Camp Bonneville
Sampling and Quality Assurance Plan

Vancouver, Washington

Technical Direction Document Number: 10-03-0010 and 11-02-0010

May 2011

Prepared for:
United States Environmental Protection Agency
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SAMPLING AND QUALITY ASSURANCE PLAN FOR:

Camp Bonneville
Vancouver, Washington

Contract Number: EP-S7-06-02
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List of Abbreviations and Acronyms

Acronym	Definition
µm	micrometer
1,1,1-TCA	1,1,1-trichloroethane
1,1-DCE	1,1-dichloroethene
AEM	Atlanta Environmental Management, Inc.
amsl	above mean sea level
AP/PA	ammonium picrate/picric acid
AST	Aboveground Storage Tank
ATSDR	Agency for Toxic Substances and Disease Registry
Baker	Michael Baker Jr. Inc.
BCRRT	Bonneville Conservation Restoration and Renewal Team LLC
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAP	Cleanup Action Plan
CCC	Civilian Conservation Corps
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
cfs	cubic feet per second
CITA	Central Impact Target Area
CLP	Contract Laboratory Program
CMA	U.S. Army Chemical Materials Agency
CMTC	Citizens Military Training Camp
COCs	Constituents of Concern
COPCs	Chemicals of Potential Concern
Corps	United States Army Corps of Engineers
CS	2-chlorobenzalmalononitrile (aka tear gas)
CVF	Central Valley Floor
DA	Demolition Area
DNR	Washington State Department of Natural Resources
DOC	Dissolved Organic Carbon, United States Department of Commerce
DOD	United States Department of Defense
DQI	Data Quality Indicator
DQO	Data Quality Objective
E & E	Ecology and Environment, Inc.
EBS	Environmental Baseline Survey
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ESI	expanded site inspection

List of Abbreviations and Acronyms (cont.)

Acronym	Definition
ESU	Evolutionarily Significant Unit
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FOWP	Field Operations Work Plan
FS	Feasibility Study
GIS	Geographic Information System
GPS	Global Positioning System
GSA	Gary Struthers and Associates, Inc.
HC	Hart Crowser
HE	Hand Grenade
ICs	Institutional Controls
ID	Identification
IDW	Investigation-Derived Waste
LCS	Laboratory Control Sample
LRA	Local Redevelopment Authority
MCL	Maximum Contaminant Level
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MEL	Manchester Environmental Laboratory
MIS	Multi-increment (surface soil sample)
mm	millimeter
MTCA	Model Toxics Control Act
NAD	North American Datum
ng	Nanograms
NRC	National Research Council
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
OB/OD	Open Burn/Open Detonation
OE	Ordnance and Explosive
PA	Preliminary Assessment
PAHs	Polyaromatic Hydrocarbons
Parsons	Parsons Engineering Science, Inc.
PBS	PBS Environmental
PCBs	Polychlorinated Biphenyls
PE	Performance Evaluation
Pentec	Pentec Environmental Inc.
PETN	Pentaerthritol Tetranitrate
PID	Photoionization detector
PO	Project Officer
PPE	Probable point of entry
ppm	parts per million
PRG	Preliminary Remediation Goals
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan

List of Abbreviations and Acronyms (cont.)

Acronym	Definition
QC	Quality Control
QMP	Quality Management Plan
RAU	Remedial Action Unit
RBC	Risk-based Concentration
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
ROTC	Reserved Officer Training Corps
RPC	Reuse Planning Committee
RPD	Relative Percent Difference
RSCC	Regional Sample Control Coordinator
RSF	Range Safety Fan
RWA	Remedial Work Area
SARA	Superfund Amendments and Reauthorization Act
SDMS	Sample Data Management System
SI	Site Inspection
SIS	Sample Information System
SOP	Standard Operating Procedure
SOW	Statement of Work
SPAF	Sample Plan Alteration Form
SQAP	Sampling and Quality Assurance Plan
SSI	Supplemental Site Investigation
START	Superfund Technical Assessment and Response Team
SVOCs	Semivolatile Organic Compounds
SWI	Shannon and Wilson, Inc.
TDD	Technical Direction Document
TDL	Target Distance Limit
TM	Task Monitor
TOC	total organic carbon
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
URS	URS Corporation
USDA	United States Department of Agriculture Soil Conservation Service
USGS	United States Geological Survey
UST	Underground storage tank
UXO	Unexploded Ordnance
VOCs	Volatile Organic Compounds
WAC	Washington Administrative Code
WC	Woodward Clyde Consultants
WDFW	Washington State Department of Fish and Wildlife
WRCC	Western Regional Climate Center

1 Project Management

1.1 Project/Task Organization

This subsection outlines the individuals directly involved with Camp Bonneville and their specific responsibilities. Communication lines are shown in the Project Organization Chart (Figure 1-1).

1.1.1 United States Environmental Protection Agency, Region 10, Task Monitor

The United States Environmental Protection Agency (EPA) Task Monitor (TM) is the overall coordinator of the project and decision maker. The TM reviews and approves the site-specific sampling and quality assurance plan (SQAP) and subsequent revisions in terms of project scope, objectives, and schedules. The TM ensures site-specific SQAP implementation and is the primary point of contact for project problem resolution and has approving authority for the project.

1.1.2 EPA Region 10 Quality Assurance Officer

The EPA Quality Assurance (QA) officer reviews and approves the site-specific SQAP and revisions in terms of QA aspects and may conduct assessments of field activities.

1.1.3 EPA, Region 10, Regional Sample Control Coordinator

The EPA Regional Sample Control Coordinator (RSCC) coordinates sample analyses performed through the EPA Contract Laboratory Program (CLP) or the EPA Region 10 Manchester Environmental Laboratory (MEL) or both and provides sample identification numbers.

1.1.4 Ecology and Environment, Inc. Superfund Technical Assessment and Response Team-3 Project Manager

The Ecology and Environment, Inc. (E & E) Superfund Technical Assessment and Response Team (START)-3 PM provides overall coordination of field work and provides oversight during the preparation of the site-specific SQAP. The PM implements the final approved version of the site-specific SQAP and records any deviations and acts as the primary contact point with the EPA TM. The PM receives CLP/EPA Region 10 laboratory information from the RSCC, acts as primary START-3 point of contact for technical problems, and is responsible for the execution of decisions and courses of action deemed appropriate by the TM. In the absence of the START-3 PM, a START-3 site manager will assume the PM's responsibilities.

1.1.5 E & E START-3 Quality Assurance Officer

The Quality Assurance Officer (QAO) reviews and approves the site-specific SQAP, conducts in-house audits of field operations, and is responsible for auditing and reviewing the field activities and final deliverables and proposing corrective action, if necessary, for nonconformities.

1.1.6 E & E START-3 Program Manager and EPA Project Officer

The Project Officer (PO) is responsible for coordinating resources requested by the TM for this project and for the overall execution of the START-3 program.

1.2 Problem Definition/Background

Pursuant to EPA START-3 Contract Number EP-S7-06-02 and Technical Direction Document (TDD) numbers 10-03-0010 and 11-02-010, E & E will perform a site inspection (SI) at Camp Bonneville, which is located near Vancouver, Washington. The SI will consist of sampling at potential contaminant source and target areas for site characterization purposes. This document outlines the technical and analytical approaches E & E will employ during the SI field work. This document is a combined field operations work plan (FOWP) and site-specific quality assurance project plan (QAPP) for field sampling activities. The combined FOWP/QAPP, hereafter called the SQAP, includes a brief site summary, project objectives, sampling and analytical procedures, and QA requirements that will be used to obtain valid, representative field samples and measurements. The SQAP is intended to be combined with information presented in E & E's (2005a) quality management plan (QMP) for Region 10 START-3. A copy of the QMP is available in E & E's office located at 2101 Fourth Avenue, Suite 1900, Seattle, Washington 98121.

This subsection discusses the site background (subsection 1.2.1), site operations and source characteristics (subsection 1.2.2), and site characterization (subsection 1.2.3).

1.2.1 Site Background

Information presented in this subsection is based on a review of site background information and the preliminary assessment (PA) conducted by E & E.

1.2.1.1 Site Location

Site Name:	Camp Bonneville
CERCLIS ID Number:	WAN001002030
State ID Number	5093080
Site Address:	23201 NE Pluss Road Vancouver, Washington 98682
Latitude:	45° 41' 29.338" North (at center of site)
Longitude:	122° 24' 0.144" West (at center of site)
Legal Description:	Township 3 North, Range 3 East, Sections 34 and 35 Township 2 North, Range 3 East, Sections 1, 2, 3, and 10
County:	Clark
Congressional District:	3

1.2.1.2 Site Description

Camp Bonneville is located in Clark County, approximately 12 miles northeast of Vancouver, Washington (Figure 1-2). Generally, Lacamas Creek flows through the middle of the site with a number of tributaries that feed it. The general topography of the site is flat in the Lacamas Creek Valley, the remainder of the site consists of gently rolling hills. Camp Bonneville is a sub-installation of the Vancouver Barracks (located approximately 12 miles southwest of Camp Bonneville in Vancouver, Washington), which is a sub-installation of Fort Lewis (located approximately 100 miles north of Camp Bonneville in Tacoma, Washington). Camp Bonneville consists of approximately 3,840 acres of land that historically was used by the United States Department of Defense (DOD) to provide training for active Army, Army Reserve, National Guard, Marine Corps Reserve, Navy Reserve, Coast Guard Reserve units, and other DOD personnel. The installation consists of two cantonment areas, Bonneville cantonment and Killpack cantonment, 25 firing ranges, former sewage lagoons, and four historic landfills (Figures 1-3 through 1-5; WC 1997).

Camp Bonneville is located on the western slope of the Cascade Mountains in the Lacamas Creek Valley. The terrain is generally rolling. Elevations range from 289 feet above mean sea level (amsl) in Lacamas Creek at the southwest corner of the site to 1,000 feet amsl at the northwest corner, 1,350 feet amsl at the southeast corner, and 1,452 feet amsl at the south central boundary (WC 1997).

In 1910, the federal government entered into a lease with a purchase option on approximately 3,000 acres of land to use for military training. The lease expired in 1915, and the War Department acquired the land in 1918 by purchase and condemnation. The site was briefly declared surplus in the mod 1940s, but in May 1947, Camp Bonneville was removed from surplus status. In the early 1950s, the Defense Department leased an additional 840 acres from the State of Washington, and in 1957, the federal government returned 20 acres of the overall property to the State of Washington. From 1957 until placement on the Base Realignment and Closure (BRAC) list in 1995, the remaining 3,839 acres remained under the military's jurisdiction (Parsons 2004). Following is a more detailed time-line of uses at Camp Bonneville.

