Screen Interval (ft bgs)	First quarter (spring/wet season i.e., March) Sampling Event		2nd Quarter PDB Installation	Third Quarter (fall/dry season i.e., September) Sampling Event		4th Quarter PDB Installation	Methods
								Depth to Water Measured	VOCs		Depth to Water Measured	VOCs		
815-2	12-Oct-2005	5172445.5	694687.7	1301.86	1304.28	132.0	115-130	X	X	X	X	X	X	Water level meter, SOP 010, PDB, SOP 013A
MMP-1	2-Mar-1993	5172215.3	694553.4	1298.39	1301.37	100.5	88-98	X	X	---	X	---	X	
MTS-1	24-Feb-1993	5172404.6	695196.9	1359.05	1361.02	127.0	115-125	X	X	X	X	X	X	
MTS-2	25-Feb-1993	5172405.4	695135.9	1348.79	1351.88	113.0	101-111	X	X	X	X	X	X	
MTS-3	27-Oct-2004	5172439.6	695366.1	1362.62	1362.36	72.0	62-72	X	---	---	X	---	---	
MTS-4	28-Oct-2004	5172347.7	695078.6	1332.14	1331.88	97.0	82-97	X	X	X	X	X	X	
TVR-1	25-Feb-1993	5172286.6	694936.0	1317.32	1320.17	105.0	93-103	X	X	X	X	X	X	
TVR-2	26-Feb-1993	5172337.7	694910.0	1314.18	1317.56	95.0	83-93	X	X	---	X	---	X	
TVR-3	29-Oct-2004	5172282.5	694872.9	1310.86	1310.60	158.0	143-158	X	X	X	X	X	X	
TVR-5	185-Oct-2005	5172275.0	694704.2	1299.42	1302.04	142.0	132-142	X	X	X	X	X	X	
TVR-6	20-Oct-2005	5172214.0	694866.4	1310.30	1310.06	139.0	139-149	X	X	X	X	X	X	
TVR-7	22-Oct-2005	5172255.6	694882.5	1311.63	1310.95	140.0	140-150	X	X	X	X	X	X	
Pomona Well	---	---	---	---	---	---	---	---	X	---	---	X	---	Grab sample from tap
PAIC Well	---	---	---	---	---	---	---	---	X	---	---	X	---	

a. Northing and easting coordinates are in Universal Transverse Mercator (UTM) World Geodetic System of 1984 (WGS84), meters.
b. Vertical values are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

NOTES:
AMSL = Above mean sea level.
bgs = Below ground surface.
ft = feet.
PAIC = Pomona Artesian Irrigation Company.
PDB = Passive diffusion bag.
SOP = Standard operating procedure.
VOC = Volatile organic compounds.

Worksheets #19 and 30: Sample Containers, Preservation, and Hold Times

Laboratory: ALS Environmental – Kelso Facility
1317 South 13th Avenue, Kelso, Washington 98626
Contact: Kurt Clarkson (Project Manager)
kurt.clarkson@alsglobal.com
Phone (360) 501-3356

List Required Accreditations/Certifications: DoD ELAP Certificate Number (No.) L16-58-R3 and Scope of Testing Ecology Laboratory ID C544 (valid to 8 July 2019) (presented in Appendix C of the Programmatic UFP-QAPP, EA 2018b)

Sample Delivery Method: Hand delivery or overnight shipping via Federal Express or United Parcel Service.

Analyte/ Group	Matrix	Method	Container(s) (number, size, and type per sample) [(a)]	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
VOC	Water	SW8260C	Three 40-mL VOA vials with Teflon®-lined septum cap	Cool to ≤6°C	Not applicable	14 days from sample collection until analysis	15 working days
SVOC	Water	SW8270C	Two 500-mL amber glass jars	pH ≤2 with hydrochloric acid (HCl); cool to ≤6°C	14 days from sample collection until extraction	40 days from extraction until analysis	15 working days
TPH-G	Water	NWTPH-Gx	Three 40-mL VOA vials with Teflon®-lined septum cap	pH ≤2 with HCl; cool to ≤6°C	Not applicable	14 days from sample collection until analysis	15 working days
TPH-D/ TPH-O	Water	NWTPH-Dx	Two 500-mL amber glass jars	pH ≤2 with HCl; cool to ≤6°C	14 days from sample collection until extraction	40 days from extraction until analysis	15 working days

a. For locations requiring MS/MSD samples, triplicate volume (three sets of bottles) will be collected, if possible.