- **Pre-World War II Era:** Troops from Vancouver Barracks began to use the land for a target range in 1910 due to the near-level range floor that was protected from wind by the foothills of the Cascade Mountains. The plateau-valley (350 yards wide by 2,000 yards long) contained the Army's 14 short-range and 7 long-range small arms ranges. The federal government did not own the land at this time but had an option on the property. In 1912, the government obtained another option, but after it expired in 1915, the army began conducting its target practice at an Oregon National Guard range near Clackamas, Oregon. The acquisition of the original reservation (consisting of approximately 3,000 acres) occurred in 1918 by purchase and condemnation. When the Army resumed activities at Camp Bonneville in 1918, the valley contained 24 targets. The installation was officially named Camp Bonneville in 1926. At some point prior to 1929, a machine gun range was added to the training facilities. Camp Bonneville contains two separate cantonment areas. The Camp Bonneville cantonment area was built in the late 1920s and in 1935 the Civilian Conservation Corps (CCC) built and occupied the Camp Killpack cantonment area. These facilities included barracks, kitchens and mess halls, an infirmary, latrines, administration and recreation buildings, and a library. Several organizations other than the garrison at Vancouver Barracks used the facilities at Camp Bonneville. Citizens Military Training Camps (CMTC) and the Reserve Officer Training Corps (ROTC) used the camp. The ROTC program prepared college students for a commission in the army and CMTC exposed high-school-aged males to military discipline and training. (Parsons 2004)
- **World War II Era:** Camp Bonneville continued to be used as a training area for the Vancouver Barracks during World War II. The camp reportedly housed Italian prisoners-of-war during this period. In 1946, the War Department declared the property excess. In May 1947, the military withdrew the camp from surplus citing a continued need for its training facilities. The ranges activated during the World War II era were the 0.22-caliber, 0.30-caliber, and 0.45-caliber small arms ranges.
- **Post World War II (1950s Era):** The army refurbished many of the buildings and systems at the cantonment areas along with the ranges on the installation in 1950. This project was performed in preparation for training by the US Army Reserve units in southern Washington and northern Oregon. During this time, the National Guard and the Marine Corps also expressed an interest in training at Camp Bonneville. In the early 1950s, the Defense Department arranged to lease an additional 840 acres from the State of Washington Department of Natural Resources (WDNR) to expand the training facilities at Camp Bonneville. The Army returned 20 acres of the leased land to WDNR in 1957. In 1959, Vancouver Barracks became a sub-installation of US Army, Fort Lewis. As a result, Fort Lewis assumed responsibility for Camp Bonneville. By 1959, the property inventory included a known distance range, a pistol

range (20 targets), a submachine gun range (21 targets), a live hand grenade range, and a mortar training range. Targets and target storage buildings for machine gun and anti-aircraft ranges were inventoried; however, the actual ranges could not be located (the purposed of the inventory is not known). Two demolition areas of unknown chronology were also mentioned. These demolition areas were approximately located in the southwest quadrant of the site along Lacamas Creek and in the northwest quadrant of the site near Little Elkhorn Mountain. These demolition areas had been used for destruction of unserviceable munitions since the late 1950s. Since 1993, the destruction of unserviceable munitions by any method (burning or detonation) has not been permitted.

- **Late 1960s through 1995:** Camp Bonneville provided training areas for a variety of military units as well as federal, state, and local law enforcement agencies until selection for closure under the BRAC process in 1995. From 1969 to 1985, artillery units had conducted live firing exercises about twice a year with each training session resulting in the firing of approximately 50 rounds. During the 1970s, the military switched to sub-caliber rounds for training purposes. Additional training maneuvers, bivouacking, and tactics were practiced on the many preexisting training areas at Camp Bonneville, and occasionally vehicles would support this training with the use of smoke or riot control agents. These training areas utilized land from previously established ranges. No new range installation occurred during this time. (Parsons 2004)
- **1987 though 1991:** During the period from 1987 to 1991, three new ranges were introduced at Camp Bonneville. The ranges included an M16 rifle range and two M203 ranges. The M203 ranges were used for troop training in the use of 40mm rifle grenades. One range was reportedly used solely for inert, practice 40mm training, while the second range was used for High Explosive (HE) 40mm training. (Parsons 2004)

In 1996, following the selection of Camp Bonneville for closure (in 1995) under the BRAC authorization, all active military training units ceased operations at the camp. All out-grants for use of the facilities were cancelled with the exception of the FBI firing range. (SWI 1999a)

1.2.1.3 Site Ownership History

In 1910, the federal government entered into a lease for approximately 3,000 acres of land. In 1912, the government obtained another option which expired in 1915. The land was obtained in 1918 through purchase and condemnation. An additional 840 acres was added through a lease with WDNR and approximately 20 of these acres were returned to WDNR in 1957. In October 2006, the Army transferred ownership of the property to Clark County in an “early transfer,” under which the DOD continued to provide funding for cleanup of the site. Clark County then transferred ownership of the land to the Bonneville Conservation Restoration and Renewal Team LLC (BCRRT), an organization managing a team of contractors in the cleanup and removal of hazardous wastes and unexploded ordnance (UXO). Currently, BCRRT is the site owner, but the County operates the site under lease from BCRRT.

1.2.2 Site Operations and Source Characteristics

Historical operations at the site have included the storage of pesticides, maintenance of vehicles, storage of diesel fuel for building heating, sewage lagoons, at least four landfills (one landfill, Landfill 1 has been reported but not located), various caliber firing ranges, and troop maneuvers. All of these historical operations are discussed in detail in the “Previous Investigations” section below.

Current operations include continuing evaluation of contamination in one landfill (Landfill 4; discussed in detail below), and clearing of UXO.

1.2.3 Previous Investigations

This section discusses previous investigations that concern the discovery, classification, or sampling of areas or features which may have involved the use, storage, disposal, or spilling of hazardous substances. A complete administrative record of all reports relating to the site is available at the Washington State University – Vancouver library.

1.2.3.1 Environmental Baseline Survey

In 1997, Woodward Clyde completed an Environmental Baseline Survey (EBS) report for the United States Army Corps of Engineers (Corps). The purpose of the report was to classify discrete areas of property associated with Camp Bonneville subject to transfer or lease into one of the standard environmental conditions types as defined in the Community Environmental Response Facilitation Act (CERFA) guidance and the DOD BRAC Cleanup Plan Guidebook. The standard environmental condition of property types are presented below (WC 1997):

- **Category 1:** Areas where no storage of hazardous substances or petroleum products has occurred for 1 year or longer and no release or disposal of hazardous substances or petroleum products has occurred (including no migration of these substances from adjacent properties). Additionally, Category 1 includes areas where no evidence exists for the release, disposal, or migration of hazardous substances or petroleum products; however, the area has been used to store less than reportable quantities of hazardous substances (40 CFR 302.4) or 600 or fewer gallons of petroleum products.
- **Category 2:** Areas where only storage of hazardous substances in amounts exceeding their reportable quantity or petroleum products exceeding 600 gallons has occurred, but no release, disposal, or migration has occurred.
- **Category 3:** Areas where storage, release, disposal, or migration of hazardous substances or petroleum products has occurred, but at concentrations that do not require a removal or remedial action.
- **Category 4:** Areas where storage, release, disposal, or migration of hazardous substances or petroleum products has occurred, and all removal or

remedial actions to protect human health and the environment have been taken.

- **Category 5:** Areas where storage, release, disposal, or migration of hazardous substances or petroleum products has occurred, and removal or remedial actions are under way, but all required actions have not yet been implemented.
- **Category 6:** Areas where storage, release, disposal, or migration of hazardous substances or petroleum products has occurred, but required removal or remedial actions have not yet been initiated.
- **Category 7:** Areas that are not evaluated or require additional evaluation.

Areas that are designated Category 1 through 4 are suitable for property transfer or lease, subject to consideration of the qualifiers. Areas that are designated Category 5 through 7 are not suitable for transfer, but may be suitable for lease (WC 1997). The designation of site areas identified under the BRAC Cleanup Plan and the basis for their designation is presented in Table 1-1. The reference map for this survey is provided in Figure 1-6. No samples were collected as part of this survey.

1.2.3.2 Base Realignment and Closure Cleanup Plan

In 1995, Woodward Clyde prepared a BRAC Cleanup Plan for the Corps. The BRAC Cleanup Plan included a brief history of site operations and outlined the areas of concern with regard to environmental cleanup and disposal, and reuse of the site. The objectives of the cleanup plan were to: summarize the current status of Camp Bonneville environmental restoration programs; present a comprehensive strategy for implementing response actions necessary to protect human health and the environment; and present schedules for restoration and compliance activities. (WC 1995)

Twenty areas of concern for restoration or assessment were identified during the investigation; of these 20 areas, 10 consisted of known or suspected disposal areas (Figure 1-6). A summary of these areas is provided below:

- **Landfill 1:** A cultural resources survey performed in 1980 located a landfill east of the Bonneville cantonment and north of the sewage lagoon. The cultural resources survey described the disposal area as a 4-meter by 5-meter shallow depression and stated that bottle fragments contained in the landfill date its use to the early 1900s. Neither the length of use nor a comprehensive list of the quantities and types of trash disposed of in this landfill is known (WC 1995).
- **Landfill 2:** This landfill, located northeast of the Bonneville cantonment, was reported to have been partially excavated during the construction of the sewage lagoon in approximately 1978. According to an interview conducted for the EBS, fill material was unearthed at the eastern and northern borders of the sewage lagoon. Neither the type nor quantity of material disposed of in this landfill is known. The period of use is estimated at 1940-1950 (WC 1995).

- **Landfill 3:** This landfill, which is suspected to have been used as a trash burial area, is located south of Landfill 2 and the sewage lagoon. According to an interview conducted for the EBS, this area contains a refrigerator and a locker. Neither the length of use nor a comprehensive list of the quantities and types of trash is known. The period of disposal is estimated to have been in the 1970s (WC 1995).
- **Three Grease Pits:** Two grease pits are located at the Bonneville cantonment north of Building 1828, and one is located at the Killpack cantonment east of Building 4389. The pits are composed of corrugated metal tubes, approximately 2 feet in diameter, that extend into gravel-filled pits to an unknown depth. The pits reportedly received cooking grease and oils from the mess halls. An interview conducted for the EBS indicates there was a potential for the uncontrolled disposal of potentially hazardous substances in these pits. The period of disposal is estimated to have been from 1935 to shortly before base closure (WC 1995).
- **Drum Burial Area:** A suspected drum disposal site was identified in May 1996 by an anonymous telephone caller, identifying himself as a former facility employee to the current Camp Bonneville Facility Manager. The suspected drum disposal area was located southeast of the Killpack cantonment and east of the gravel road. Metal anomalies have been confirmed at this location (WC 1995).
- **Paint/Solvent Burial Area:** A suspected paint/solvent disposal area was identified in May 1996 by an anonymous telephone caller, identifying himself as a former facility employee to the current Camp Bonneville Facility Manager. The suspected paint/solvent disposal area was located southeast of the Killpack cantonment and west of the gravel road. It was reported by the caller that paint, pesticides, and solvents were disposed of in this area (WC 1995).
- **Two Wash Racks:** The first wash rack, associated with Building 4475 at the Killpack cantonment, was identified in one of the previous environmental compliance inspections performed at Camp Bonneville. The wash rack does not have an oil/water separator. The second wash rack, associated with Building 4476, is an open gravel-covered area that gently slopes toward the road. The wash racks may have received waste oil and antifreeze during their period of use (WC 1995).
- **Maintenance Pit:** Building 4475 at the Killpack cantonment reportedly had a maintenance pit located west of the building that is now covered with concrete. The pit was an unlined excavation in the ground that potentially received vehicle fluids such as oil or antifreeze for an unknown period of time. Additionally, the ground south of the building in an area measuring approximately 4 feet by 85 feet was noted during the EBS to have stressed vegetation and red staining. This area received runoff from the galvanized steel roof of Building 4475 (WC 1995).
- **Chemical Warfare Burial Area:** The Department of the Army informed the BRAC Cleanup Team that chemical warfare burial sites had been identified at training facilities with similar utilizations and construction dates as Camp Bonneville. There had been no documentation at the time of this report that

chemical warfare material was buried on the property; however, the potential was recognized and noted (WC 1995).

- **Burn Pit:** The burn pit is located north of Landfill 3. The area had been repeatedly used on an infrequent basis to burn wood and debris. Wood debris was observed to have been disposed of in this area (WC 1995).

1.2.3.3 Endangered Species Survey

In 1995, Pentec Environmental, Inc. (Pentec) conducted an endangered species survey for the Corps. The objective of the survey was to determine the presence of plant and animal species that were Federally or State-listed as endangered or threatened, or were candidates for such listing, and to estimate the relative abundance of these species within the boundaries of the site. Five target species were identified within the Camp Bonneville boundaries. None of the species were Federally listed threatened or endangered. Among the animals, two were State candidate species and one was a Federal candidate species. Among the plants, one was a State endangered species and one was a State sensitive species. The report recommended monitoring of invasive species and implementation of control measures. The hairy-stemmed checker-mallow population was deemed at risk because of its roadside location. It was recommended to install permanent markers around the plants to ensure that the area is not mowed or sprayed with herbicides. (Pentec 1995)

1.2.3.4 Archives Search Report

In July 1997, the Corps conducted an archives search to determine the types, quantities, and probable locations of ordnance items abandoned by DOD prior to relinquishing ownership of Camp Bonneville. Information in the report was based on a review of existing historical documents and maps, interviews, a site inspection, and descriptions of known or suspected contamination. The conclusions and recommendations from the archives search report are discussed below in the following subsections. (Corps 1997)

1.2.3.4.1 Ranges and Training Areas

The Army started target practice on a rifle range at Camp Bonneville in 1910. The Army placed 14 short-range and seven long-range targets in the valley, which was 350 yards wide and 2,000 yards long. In 1918, the range contained 24 targets. At some time prior to 1929, a machine gun and howitzer range was added to the training facilities. The 1959 property inventory includes the following ranges: a known distance range, a pistol range (20 targets), a submachine gun range (21 targets), a live hand grenade range, and a mortar training shell range. These targets are also depicted on a historical map dated May 28, 1943. Artillery units conducted firing exercises about twice a year from 1969 to 1985, resulting in approximately 50 rounds being fired into the impact area during each training session. Sometime in the 1970s, however, the military switched to sub-caliber rounds for training purposes. Historical maps dated between 1926 and 1994 identified many additional ranges and firing points throughout Camp Bonneville. These included the following:

- Rifle Range;

- Machine Gun Range;
- Anti-Aircraft Range – 500 inches miniature (includes overhead, parachute, climbing, and diving, and horizontal targets);
- Pistol Range;
- 1,000 inches Rifle and Light Machine Gun Range;
- Infiltration Course;
- Sub-machine Gun Range;
- Artillery Impact Area;
- Field Firing Area;
- Record Firing Range;
- 1,000 inches and Moving Target Range;
- Artillery Firing Points;
- Mortar Training Shell Course;
- Practice Grenade Range;
- Live Grenade Range;
- Rifle Grenade;
- Rocket Launcher;
- TF-1 25M;
- Free Firing .30 caliber Machine Gun Range Mortar Positions;
- Close Combat Course;
- Night Fire, KD Range;
- M60 and 25M Range;
- 14.5 Range;
- LAW, Sub-caliber, and M203 Practice Range 25-Meter Range;
- M16 Qualification Range;
- FBI Range;
- ARF Range;
- Combat Pistol Range;
- M203 Grenade Launcher (HE) Range M-31 Field Artillery Range; and
- Known Distance and Training Fire Range 25-Meter and Machine Gun Range.

Additional training in maneuvers, bivouacking, and tactics was accomplished on the many training areas at Camp Bonneville. Occasionally, vehicles would support this training, and the use of smoke or riot control agents would be authorized.

The archives search report concluded that it was possible that unserviceable munitions may have been burned in the demolition areas. A 1971 agreement between the Army and Air Force stated that all munitions had to be destroyed by burning or detonation. A 1986 amendment allowed unserviceable munitions to be destroyed by a high order detonation only, and later in 1993, the destruction of unserviceable munitions by any method was not permitted.

1.2.3.4.2 Ammunition and Storage Facilities

A building list from 1946 listed two ammunition magazines, buildings, 2950 and 3754. The property inventory produced in 1959 when Camp Bonneville became a sub-installation of Fort Lewis shows that building 2950 was still used as a ammunition storage facility, but it does not show a building 3754. The archives search report indicated that the EBS building list noted three ammunition bunkers, and buildings 2950-52, and it listed their construction date as 1976.

1.2.3.4.3 Chemical Warfare Service Activities

Several documents from the 1930s discussed the expenditure of detonating gas identification (ID) sets from the Vancouver Barracks' supply. The gas ID sets consisted of a chemical agent placed in glass ampoules, vials, or bottles to train soldiers in the safe handling, identification, and decontamination of chemical warfare agents (CMA 2007). These documents all referred to the use of one set per instance, but they did not specify the location or extent of the training involved. The archives search report indicated it was known, however, that Camp Bonneville could have been the location of this activity. Camp Bonneville had two gas chambers, and it also had a 100-yard by 100-yard mustard training area. An undated map from the Real Estate Office at Fort Lewis was reviewed. It had a hand-written note in the mustard training area which read, "Gas ID." Other Chemical Warfare Service items mentioned in historical documentation included gas masks, smoke pots, demustardizing agents and apparatuses, tear gas capsules, and land mines. It was reported that the old gas chamber was burned in the 1970s. The two possible locations for the second gas chamber are Buildings 1834 and 1864, both of which are located in the Bonneville cantonment.

1.2.3.4.4 Potential and Confirmed Ordnance Presence

The archives search report concluded that the potential for ordnance existed throughout most of the installation. Figure 1-7 identifies the areas recommended for further action with respect to ordnance. The types of UXO determined to possibly be present at the site ranged from small arms ammunition to 155-millimeter (mm) artillery rounds, up to 4.2-inch mortars, 2.36-inch and 3.5-inch rockets, and grenades (hand and rifle). Training devices were also expected to be found throughout the post.

Ordnance confirmed to be present throughout the post included one 2.36-inch rocket, which was found near the sewage treatment facility, 3.5-inch rockets, 40-mm grenades (HE), 3-inch Trench Mortar (sandfilled), 10-mm and 155-mm phosphorous grenades, and several pieces of small arms ammunition. Based on interviews with people knowledgeable about Camp Bonneville, it was determined that ordnance items also have been found off post near the post's eastern boundary and north of the Bonneville cantonment area.

1.2.3.4.5 Archives Search Report Recommendations

The archives search report recommended that statistical sampling for UXO be conducted to delineate the areas containing UXO. The areas with the greatest potential for UXO were depicted on an Areas Recommended for Further Action figure (Figure 1-7).

1.2.3.5 Surface Water Investigation of Lacamas Creek and Tributaries

In 1998, Hart Crowser performed a limited surface water investigation of Lacamas Creek and its tributaries for the Corps. The objectives of the investigation were to determine where constituents of concern (COCs) were entering Camp Bonneville via tributaries of Lacamas Creek; and whether COCs were exiting Camp Bonneville via Lacamas Creek and potentially impacting Lacamas Lake (HC 1998). The sample locations for this investigation are provided in Figure 1-8.

A total of six surface water samples (HC-H1 through HC-H5 and HC-D1) and one blind duplicate sample (HC-D10) were collected during the investigation. Five samples were collected from near the headwaters of various tributaries to Lacamas Creek near their entry points to the post to determine concentrations upstream of the post: sample HC-H1 was collected from East Fork Lacamas Creek, sample HC-H2 was collected from an unnamed tributary to David Creek, sample HC-H3 was collected from David Creek, sample HC-H4 was collected from North Fork Lacamas Creek, and sample HC-H5 was collected from an unnamed tributary to the North Fork Lacamas Creek (Figure 1-8). Samples HC-H1 through HC-H5 were composited at the laboratory into one sample. One sample was collected from Lacamas Creek downstream of the post (HC-D1) just before the creek exits the post.

The samples were analyzed for hardness (EPA Method 6010), total suspended solids (EPA Method 160.2), cyanide (EPA Method 9012), nitrate (EPA Method 300.0), nitrate/nitrite (EPA Method 353.2), total phosphorus (EPA Method 365.4), orthophosphate (EPA Method 365.2), fecal coliform (SM 9331E), fecal streptococcus (SM 9330C), total and dissolved priority pollutant metals and barium (EPA Method 6020/7470), total petroleum hydrocarbons (TPH; Methods NWTPH-Gx and NWTPH-Dx), semivolatile organic compounds (SVOCs; EPA Method 8270C), pesticides/polychlorinated biphenyls (PCBs; EPA Method 8081A/8082), organophosphorous pesticides (EPA Method 8141A), pentaerthritol tetranitrate (PETN; EPA Method 8330), and ammonium picrate/picric acid (AP/PA, LTL 8303).

Sample results indicated that the dissolved metal barium and the total metals arsenic, barium, cadmium, chromium, copper, silver, and zinc were detected at concentrations above the composited up-post sample concentrations. No other analytes were detected at concentrations above the up-post concentrations and no SVOCs or pesticides/PCBs were detected above the instrument detection limit in any samples. (HC 1998)

The report concluded that site activities had not impacted the water quality of Lacamas Creek. (HC 1998)

1.2.3.6 Camp Bonneville Reuse Plan

In September 1998, a Reuse Plan was published for future possible uses of the site. The plan was prepared by the Camp Bonneville Local Redevelopment Authority (LRA) with the assistance of Otak, Inc. The plan was subsequently updated in February 20, 2003 and November 15, 2005. When the military closes a base, it asks the local community to form an LRA to prepare a reuse plan for the property. The LRA typically includes any jurisdictions, such as cities and counties, in which the military base is located. Since Camp Bonneville is in Clark County and is not within any city boundaries, Clark County formed the officially recognized Camp Bonneville LRA in November 1995. (LRA 1998)

Figure 1-9 illustrates the future possible uses of the site as outlined in the Preferred Reuse Plan.

To assist with the community-based planning effort, the Clark County Board of County Commissioners appointed a five-member Reuse Planning Committee (RPC) to oversee the reuse planning process. The RPC established six subcommittees made up of community representatives to assist in preparing planning options. The LRA RPC established seven guiding principles for planning, which required the reuse plan to be self sustaining, locally focused and directed, an open process, considerate of impacts to the surrounding neighborhoods, addressed to overall community need, based on cooperation and consensus building, and environmentally conservative (LRA 1998). The preferred reuse plan components are discussed in the following subsections.

1.2.3.6.1 Regional Park

A regional park was proposed that would comprise approximately 1,000 acres along the western portion of the property. The public park would provide opportunities for the local community to enjoy both active and passive recreational activities. The park would be managed and maintained by Clark County and would provide the following recreational opportunities:

- Recreation trails (for hiking, mountain biking, and equestrian use);
- Group picnic areas and picnic shelters;
- Amphitheater and stage (for outdoor school and small local events);
- Restroom facilities;
- Tent camping facilities;
- Recreational vehicle camping facilities;
- Public firing range;
- Archery practice range;
- Park watch person’s residences;
- Vehicle access road;
- Designated parking area;
- Ponds for recreational use and environmental education;
- Native American cultural center in the Bonneville cantonment area;
- Environmental study area; and
- Orienteering.

1.2.3.6.2 Law Enforcement Training Center

A law enforcement training center was proposed to serve the regional needs of law enforcement agencies of southwest Washington. At this facility, police officers would receive basic training, learn new skills, and learn firearms techniques. The training center would be located in the Killpack cantonment. A new training building would be constructed to provide three to six classrooms for use by Clark College and county law enforcement for environmental and law enforcement training. Additionally, local law enforcement firing ranges were proposed east of Lacamas Creek in the southwest corner of the property. An equestrian riding ring was proposed in the general vicinity of the Killpack cantonment, and would be open to the general public when not being used for local law enforcement training. A physical fitness course and canine training areas were also proposed in the area. Proposed firing ranges would include a handgun range, a rifle range, and an area for the future construction of an indoor firing range.