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Worksheet #20: Field Quality Control Summary

Matrix	Analytical Group	No. of Samples[a]	No. of Field Duplicates [b]	Number of Matrix Spike/Matrix Spike Duplicate Pairs[c]	Number of Trip Blanks[d]	Number of Equipment Blanks[e]
Former Fire Training Pit Site First Quarter (Spring/Wet Season i.e., March) Sampling Event						
Groundwater	VOCs	4	1	1	1	1
Groundwater	SVOCs	4	1	1	0	1
Groundwater	TPH-G	4	1	1	1	1
Groundwater	TPH-D and TPH-O	4	1	1	0	1
Former Fire Training Pit Site Third Quarter (Fall/Dry Season i.e., September) Sampling Event						
Groundwater	VOCs	4	0	1	1	1
Groundwater	SVOCs	4	0	1	0	1
Groundwater	TPH-G	4	0	1	1	1
Groundwater	TPH-D and TPH-O	4	0	1	0	1
Tracked Vehicle Repair/Old Mobilization and Training Equipment Site First Quarter (Spring/Wet Season i.e., March) Sampling Event						
Groundwater	VOCs	10	1	1	1	0
Tracked Vehicle Repair/Old Mobilization and Training Equipment Site Third Quarter (Fall/Dry Season i.e., September) Sampling Event						
Groundwater	VOCs	10	1	1	1	0

a. Standard non-quality control field samples per sampling event. Sample numbers listed are anticipated but may depend on sample recovery. See Worksheet #18 for more detail regarding sample numbers.
b. One field duplicate will be collected annually at the FTP site. One field duplicate sample will be collected per sampling event at TVR/Old MATES.
c. MS/MSD samples will be collected at each site at a rate of 5 percent of project samples (1 set per 20 field samples). MS/MSD pairs require extra volume (i.e., triple volume for each analysis). These will be collected in separate containers; however, because they are not separate samples, they are not included in the total number of samples. Note that only one MS/MSD sample pair will be collected per analyte between the sites per event.
d. Trip blanks will be shipped at a rate of 1 per cooler containing aqueous samples for VOC analysis.
e. Minimum 1 equipment blank per analyte per day.

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Worksheet #21: Field Standard Operating Procedures

SOP Reference Number	Responsible Organization	Title, Revision Date and/or Number	Equipment Type or Instrument	Comments
SOP 001	EA	SOP for Sample Labels, Revision 0, December 2014	Sample labels.	Field SOPs are provided in Appendix A of the Programmatic UFP-QAPP.
SOP 002	EA	SOP for Chain-of-Custody Form, Revision 0, December 2014	Chain-of-custody record.	
SOP 004	EA	SOP for Sampling Packing and Shipping, Revision 0, December 2014	Coolers and shipping materials (bags, tape, ice).	
SOP 005	EA	SOP for Field Decontamination, Revision 1, December 2014	Potable water and cleaning agents, field logbook and field forms.	
SOP 010	EA	SOP for Water Level and Well Depth Measurements, Revision 0, December 2014	Solinst Model 101 water level meter or similar and/or interface probe, field logbook and field forms	
SOP 013	EA	SOP for Monitoring Well Sample Collection, Revision 0, December 2014	Various, including but not limited to: Horiba® U-52 water quality probe, water level meter, pump, field logbook and field parameter forms, plastic sheeting, polypropylene rope, sample bottles, and labels.	
SOP 013A	EA	SOP for Groundwater Sampling with Passive Diffusion Bags	Passive diffusion bag, field logbook and field forms, sample bottles, and labels.	
SOP 016	EA	SOP for Surface Water, Groundwater, and /Soil/Sediment Field Logbooks, Revision 0, December 2014	Log books and appropriate field forms.	
SOP 039	EA	SOP for Sample Preservation and Container Requirements, Revision 1, December 2014	Sampling supplies from laboratory.	
SOP 042	EA	SOP for Disposal of Investigation-Derived Materials, Revision 1, December 2014	Containers for investigation-derived materials, field logbook and field forms.	
SOP 048	EA	SOP for Low-Flow Sampling, Revision 0, December 2014	Adjustable rate, positive displacement groundwater sampling pump, interface probe or equivalent, field logbook and field forms.	
SOP 059	EA	SOP for Field Logbook, Revision 1, December 2014	Field logbook.	

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Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[a]
Electronic Water Level Indicator	None	Decontaminate between wells	Field test in accordance with the manual	Inspect tape for kinks and cuts, inspect probe for dirt, check batteries	Daily	Response	Replace battery if no response during test button check. If battery replacement does not correct problem, replace.	Field personnel	SOP 010
Grundfos® Pump	None	None	Field checks per manual	Inspect for external damage	Daily	Pumping at required flow pressure and rate for sample recovery	Operator correction or return to manufacturer	Field personnel	Equipment manual

a. Field SOPs are provided in Appendix A of the Programmatic UFP-QAPP. Calibration logs are provided in Appendix B of the Programmatic UFP-QAPP.

The Field Team Leader will be responsible for ensuring that these instruments are calibrated before each field-sampling event. Field equipment must be inspected and calibrated before use according to the criteria given in the referenced SOPs. If problems occur with field instruments or equipment that cannot be resolved by the field team personnel, they should contact the Field Team Leader. If field equipment fails inspection, it is the Field Team Leader’s responsibility to investigate and resolve the problem. The Equipment Facility Manager can also be contacted by the field crew or the field team leader to help resolve problems with field equipment and supply or obtain any spare or replacement parts or equipment.

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Worksheets #23 through 37: Presented in Programmatic Quality Assurance Project Plan

Worksheets #23 through #37 cover various aspects of the analytical and data quality management program and are presented in the Programmatic UFP-QAPP (EA 2018b).

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