1.2.3.6.3 Rustic Retreat Center/Outdoor School

A Rustic Retreat Center/Outdoor School was proposed as the primary reuse of the barracks areas. The retreat center/outdoor school would reuse many of the existing structures after upgrades were completed for compliance with applicable building codes, and structural and utility service improvements. New buildings such as a meeting hall would be located within the existing Bonneville cantonment area.

1.2.3.6.4 Native American Cultural Center

Rattling Thunder, a non-profit Native American cultural group representing area tribes, provides training (drums, art, Native American culture) to Native American youth in the region and assists in coordinating tribal activities such as regional powwows. Rattling Thunder requested use of a barracks building and access to kitchen and meadow areas at Camp Bonneville for a Native American Cultural Center. The center would also be open to the general public visiting the regional park and outdoor school. The Cowlitz Indian Tribe and the Confederated Tribes of Grand Ronde were also involved in the planning process and were supportive of the development of a Native American Cultural Center at Camp Bonneville.

1.2.3.6.5 Clark College Environmental Field Station

Approximately 50 to 60 acres were proposed to be designated for environmental studies in the southwest corner of the property. This area was selected due to the various ecosystems in this creek watershed area and its suitability for water quality research, wildlife habitat studies, and native plant community preservation and restoration programs. A new classroom building at the Killpack cantonment would also be constructed to provide three to six classrooms for use by Clark College and county law enforcement for environmental and law enforcement training.

1.2.3.6.6 Trails and Nature Area
Approximately 2,000 acres were proposed to be maintained for trails and nature areas in the central and eastern portions of the property. The public would access this area through hiking trails, mountain bike trails, and equestrian riding trails. Environmental learning areas would be developed for use by all age groups. Most of these recreational trails would utilize gravel and unpaved roads and cart tracks that already exist throughout the property; however, additional trails would be created as funding became available. Trails in these natural areas would also be utilized by trail maintenance staff, timber management crews, and emergency response personnel such as firefighters.

1.2.3.6.7 Federal Bureau of Investigation Firing Range
An area immediately adjacent to the law enforcement firing ranges was identified for lease by the FBI. Noise studies indicate that firing ranges must be located no closer than 2,000 feet from neighborhoods and public use areas. Because of this, the FBI had been asked (and had agreed) to move its range to an area that would meet this criterion. Due to safety issues, the FBI was supportive of the LRA's requirement that the relocated FBI range be baffled. The FBI estimated past usage to be 60 – 80 days per year, with usage (except for emergency training) usually able to be scheduled in advance. It was determined to be essential for the viability of the regional park that FBI use of the firing range be limited to solely meeting the FBI's needs, particularly during the peak months for park and outdoor school usage at the nearby meadow areas. The FBI was willing to share range usage with law enforcement agencies when FBI agents are available to oversee the usage.

1.2.3.6.8 Timber Resource Management Area
The property has significant forested areas that provide valuable wildlife habitat, stream water quality and watershed protection, and open space. Timber thinning was recommended as part of the management plan to maintain the health of this forest environment, reduce potential fire hazards, and provide a revenue product from timber sales. Forest management goals would include, but not be limited to: simulating an old growth timber stand structure by generating an older age class of Douglas fir; and optimizing growth, yield, and forest health. The county forestry staff planned to use several silvicultural techniques to accomplish this, which would be addressed in detail in a forest management plan that would span a 50-year period. The Timber Resource Management Area was divided into two phases. Phase 1 would consist of the western portion of the property, most of which is proposed as a county regional park. Phase 2 would include the balance of the property, the majority of which would be designated as open space greenway.

1.2.3.6.9 Wetland/Riparian Area Restoration/Enhancement and Habitat Restoration
The plan proposed the restoration and enhancement of existing wetland and riparian areas. Additionally, it was intended that the reuse development process would enhance the entire site for wildlife, fish, and native plants. Clark County

would work with the Washington State Department of Fish and Wildlife and the United States Fish and Wildlife Service to explore opportunities on the site to enhance fish population and reintroduce native species.

1.2.3.7 Multi-Sites Investigation

In 1999, Shannon and Wilson, Inc. (SWI) conducted a Multi-Sites Investigation for the Seattle District U. S. Army Corps of Engineers. The overall objective was to identify contaminated areas and determine the next appropriate step toward restoration of those areas. The areas that were investigated included the three landfills, two suspected disposal areas, the former burn area, the former vehicle maintenance pit, the two former vehicle wash racks, and two hazardous material storage buildings. During the investigation, each of the areas was characterized and samples were collected, with the exception of Landfill 1, which could not be located. The analyses and methods applied are presented in Table 1-2.

Ground water sample results were compared to federal maximum contaminant levels (MCLs), EPA Region 3 tap water standards, and Model Toxics Control Act (MTCA) Method B standards for ground water protection. Soil sample results were compared to EPA Region 3 risk-based concentrations for residential soil exposure levels, MTCA Method A and Method B cleanup levels, and statewide background concentrations for metals. Additionally, a number of background soil samples were collected to determine background metals concentrations for the site (SWI 1999a). Each of the areas assessed is discussed below in the following subsections. Figures 1-10 through 1-17 provide illustrations of the exploration plan areas. The investigation of an additional location (Landfill 4) was to be described in an addendum to the Multi-Sites Investigation report, but this addendum could not be located.

1.2.3.7.1 Landfill 2

This former landfill was discovered in about 1978 during excavation for construction of the sewage lagoon. According to an interview conducted during the EBS, landfill material was unearthed at the eastern and northern borders of the sewage lagoon. No description was found of the materials encountered during construction of the sewage lagoon. There is no record of the type or quantity of material that was placed in this landfill, and the dates of use are not known.

The general landfill area is bounded by the existing sewage lagoon to the northwest and wooded areas to the south and east (Figure 1-10). The landfill area slopes gently southward toward Lacamas Creek. Although most of the site area is relatively flat, portions of the area are bumpy and uneven. The area between the sewage lagoon and the gravel road to the south is covered with native grasses.

Sixty-four soil gas samples were collected in the Landfill 2 area. The soil gas sample locations were not depicted on the report map. The samples were analyzed for halogenated hydrocarbons and benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds by EPA Methods SW8010 and SW8020. These data were used as a screening tool to determine whether volatile constituents were present in and escaping from the landfill, rather than to provide a reliable quantitation of concentrations. Analytical results from this sampling event were below the method detection limits for all soil gas samples with the exception of chloroform. Trace concentrations of chloroform were detected in two samples at 4 nanograms (ng) in sample L2-SG-40 and 6 ng in sample L2-SG-58. These trace concentrations of chloroform may be due to contamination from sampling or analytical procedures.

Three soil borings (L2-SB01, L2-SB02, and L2-SB03) were drilled in the Landfill 2 area during July 1998. Monitoring wells were installed in all three borings (L2-MW01, L2-MW02, and L2-MW03). The monitoring wells were installed at locations assumed to be upgradient (one well) and downgradient (two wells) of the landfill. The locations were determined based on area topography and surface drainage. For safety purposes, each soil boring was initially advanced by the UXO specialists to a depth of approximately 5 to 7 feet below ground surface (bgs), which is also below the water table. The drilling rig was then moved over the hole (or immediately adjacent to it), and drilling continued by the hollow-stem auger method. One soil sample was collected for chemical analysis at or immediately above the water table in each of the downgradient soil borings. No ground water was encountered in the upgradient boring. Because the UXO specialists were required to advance the holes to depths below the water table (for safety purposes), soil samples for chemical analysis were collected from the hand auger barrel in the two downgradient borings. A soil sample was collected from the anticipated wet season water table zone at the upgradient boring (L2-SB03) using a split-spoon sampler. One soil sample was collected from each of the three soil borings.

The samples were analyzed for TPH, volatile organic compounds (VOCs), SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, cyanide, total organic carbon (TOC), and priority pollutant metals. In the soil samples, arsenic, barium, beryllium, chromium, copper, and thallium were detected at concentrations that exceeded one or more of the regulatory criteria. Of these, copper was detected at a concentration that exceeded the background concentration in one of the soil samples. PETN was detected above the instrument detection limit in one of the samples; however, there are no regulatory criteria for this constituent and the background sample was not analyzed for PETN.

Due to the suspect landfill material that was found to extend to and slightly within a dense stand of trees south of the gravel road, the two downgradient monitoring wells (L2-MW01 and L2-MW02) were installed to the south of the trees, as close to the landfill as possible (Figure 1-10). These two wells were installed to depths of 13.3 feet and 12.7 feet bgs, respectively. The upgradient well (L2-MW03) was installed to a depth of 10.4 feet bgs, near the northwest corner of the sewage lagoon, to allow for potential seasonal monitoring of ground water. This depth corresponded with the top of the bedrock, which is expected to perch shallow ground water during the rainy season.

Ground water samples were collected from both downgradient monitoring wells and analyzed for TPH, VOCs, SVOCs, PETN, picric acid, explosives, pesticides/PCBs, total metals, dissolved metals, and cyanide. Sample results indicate that both total and dissolved arsenic were detected at concentrations that exceeded one or more of the regulatory criteria in both ground water samples. Naphthalene was detected above the instrument detection limit but not above the regulatory criterion.

1.2.3.7.2 Landfill 3

This former landfill was located southeast of the existing sewage lagoon, near Lacamas Creek, and approximately 300 feet southeast of Landfill 2 (Figure 1-10). The site was described by the previous Camp Bonneville Facility Manager as having been used as a trash burial area from the mid- to late 1970s to the early mid-1980s. The landfill reportedly was approximately 40 feet long by 12 feet wide by 8 feet deep, and trended north-south. Objects such as a refrigerator, a locker, wallboard, and paint cans were reportedly buried here. Soil had been scraped from nearby and pushed onto the landfill, creating a broad mound that marked the location of the landfill in an otherwise fairly flat area on the Lacamas Creek floodplain. Lacamas Creek flows along the eastern and southern sides of the area. At its closest point, Lacamas Creek was approximately 20 feet east of the landfill area.

Eleven soil gas samples were installed in and around the perimeter of the Landfill 3 area to screen for halogenated hydrocarbons and BTEX compounds. The analyses were performed by EPA Methods SW8010 and SW8020. Analytical results for the soil gas samples were below the detection limits for all analytes in every sample.

Five soil borings (L3-SB01 through L3-SB05) were drilled in the Landfill 3 area during July 1998. The borings were drilled to characterize the shallow subsurface conditions and to evaluate potential pathways for contaminant migration from the landfill. For safety purposes, each soil boring was initially advanced by the UXO specialists to a depth of approximately 5 feet bgs. The drilling rig was then moved over the hole, and drilling continued by the hollow-stem auger method. One soil sample was collected at or immediately above the water table in each soil boring to characterize the shallow ground water pathway. Because the water table was shallow and safety provisions required the UXO specialists to advance the holes to depths of approximately 5 feet bgs using hand augers, soil samples for chemical analysis were collected from the hand auger rather than from split-spoon samplers advanced by the drilling rig. The samples were analyzed for TPH, VOCs, SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, cyanide, TOC, and priority pollutant metals. Sample results indicate that arsenic, barium, beryllium, chromium, copper, and thallium were detected at concentrations that exceeded at least one of the regulatory criteria.

Four ground water samples (L3-MW01 through L3-MW04) were collected from the monitoring wells installed in Landfill 3. All samples were analyzed for TPH, VOCs, SVOCs, nitroaromatic and nitramine explosives, PETN, picric acid, PCBs/pesticides, cyanide, and priority pollutant metals (total and dissolved). Sample results indicate that arsenic was detected at concentrations that exceeded at least one of the regulatory criteria and the background concentration in all of the ground water samples. Naphthalene was detected above the instrument detection limit but not above the regulatory criterion.

1.2.3.7.3 Burn Area

The former Burn Area was located immediately north of Landfill 3, to the southeast of the sewage lagoon (Figure 1-10). A pile of wooden debris approximately 20 feet long by 15 feet wide marked the area. The use of the area to burn wood and debris was reportedly infrequent and there is no record of the period of use or list of materials burned. This area has apparently not been used for burning material since the mid-1980s.

Surface and near-surface soil samples were collected from five locations in and adjacent to the former Burn Area (Figure 1-10). The samples were collected to evaluate the potential for contamination resulting from past disposal and burning activities. Three sampling locations (BA-SS-03, BA-SS-04, and BA-SS-05) were within the former Burn Area. The other two locations (BA-SS-01 and BA-SS-02) were upslope (background) and downslope of the Burn Area, respectively. Two samples were collected from each location to assess the vertical extent of contamination: one from the 0 to 1-foot bgs interval, and one from the 1- to 2-foot bgs interval. Each sample was analyzed for TPH, VOCs, SVOCs, pesticides/ PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals. Sample results indicate that arsenic, beryllium, chromium, copper, and thallium were detected at concentrations that exceeded at least one regulatory criterion. Of these, thallium was also detected at a concentration slightly above the background concentration. Four VOCs (acetone, toluene, m- & p-xylenes, and o-xylene) were detected above the instrument detection limit but not above the regulatory criterion. The background sample was not analyzed for VOCs.

1.2.3.7.4 Former Buildings 1962 and 1983

Buildings 1962 and 1983 were located near the southeastern corner of the Bonneville cantonment (Figure 1-11). They were burned in place, and the burn debris was removed to an unknown location. The report does not indicate when the buildings were burned, only that they had been burned in the past. Both buildings were constructed in the 1930s with wooden frames, walls, floors, and wooden post/concrete pillar foundations and rolled composition roofs. Based on the age and type of construction, it was assumed that lead-based paint may have been used in the buildings. Lead from the paint may have been released to soil when the buildings were burned. Additionally, asbestos and SVOCs may have been present in the composition roofing materials and, therefore, released to the soils when the buildings were burned.

Fifteen soil samples (BD-SS01-01, BD-SS02-01, BD-SS03-01, BD-SS04-03, BD-SS05-01, BD-SS06-01, BD-SS06-02, BD-SS07-01, BD-SS07-02, BD-SS08-01, BD-SS08-02, BD-SS09-01, BD-SS09-02, BD-SS10-01, and BD-SS10-02) were collected from 10 locations at the Former Buildings 1962 and 1983 areas. The samples were analyzed for SVOCs, asbestos, and lead. No SVOCs or asbestos was detected in any of the samples. Lead was not detected at concentrations that exceeded the regulatory criteria.

1.2.3.7.5 Drum Disposal Area

A suspected drum burial area was identified in May 1996 by an anonymous caller to the Camp Bonneville Facility Manager. The caller, who claimed to be a former employee at the camp, reported that pesticides, paints, and solvents were disposed of in this area (and in the Paint and Solvent Disposal Area, described in Section 2.5.7.6). The Drum Disposal Area reportedly was located south of the Killpack cantonment, east of the gravel road leading south from the main east-west roadway through the facility (Figure 1-12). Following the anonymous call, the Facility Manager located suspected buried metal in this area using a metal detector.

Borings DB-SB01 and DB-SB02 were advanced immediately north and south of the disposal area, respectively (Figure 1-12). The UXO contractors advanced the borings to a total depth of 5 feet bgs. Downhole magnetometer readings were obtained every 2 feet. Refusal of the hand auger was encountered at shallow depth because cobbles were present. Therefore, a shovel was used to excavate a large hole to a depth of approximately 4 feet bgs at each location. A hand auger was then used to collect the samples from the 4- to 5-foot bgs interval (approximately 1 foot below the estimated depth of the buried drums). Soil samples from various depths were screened using a photoionization detector (PID) during excavation of the borings/holes. A wide range of analyses were performed on the soil samples from this site because of the unknown contents (if any) of the buried drums. Each soil sample was analyzed for TPH, VOCs, SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals.

Sample results indicate that antimony, arsenic, beryllium, chromium, and copper were detected at concentrations that exceeded at least one of the regulatory criteria, and antimony, barium, and copper also exceeded the background concentration. An unknown hydrocarbon, and a total of 13 VOCs (acetone, 2-butanone, ethylbenzene, m- & p-xylenes, o-xylene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, tert-butylbenzene, 1,2,4-trimethyl-benzene, isopropyltoluene, naphthalene, and 2-hexanone) were detected above the instrument detection limit; however, none of the concentrations exceeded the regulatory criteria. The background sample was not analyzed for VOCs.

1.2.3.7.6 Paint and Solvent Disposal Area

The suspected Paint and Solvent Disposal Area was identified in May 1996 by an anonymous caller to the Camp Bonneville Facility Manager. The caller, who claimed to be a former employee at the camp, reported that pesticides, paints, and solvents were disposed of in this area and in another nearby location (the Drum Disposal Area, discussed in Section 2.5.7.5). The Paint and Solvent Disposal Area was reportedly located south of the Killpack cantonment, in an open area where a (covered) tractor shed currently exists (Figure 1-13). Following the anonymous call, the Facility Manager used a metal detector in this area to locate suspected buried metal.

Two soil borings were advanced adjacent to each of the two identified disposal locations. The UXO contractors advanced the borings to their total depths with a hand auger. Downhole magnetometer readings were obtained every 2 feet. Refusal of the hand auger was encountered at shallow depths in all boring locations because of cobbles; therefore, a shovel was used to excavate a large hole to the top of the sampling interval. A hand auger was then used to collect the samples from the desired interval. One soil sample was collected from each of the four soil borings (PD-SB01 through PD-SB04). The samples were collected from depths estimated to be just below the base of the debris. Soil samples were screened using a PID during excavation of the borings/holes. All soil samples collected at the Paint and Solvent Disposal Area were analyzed for TPH, VOCs, SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals. Sample results indicate that an unknown hydrocarbon, arsenic, barium, beryllium, chromium, and copper were detected at concentrations that exceeded at least one of the regulatory criteria. None of these analytes, however, were detected at concentrations that exceeded the background concentration (the background sample was analyzed only for metals).

1.2.3.7.7 Maintenance Pit

The Maintenance Pit was located beneath the concrete floor slab under the west end of Building 4475, in the Killpack cantonment (Figure 1-14). Building 4475 was used as the Camp Bonneville shop office. The Maintenance Pit reportedly was an unlined excavation; the exact size, depth, and location are not known. The pit may have received vehicle fluids, such as gasoline, waste oil, lubricants, and antifreeze, as well as solvents, for an unknown period of time. In addition, pesticides may have been handled in front of the building. Building 4475 and the Maintenance Pit were bounded by Wash Rack No. 1 and a small stream to the west, a gravel drive and storage buildings to the north, and a ditch and the main road to the south. The building extends east of the Maintenance Pit area over a former underground storage tank (UST) location, which was remediated. A heating oil aboveground storage tank (AST) was located along the front (north) wall of the building. A chain link fence surrounds the entire shop office area, including the wash rack, a Hazardous Material Accumulation Point associated with the building, and a number of smaller buildings. The fence runs between Building 4475 and the ditch to the south. Numerous underground and aboveground utilities run through the area immediately west of the building. The surrounding ground surface is a mix of gravel (to the north and south) and soil (to the west). Much of this area appeared to have been filled to provide a level work area. Stressed vegetation was noted around this area. Potential causes of the vegetative stress include metals contamination from roof runoff, or other unknown factors.

Six soil samples were collected from two soil borings at the Maintenance Pit area. An attempt was made to advance soil borings at three locations in the Maintenance Pit area. One soil boring (MP-SB01) was drilled on the northeast side of the building, near the front door. Boring MP-SB01 was drilled and sampled to 11.5 feet bgs, using a hollow-stem auger drilling rig and split-spoon sampler. Three soil samples were collected from boring MP-SB01 at depths of 0, 2.5, and 10 feet bgs for laboratory analysis. Samples from boring MP-SB01 were not analyzed for pesticides/PCBs as originally planned. Therefore, a second boring (MP-SB01A) was drilled and sampled adjacent to the original boring. Boring MP-SB01A was advanced and sampled using a Geoprobe™ sampling system. Samples were collected from this boring for PCB/pesticide analyses only. Boring MP-SB02 was attempted inside of the shop office building at the Maintenance Pit location. A hole was cut in the concrete floor, and a hand auger was used to attempt to dig down to the bottom of the pit. No samples were collected from boring MP-SB02 because rubble that had apparently been placed in the pit when it was abandoned prohibited drilling and sampling. Boring MP-SB03 was drilled and sampled behind (south of) the building. Because access was limited, a Geoprobe™ sampling system was used. Three soil samples were collected from this boring for laboratory analyses: at the ground surface, starting at 1.5 feet bgs, and starting at 3.5 feet bgs. All samples were analyzed for TPH, SVOCs, pesticides/PCBs, and priority pollutant metals. Subsurface samples were also analyzed for VOCs. Sample results indicate that an unknown hydrocarbon, one VOC (vinyl chloride), five pesticides (4,4,-DDE, 4,4-DDD, 4,4-DDT, alpha chlordane, and gamma chlordane), and six metals (arsenic, barium, beryllium, chromium, copper, and lead) were detected at concentrations that exceeded at least one of the regulatory criteria. Of the metals, copper and lead were detected at concentrations above the background concentration (the background sample was analyzed only for metals).

1.2.3.7.8 Wash Rack Number 1

The Wash Rack No. 1 area is located immediately west of the shop office building (Building 4475) in the Killpack cantonment (Figure 1-14). The wash rack was used for vehicle washing, reportedly between approximately 1978 and 1994. The wooden wash rack structure consisted of a two-track vehicle ramp. This area was initially identified as a concern during an environmental compliance inspection because it did not drain to an oil-water separator. Instead, wash water was discharged via uncontrolled overland flow to a nearby ditch. Potential contaminants at the Wash Rack No. 1 site include vehicle fluids, such as gasoline, waste oil, lubricants, and antifreeze; as well as solvents that may have been used during cleaning activities.

Except for a 1-inch thickness of asphalt at the extreme north end of the wash rack, the area was not paved and was covered with grass. The wash rack area is bounded by gravel (with minor asphalt) driving surfaces to the north and west. To the east of the area were a culvert and small stream, and Building 4475 (which includes the former Maintenance Pit). The wash rack structure abuts the chain-link fence that surrounds the shop office area. Most of the wash water discharge from the site would have flowed to the unnamed stream that crosses the site. The stream emerges from a culvert located below the gravel fill pad, between the shop office building and the wooden ramps of the wash rack. It flows aboveground for about 15 feet before entering another culvert running southward under the main road. A ditch that runs along the north side of the road also joins the stream and runs under the road through the same culvert. The wash rack area slopes downward to the east and south, toward the stream and ditch, respectively.

Surface soil samples (WR-SS-01-01 and WR-SS-02-01) were collected from two locations at the wash rack to evaluate potential contamination from the wash rack area. One soil boring (WR-SB01) was drilled between the two ramps of the wash rack. The boring was drilled to a depth of 11.5 feet bgs using a hollow-stem auger. Three soil samples were collected from this boring using a split-spoon sampler. All samples were analyzed for TPH, SVOCs, and priority pollutant metals. In addition, the two subsurface soil samples were analyzed for VOCs, and the two surface soil samples were analyzed for pesticides/PCBs. Sample results indicate that an unknown hydrocarbon, arsenic, barium, beryllium, cadmium, chromium, copper, and lead were detected at concentrations that exceeded at least one of the regulatory criteria. Of the metals, cadmium, copper, and lead also exceeded the background concentration. One VOC (acetone), two SVOCs [bis(2-ethylhexyl)phthalate and di-n-butylphthalate], and three pesticides (4,4-DDT, alpha chlordane, and gamma chlordane) were detected at concentrations above the instrument detection limit but not above any of the regulatory criteria (the background sample was not analyzed for these constituents).

1.2.3.7.9 Grease Pits

Three grease pits were identified: two located in the Bonneville cantonment north of Buildings 1828 and 1920 (Figure 1-11), and one located in the Killpack cantonment northeast of Building 4389 (Figure 1-14). Each of the grease pits consisted of a gravel-filled excavation with a corrugated metal pipe extending vertically down into the gravel. The grease pits were used for disposal of waste cooking greases and oils from nearby mess halls. Use of the pits reportedly began around 1935.

Four soil samples (GP-SB02-01, GP-SB02-02, GP-SB03-01, and GP-SB03-02) were collected from the grease pits at depths ranging from 3 to 9 feet bgs. The samples were analyzed for TPH, SVOCs, pesticides/PCBs, VOCs, and priority pollutant metals. Sample results indicate the presence of arsenic, barium, copper, and thallium in at least one of the four samples at concentrations that exceeded the regulatory cleanup criteria.

1.2.3.7.10 Pesticide Mixing/Storage Building

The pesticide mixing/storage building (number 1864) is located in the Bonneville cantonment (Figure 1-11). The building was reportedly built in 1955 and was used for pesticide mixing and storage from 1977 to 1980. A small unnamed creek, located approximately 130 feet east of the building, flows south towards Lacamas Creek. A sink inside the building was located during the investigation and found to discharge to a dry well along the eastern side of the building.

During the investigation, two surface soil samples (PM-SS01 and PM-SS02) were collected from the south side of the building. Additionally, four boring locations (PM-SB01 through PM-SB04) were drilled around the building. Boring PM-SB03 was advanced using a hand auger due to the presence of overhead power lines. Samples were collected from three intervals in each of the borings. Monitoring wells were installed in these borings and ground water samples were collected. Samples were analyzed for TPH, VOCs (only on subsurface samples), SVOCs, PCBs/pesticides, organophosphorus pesticides, chlorinated herbicides, and priority pollutants metals. Sample results for the soil samples indicate an unknown hydrocarbon, one SVOC (hexachlorobenzene), two pesticides (4,4-DDE and 4,4-DDT), and eight metals (arsenic, barium, beryllium, cadmium, chromium, copper, lead, and thallium) were detected at concentrations that exceeded at least one of the regulatory criteria. Of the metals, arsenic, cadmium, copper, and lead were detected at concentrations that also exceeded the background concentration. Two VOCs (acetone and carbon disulfide), three SVOCs [di-n-butylphthalate, bis(2-ethylhexyl)phthalate, and butylbenzylphthalate), one pesticide (4,4-DDD), and two chlorinated herbicides (2,4-D and 2,4,5-T) were detected at concentrations above the instrument detection limit but not above their regulatory criteria (the background sample was not analyzed for these constituents). Sample results for the ground water samples did not indicate the presence of analytes above the regulatory criteria.

1.2.3.7.11 Aboveground Storage Tanks

A total of 26 ASTs were present at Camp Bonneville. Three were located in the Killpack cantonment and 23 were located in the Bonneville cantonment. During the investigation, no evidence of releases from the tanks was discovered; however, incidental spillage was reported to have occurred during tank filling. Each of the AST locations was inspected for evidence of leaks or spills. Stained soils and/or elevated PID readings were discovered at eight ASTs. One soil sample was collected from each of the eight areas and submitted for off-site fixed laboratory analysis of TPH. Sample results indicate the presence of diesel or hydrocarbons in all eight samples at concentrations that exceeded the regulatory criteria.

1.2.3.7.12 Former Sewage Pond

The sewage pond was located south of the Bonneville cantonment area (Figure 1-15). The exact location and dimensions of the pond were not documented. Anecdotal information indicates that the pond was an unlined lagoon that was pumped out and filled with clean soil from a local source when the lagoon was abandoned in 1978. The general area of the former sewage pond is on the Lacamas Creek floodplain and within approximately 200 feet of the creek.

During the investigation, five soil borings were advanced in the former sewage pond area. Borings SP-SB01, SP-SB02, and SP-SB03 were drilled within the apparent former pond area. Additionally, borings SP-SB04 and SP-SB05 were advanced for the installation of monitoring wells: one at an upgradient location (SP-SB04) and one at a downgradient location (SP-SB05). Ground water was encountered at a depth of 4 to 5.5 feet bgs. A total of 15 subsurface soil samples were collected from these boring locations. All samples were analyzed for TPH, SVOCs, VOCs, pesticide/PCBs, and priority pollutant metals; however, the water samples were not analyzed for pesticides/PCBs. In the soil samples, arsenic, beryllium, chromium, copper, and thallium were detected at concentrations above one or more of the regulatory criteria. Arsenic, copper, and thallium were detected at concentrations that also exceeded the background concentration. In the ground water samples, arsenic was detected at a concentration that exceeded at least one of the regulatory criteria. This detection was in the upgradient well.

1.2.3.7.13 Ammunition Storage Magazines

The Ammunition Storage Magazines are located east of the Bonneville cantonment and southwest of the sewage treatment lagoon (Figure 1-16). The three magazines are designated as Buildings 2950, 2951, and 2953. These small structures were constructed of concrete with heavy metal doors, and each was covered with a mound of soil. The buildings are reported to have been constructed in 1976. The magazines were used to store munitions of various types that were brought to Camp Bonneville for training. The area was surrounded by a chain-link barbed wire-topped fence. Lacamas Creek is located immediately south of the fence.

During the investigation, 15 surface soil samples (AS-SS01 through AS-SS15) were collected from areas around the magazines. Additionally, one soil boring (AS-SB01) was advanced in the area to a total depth of 6 feet bgs. Samples were analyzed for priority pollutant metals, nitroaromatic and nitramine explosives, PETN, and picric acid. Sample results indicate that arsenic, barium, beryllium, cadmium, chromium, copper, nickel, thallium, and zinc were detected at concentrations that exceeded at least one of the regulatory criteria.

1.2.3.7.14 Hazardous Materials Accumulation Point

The Hazardous Material Accumulation Point, Building 4476, is located in the northeast corner of the Camp Bonneville shop area, in the Killpack cantonment (Figure 1-14). The building is a three-walled structure, built in 1990, with cement masonry block walls and a concrete slab floor. The open front of the structure is secured with locking metal gates. The structure, also referred to as the Covered Vehicle Maintenance Storage, has been used for the storage of drums containing liquids such as antifreeze and waste oil. It may have been used for temporary storage of drums of other hazardous materials. The concrete floor of the building is sloped toward a sump in the middle of the floor. The sump measures approximately 2 feet square and is approximately 2 feet deep. No drains are present in the sump. No evidence or reports of spills at this location were found. The building is bounded by a gravel driving surface to the south and east, small storage buildings and equipment to the west, and woods to the north. A vehicle fuel AST, covered and within a concrete containment structure, is located immediately west of the building. The chain-link fence that surrounds the shop office area runs along the north and east sides of the building. The area is fairly flat. Drainage from the area likely flows to the ditch running parallel to the main access road, south of the fenced shop area.

Two surface soil samples (HM-SS-01 and HM-SS-02) were collected from the area. Additionally, one liquid sample (HM-SU01-01) was collected from the sump. The samples were analyzed for TPH, SVOCs, PCBs/pesticides, and priority pollutant metals. Soil sample results indicate that arsenic and beryllium were detected at concentrations above one of the regulatory criteria but not above the background concentration. Additionally, TPH and one SVOC [bis(2-ethylhexyl)phthalate] were detected at concentrations above the instrument detection limit but not above the regulatory criterion. These constituents were not analyzed in the background sample. For the liquid sample, an unknown hydrocarbon, one SVOC [bis(2-ethylhexyl)phthalate], and five metals (antimony, arsenic, beryllium, lead, and zinc) were detected at concentrations that exceeded at least one regulatory criterion and, in the case of metals, also exceeded the background concentration.

1.2.3.7.15 Former CS Training Building

The former CS training building was located south of the Bonneville cantonment and north of Lacamas Creek (Figure 1-17). The building burned to the ground sometime in the 1970s. CS gas (aka tear gas) is the common name for 2-chlorobenzalmalononitrile.

During the investigation, five soil borings were drilled at the CS training building area and 10 samples were collected. All samples were analyzed for tear gas and cyanide; additionally, one sample from each boring was submitted for SVOC and lead analysis. Sample results indicate that one SVOC [benzo(b)fluoranthene] and lead were detected above the regulatory criteria in at least one of the samples.

1.2.3.7.16 Wash Rack Number 2

The former Wash Rack Number 2 (or former maintenance rack site) is located in the Killpack cantonment at the northeast corner of the shop office area, near Building 4476 (Figure 1-14). No visible signs of contamination were noted. The wash rack was demolished in the 1980s.

During the investigation, four subsurface soil samples (W2-SB01-01, W2-SB01-2, WS-SB02-01, and W2-SB02-02) were collected from the Wash Rack Number 2 area. The samples were analyzed for TPH, SVOCs, and priority pollutant metals. Sample results indicate the presence of an unknown hydrocarbon, arsenic, barium, beryllium, chromium, and copper at concentrations that exceeded at least one of the regulatory criteria. None of the metals were detected at concentrations that exceeded the background concentrations.

1.2.3.7.17 Investigation Recommendations

The Multi-Sites Investigation report prepared by Shannon and Wilson, Inc. for the Seattle District U. S. Army Corps of Engineers recommended no further action for various locations because either no evidence of contamination was detected or constituents of concern were detected at concentrations below the project screening level. The locations where no further action was recommended are:

- Landfill Number 1 (existence could not be substantiated);
- Landfill Number 2;
- Landfill Number 3;
- Burn area;
- Paint and Solvent Disposal Area;
- Hazardous Materials Accumulation Point; and
- Wash Rack Number 2.

The report also recommended remedial action for those areas where soil contamination posed a potential risk to human health and the environment. Locations where remedial action was recommended are:

- Drum disposal area; and
- Wash Rack Number 1.

One area, the Maintenance Pit, was recommended for additional investigation (SWI 1999a). The Multi-Sites Investigation report did not provide the recommendations for the CS building, ammunitions building, sewage pond, ASTs, pesticide mixing/storage building (1862), grease pits, and Buildings 1962 and 1983.

1.2.3.8 Landfill 4 Investigation

In December 1998, SWI conducted an investigation of Landfill 4 as part of the Multi-Sites Investigation. A delay in the investigation of Landfill 4 was necessary to complete UXO clearance at the landfill. The investigation of Landfill 4 included UXO avoidance, geophysical surveying, collection of surface and subsurface soil samples, installation of monitoring wells, and collection of ground water samples from the monitoring wells. It was reported that building demolition debris was deposited in the landfill during the mid-1960s. The facility manager (at the time of the report) indicated that firearms were also disposed at the landfill; however, the time frame of this disposal was not reported. (SWI 1999b)

During the investigation, two surface soil samples (L4-SS01 and L4-SS02) were collected in an area of discolored soil. The samples were submitted for analysis of SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals. Sample locations are depicted on Figure

1-18. No background samples were collected during the investigation; however, the surface soil samples were compared to the background samples collected during the Multi-Sites Investigation. Soil samples were compared to background, EPA Region 3 risk-based concentrations for residential exposure to soil, and MTCA Method A, Method B, and Method B protection of ground water criteria. The report does not specify if these are unrestricted land use or industrial use. Arsenic, barium, beryllium chromium, and copper were detected at concentrations that exceeded one or more cleanup criteria but were below the site background concentrations. No other analytes were detected above the instrument detection limit in the surface soil samples. Five soil borings (L4-MW01, L4-MW02, L4-SB03, L4-SB04, and L4-SB05) were drilled and monitoring wells (L4-MW01 and L4-MW02) were installed in two of the borings. Boring locations are depicted on Figure 1-18.

Three soil samples were collected from each of the borings and were submitted for off-site fixed analysis of TPH, SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals. Additionally, the two deep samples were submitted for VOC analysis. Barium, chromium, and copper were detected at concentrations that exceeded one or more of the cleanup criteria and background concentrations. No other analytes were detected at concentrations that exceeded cleanup criteria. Finally, two ground water samples were collected from the monitoring wells and were submitted for off-site fixed laboratory analysis of TPH, VOCs, SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals (total and dissolved). No background ground water samples were collected during the investigation. Sample results were compared to EPA maximum contaminant levels, EPA Region 3 risk-based concentrations for tap water, and MTCA Method A and Method B cleanup criteria. Sample results indicated the presence of RDX at concentrations that exceeded at least one cleanup criteria. No other analytes were detected at concentrations that exceeded cleanup criteria. (SWI 1999b)

Based on the sample results, it was recommended that additional monitoring well installation occur at the landfill in order to further characterize potential contamination associated with it. It was also recommended that surface water and sediment samples from North Fork Lacamas Creek be collected to determine if contamination was migrating from the landfill to the creek. (SWI 1999b)

1.2.3.9 Base Realignment and Closure Hazardous, Toxic, and Radioactive Waste Site Closure Report

In September 2000, URS completed a site closure report for the Corps. The objectives of the site closure report were to document that past work at eight locations within Camp Bonneville met cleanup requirements of the Camp Bonneville BRAC cleanup team, and to prepare closeout documentation for the eight separate locations within Camp Bonneville that require no further action to meet Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. The closure report pertained only to the hazardous, toxic, and radioactive waste components of the locations and did not include UXO (URS 2000b).

In order to achieve the objectives of the closure report, previous investigations that had been performed at the facility were reviewed, existing data was compared to cleanup levels, and potential exposure pathways and receptors were evaluated in conceptual site models.

The eight locations evaluated and recommended for closure in the report include:

- Landfill 1;
- Landfill 2;
- Landfill 3;
- Former Burn Area;
- Buildings 1962 and 1983;
- Grease Pits at the Camp Bonneville and Killpack cantonments;
- Former Sewage Pond; and
- Hazardous Materials Accumulation Point.

The site closure report prepared by URS presents the rationale for no further action at these eight locations. The rationale stated in the report is provided below.

- **Landfill Number 1:** The landfill was not located by reconnaissance and geophysical methods. Previously collected information is interpreted to be consistent with the presence of a small debris pile associated with a former residence (URS 2000b).
- **Landfill Number 2:** The soil gas survey indicated no impact to air and no evidence of volatile organics in the landfill materials. Metals were the only constituents detected in downgradient borings, and none were detected at concentrations above the screening criteria and background. Both total and dissolved arsenic were detected in both ground water wells sampled at concentrations exceeding risk-based criteria but below the MCL. Arsenic concentrations in area wells are typically slightly elevated, which may be related to background conditions (URS 2000a).
- **Landfill Number 3:** The soil gas survey indicated no impact to air and no evidence of volatile organics in the landfill materials. Metals were the only constituents detected in downgradient borings, and none were detected at concentrations above the screening criteria and background. Total and dissolved arsenic were detected in the downgradient ground water wells at concentrations exceeding risk-based criteria but below the MCL. Total and dissolved arsenic concentrations in area wells are typically slightly elevated, which may be related to background conditions (URS 2000b).
- **Burn Area:** Metals were the only constituents detected in soil in downgradient borings, and only thallium was found at a concentration above the screening criteria and background. Thallium was detected in one surface soil sample at a concentration slightly above background and the MTCA Method B ground water protection criterion, but less than two times background. Slightly elevated thallium levels, detected in one surface soil

sample, may not exceed the actual natural concentration in site soils. Arsenic was detected in one nearby downgradient landfill ground water well at a concentration exceeding risk-based criteria, but below the MCL. The site does not appear to pose a threat to ground water. Arsenic concentrations in area wells are typically slightly elevated, which may be related to background conditions (URS 2000b).

- **Former Buildings 1962 and 1983:** Only lead was detected in the surface and near-surface soil samples. Concentrations detected did not exceed the screening criteria (URS 2000b).
- **Camp Bonneville Grease Pits:** No organics in soil were detected at concentrations above the screening criteria. Barium and copper were detected in soil above the MTCA Method B ground water protection level and slightly above background levels in soil, but less than two times background. Ground water was not encountered in the boring, which extends to volcanic rock (URS 2000b).
- **Camp Killpack Grease Pit:** No organics were detected at concentrations above the screening criteria in soil. Arsenic was detected in one soil sample at a concentration above the screening criteria and slightly above background, but less than two times background. Thallium was detected at a concentration above the MTCA Method B ground water criterion and slightly above background in one soil sample, but less than two times background. Ground water was not encountered in the boring (URS 2000b).
- **Former Sewage Pond:** Thallium was detected in one soil sample at a concentration above the MTCA Method B ground water protection level and slightly above background, but less than two times background. Arsenic was detected in one soil sample at a concentration above the screening levels and slightly above background, but less than two times background. Copper was detected above the MTCA Method B ground water protection criterion and slightly above background in one subsurface soil sample from the upgradient boring, but less than two times background. Arsenic, copper, and thallium, detected in only one soil sample each at concentrations only slightly above background, may be representative of natural conditions. No organic compounds were detected in ground water samples. The only metal detected in ground water above screening criteria was arsenic in the upgradient well. The ground water arsenic concentration exceeded both MTCA and Region 3 risk-based criteria but was well below the MCL. Arsenic was not detected in the downgradient ground water well. Arsenic concentrations in ground water at Camp Bonneville typically appear to be slightly elevated and may be related to background conditions (URS 2000b).
- **Hazardous Materials Accumulation Point**: The only organics detected in surface soil samples were low concentrations of TPH and bis(2-ethylhexyl) phthalate (below screening levels). No metals were detected at concentrations above the screening levels or background (URS 2000b).

The site closure report did not address the recommendations for the pesticide mixing/storage building, ASTs, ammunitions building, or Wash Rack 2. A previous report, i.e., the Multi-Sites Investigation report recommended that the drum disposal area and Wash Rack 1 locations required remediation and the maintenance pit required further investigation.

1.2.3.10 Environmental Restoration – Multi-Sites

In 2000, Gary Struthers Associates, Inc. (GSA) conducted remedial environmental restoration in areas that had been recommended for remedial work during the 1991 SWI Multi-Sites Investigation and prepared the areas for closure. The scope of the work conducted included the remediation of identified hazards at each of seven designated sites to meet regulatory cleanup standards and allow for unrestricted use of the property. The closure for each location included the excavation and stockpiling of suspected contaminated soil; screening of the in-place soil for the analytes of concern, followed by additional excavation (as needed); and concluded with confirmation sampling and fixed laboratory analysis (GSA 2000). The seven areas remediated during this investigation are described below. The remedial environmental restoration report prepared by Gary Struthers Associates, Inc. does not address the recommendations/disposition of the ASTs, ammunitions building, or Wash Rack 2.

1.2.3.10.1 Drum Disposal Area

Initial concerns with contamination in this area were raised prior to conducting excavation activities due to the discovery of surficial drum debris not previously documented. Upon commencement of the backhoe excavation activities, numerous pieces of metallic debris were found and removed, including a locker, a large sink, an apparent bookshelf, numerous rusted-through buckets, and a bumper. These items and other debris were excavated and stockpiled. Upon further excavation, a solvent-like odor was noted. Excavation immediately ceased, and field screening was conducted with a PID on the freshly exposed soil. The PID readings from the exposed area were as high as 150 parts per million (ppm).

A total of 26 test pits were excavated from the area (Figure 1-19). The test pits were numbered 1 to 26 in the approximate sequence in which they were dug. Each of these test pits had an approximate footprint of 4 feet by 6 feet and was advanced to approximately 4 feet deep. Water was observed in several of the test pits. While digging in Test Pit #25, the backhoe bucket pulled up a relatively intact bucket (approximately 5-gallon size) containing fresh paint. The paint bucket was damaged by the time it was brought to the surface, and paint was dripping from it. The bucket of paint was placed upon a separate visqueen staging area. Another item of concern, which was discovered during the test pit activities, was an apparent clay tile drain line running through the area from the general direction of the Killpack cantonment. Two soil samples and three ground water samples were collected from the 26 test pits. The samples were submitted for off-site fixed laboratory analysis of VOCs, SVOCs, pesticides/PCBs, herbicides, and metals (not all samples were analyzed for all constituents). Sample results indicated that concentrations for all analytes detected were below the site-specific cleanup criteria. Restoration at this site included placement of plastic sheeting into each of the exposed test pits prior to backfilling the test pits with the excavated soil.

1.2.3.10.2Paint and Solvent Disposal Areas

The remediation activities for this area began with a geophysical survey to attempt to identify and delineate the extent of buried drums or metal debris. The geophysical survey uncovered two disposal areas each to a limited extent. Based on the survey, two soil borings were drilled at each location (Figure 1-13). Samples were analyzed for TPH, VOCs, SVOCs, pesticides/PCBs, nitroaromatic and nitramine explosives, PETN, picric acid, and priority pollutant metals. Sample results indicated the presence of arsenic, barium, beryllium, chromium, and copper at concentrations that exceeded the regulatory criteria; however, all results were below the background concentrations. Restoration of this area consisted of returning the excavated soil, less the debris, to the excavations and regrading of the area.

1.2.3.10.3Wash Rack Number 1

The remediation activities for this area began with the dismantling of the timbers that formed the wash rack. Once the wash rack was removed, a backhoe was used to excavate the footprint of the area (Figure 1-20). The area was excavated to a depth of 3 feet bgs. At a depth of 3.0 feet bgs, a soil sample (H1) was collected from the floor of the excavation for Hanby field analysis. An additional field sample (H2) was collected from the 3.6-foot bgs depth of the excavation floor. A third field sample (H3) was collected from the 3.5-foot depth interval of the west sidewall of the excavation. These three field Hanby analyses revealed screening level concentrations of 0 ppm, 10 ppm, and 0 ppm, respectively.

Confirmation samples were collected and analyzed for diesel- and heavy oil-range TPH, cadmium, and lead. The results from the initial confirmation samples indicated that additional excavation of the northern and western sidewalls was needed due to the presence of elevated levels of diesel-range TPH. Additional excavation of 3 feet was conducted in the area. A total of eight soil samples (including one duplicate sample) were collected and submitted for off-site fixed laboratory analysis of TPH, VOCs, SVOCs, pesticides/PCBs, and metals (not all samples were submitted for all analyses). Sample results indicated that concentrations for all analytes detected were below the screening criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area.

1.2.3.10.4Maintenance Pit

Remediation of the area included excavation of the footprint of the maintenance pit to a depth of 0.8 feet bgs and collection of soil samples H4 and H5 from the eastern portion of the excavation floor, and sample H6 from the western portion of the floor (Figure 1-20). The samples were submitted for laboratory analysis for diesel- and heavy oil-range TPH, vinyl chloride, PCBs, DDD, DDE, DDT, and lead. Sample results indicated that additional excavation was required due to the presence of TPH and lead. The excavation was advanced to approximately 2.7

feet bgs and expanded in the northern, eastern, southern, and western sidewalls by approximately 2, 4.3, 0.5, and 5.6 feet, respectively. A total of 12 soil samples were collected and submitted for off-site fixed laboratory analysis of TPH, VOCs, SVOCs, pesticides/PCBs, and metals (not all samples were submitted for all analyses). Sample results indicated that concentrations for all analytes detected were below the established cleanup levels. Restoration of this area included hauling in imported backfill material to match the native material, and regrading the area.

1.2.3.10.5 Former CS Training Building

During the investigation, five soil samples were collected from the former CS training building area (Figure 1-21). Samples were analyzed for VOCs, SVOCs, and metals. Sample results indicated that lead was detected at concentrations that exceeded the regulatory criteria in two of the samples. Restoration of this area included hauling in imported backfill material to match the native material, and regrading the area.

1.2.3.10.6 Pesticide Mixing/Storage Building

Excavation was conducted south of the entry of the building (number 1864) and continued to a depth of 2.5 feet bgs (Figure 1-22). A total of eight soil samples (including one duplicate) were collected and submitted for off-site fixed laboratory analysis of TPH, VOCs, SVOCs, pesticides/PCBs, chlorinated herbicides, and metals (not all samples were submitted for all analyses). Sample results indicated that concentrations for all analytes detected were below the established cleanup levels. No remediation was conducted at this location.

1.2.3.10.7 Selected Aboveground Storage Tank Locations

A total of eight AST locations were selected for remedial action. Samples collected from the AST locations were submitted for off-site fixed laboratory analysis of TPH using method NWTPH-Gx and Dx. These locations are discussed below.

- **AST #1 – Building T-1833:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 2 feet bgs. The confirmation sample from this area indicated additional contamination. Based on these results, further excavation was conducted to 4 feet bgs. Again, confirmation samples were collected and submitted for analysis. Sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading the area. The AST support blocks were reset at the original location and the AST was placed on them.
- **AST #2 – Building T-1837:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 5 feet bgs. Confirmation sample results indicated no TPH above regulatory criteria. Restoration of this

area included hauling in imported backfill material to match the native material, and regrading the area. The AST support blocks were reset at the original location and the AST was placed on them.

- **AST #3 – Building T-1828:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 5 feet bgs. Confirmation sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area. The AST support blocks were reset at the original location and the AST was placed on them.
- **AST #4 – Building T-1940 (Day Room):** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 2.5 feet bgs. Confirmation sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area. The AST support blocks were reset at the original location and the AST was placed on them.
- **AST #5 – Building T-1922:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 2.3 feet bgs. Confirmation sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area. The AST support blocks were reset at the original location and the AST was placed on them.
- **AST #6 – Building T-1922:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 4.5 feet bgs. Confirmation sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area. The AST support blocks were reset at the original location and the AST was placed on them.
- **AST #7 – Building T-1942:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 4.5 feet bgs. Confirmation sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area. The AST support blocks were reset at the original location and the AST was placed on them.
- **AST #8 – Building T-1980:** Soil around the AST was excavated until visual observation and field screening by Hanby analysis indicated that residual contamination above regulatory criteria had likely been removed. The excavation in this area reached approximately 2.5 feet bgs. The confirmation

sample from this area indicated additional contamination. Based on these results; further excavation was conducted to 5 feet bgs. Again, confirmation samples were collected and submitted for analysis. Sample results indicated no TPH above regulatory criteria. Restoration of this area included hauling in imported backfill material to match the native material, and regrading of the area. The AST support blocks were reset at the original location and the AST was placed on them.

1.2.3.10.8 Site Summary and Recommendations

The GSA study results from the confirmation sampling data indicated that the paint and solvent disposal area, Wash Rack Number 1 area, the maintenance pit area, the former CS training building, the pesticide mixing/storage building, and the eight AST locations were in compliance with the site clean-closure levels. Additionally, results of this remedial activity indicated that further investigation of the drum disposal area and surrounding fields was necessary prior to continuing remedial actions in that area.

1.2.3.11 Supplemental Site Investigation

In 2000, URS completed a supplemental site investigation (SSI) for the Corps at two locations near the Killpack cantonment. The objectives of the SSI were to: evaluate chemicals of potential concern (COPCs) in surface soil and in flooring material of Building 4126 at the Pesticide Storage Area that had not previously been investigated; evaluate COPCs in surface and subsurface soil and ground water at the largest Ammunition Storage Magazine (Building 2953); and evaluate potential exposure to human and ecological receptors based on a conceptual site model (URS 2000a).

Sample results were compared to MTCA Method A and B cleanup levels, natural background soil metals concentrations in Washington State, and the background soil metals concentrations that were calculated in the 1999 SWI investigation. The following subsections provide a discussion of the specific areas included in the supplemental site investigation performed by URS.

1.2.3.11.1 Pesticide Storage Area

The Pesticide Storage Area (Building 4126) is located on the edge of a small, flat, grassy field approximately 75 feet south of the gravel road in front of the Killpack cantonment (Figure 1-23). Overall, the ground surface in this area slopes very gently to the south, away from the road. The building is approximately 4 feet west of an approximately 8-foot by 8-foot concrete pad. A surface soil sample (SS04) was collected from an exposed strip of soil between the building entrance and the building, and a surface soil sample (SS05) was collected from the south side of the building. Additionally, a flooring material sample (FS01) was collected.

The soil samples were submitted to an off-site fixed laboratory for analysis of petroleum hydrocarbons, organochlorine pesticides/PCBs, metals, and herbicides. Sample results indicated that 4,4-DDT and 2,4,5-T were detected at concentrations that exceeded the screening criteria. Based on these results, it was recommended that the building be demolished and that surface soil to approximately 1 foot bgs beneath the footprint of the building and to a distance of approximately 4 feet outside the footprint of the building be excavated and disposed.

1.2.3.11.2 Ammunition Storage Magazines

The Ammunition Storage Magazines (Buildings 2950, 2951, and 2953 as previously discussed in section 2.5.7.13) are located approximately 2,000 feet northeast of the Pesticide Storage Area on the south side of the road leading into the facility from the Killpack cantonment (Figure 1-16). They are positioned on a flat, graded terrace approximately 10 feet below the elevation of the road. The SSI investigated soil near the largest magazine, Building 2953 (Figure 1-24). An approximately 10-foot-wide by 50-foot-long access road descends from the main gravel road on the west side of Building 2953 and ends in front of the magazine entrance on the south side. Overall, the ground surface in this area slopes away from the road and continues to descend toward the south away from the terrace.

Three surface soil samples (SS01, SS02, and SS03) were collected in three locations in front of the magazine door. Subsurface soil samples were collected from soil boring SB-0l approximately 15 feet south of the bunker. Ground water was not encountered in the boring location. The samples were submitted to an off-site fixed laboratory for analysis of priority pollutant metals, SVOCs, ordnance, and propellants. Sample results indicated that antimony, cadmium, lead, and 2,4-dinitrotoluene were detected at concentrations that exceeded the screening criteria.

Based on these sample results, it was recommended to dispose of soil (0 to 1-foot bgs) along the short footpath leading to the door of Building 2953. This included an approximately 4-foot-wide area along the approximately 6-foot-long path. In addition, it was recommended that soil (0 to 1-foot bgs) at Buildings 2950 and 2951 be excavated and disposed of in areas where metals concentrations exceeded screening values during the 1999 SWI investigation.

1.2.3.12 Geophysical Survey

In October 2000, Parsons Engineering Science, Inc. (Parsons) conducted a geophysical survey of a suspected drum burial area. The survey was conducted using a G-858 portable cesium magnetometer/gradiometer. Eleven anomalies were encountered during the investigation that indicated the possibility of buried drums. These anomalies were mostly encountered in the suspect drum burial area, which was estimated to be approximately 10 to 15 feet across. The total depth was not determined. (Parsons 2001)

1.2.3.13 Environmental Restoration – Pesticide Storage Area and Ammunition Storage Magazines

Based on the results and recommendations of the SSI in 2001 (discussed in Subsection 2.5.10), GSA performed a remediation environmental restoration for the Pesticide Storage Area (Building 4126) and the Ammunition Storage Magazines (Buildings 2950, 2951, and 2953; GSA 2001).

1.2.3.13.1 Pesticide Storage Area

Work on the Pesticide Storage Area (Building 4126) began with characterization and sampling of the physical structure. Following sampling, the structure was dismantled. After demolition was completed, a backhoe was used to excavate the footprint of the building and its drip-line to a depth of 1 foot bgs. Samples were collected from each side wall of the excavation as well as the floor. The results from the samples indicated that no additional excavation was required. Clean backfill was imported and the excavation area filled and graded.

1.2.3.13.2 Ammunition Storage Magazines

A backhoe was used to excavate the footprint of three magazines (2950, 2951, 2953) to a depth of 1 foot bgs. Confirmation samples were collected from the four side walls as well as the floor in each of the magazines. Results from the samples indicated that no additional excavation was required. Clean fill material was imported and the areas were filled and graded.

1.2.3.14 Environmental Restoration – Drum Burial Area

Based on information contained in previous reports, an environmental restoration was performed at the drum burial area in 2002, by GSA for the Corps. During the investigation, soil from the drum burial area (as discussed in Subsections 2.5.9.1 and 2.5.11) was excavated and stockpiled. Confirmation soil samples were collected for fixed laboratory analysis of Resource Conservation and Recovery Act (RCRA) metals plus copper, VOCs, SVOCs, polyaromatic hydrocarbons (PAHs), pesticides/PCBs, and TPH. Following receipt of sample results that were below the cleanup criteria established under previous investigations, the area was backfilled and was no longer considered an environmental concern. The environmental restoration report does not indicate the depth of the excavation (GSA 2002).

1.2.3.15 Record of Decision – Multi-Sites

In August 2002, URS completed a Record of Decision (ROD) for multiple sites for the Corps. The sites included in the ROD were Landfill 1, 2, and 3; the former Burn Area; Buildings 1962 and 1983; the Grease Pits; the former Sewage Pond; the Hazardous Materials Accumulation Point; the Drum Disposal Area; the Paint and Solvent Disposal Area; Wash Rack 1; the Maintenance Pit, Wash Rack 2; the Pesticide Mixing/Storage Building 1864; the ASTs; the CS Gas Training Building; the Pesticide Storage Area Building 4126; and the Ammunition Storage Magazines 2950, 2951, and 2953. Based on analysis from previous investigations, COPCs either were not detected or were detected below the regulatory cleanup levels at some of the areas. The remaining areas contained contaminants above regulatory cleanup levels. At these areas, remediation had been conducted and contaminants had been removed. Subsequent confirmation sampling at these areas determined that contaminants were below established cleanup levels. Because contaminants were either not present or had been removed, it was determined that no risk to human health or the environment was posed at these areas. The EPA, Washington State Department of Ecology (Ecology), and the Army determined that no further action would be required at these locations (URS 2002).

1.2.3.16 Department of Ecology Enforcement Order

On February 4, 2003, an Enforcement Order 03TCPHQ-5286 was issued for Camp Bonneville. The enforcement order divided the site into three remedial action units (RAUs). The RAUs and their status are described below (Ecology 2003).

- **RAU 1:** This RAU consists of the 20 acres where hazardous substances other than military munitions had been located (Figure 1-25). This RAU contained the majority of the areas previously discussed in this PA report.
- **RAU 2:** This RAU consists of the areas where hazardous substances have been located, but not addressed through remedial actions. This RAU has been further divided into three subunits.
  - **RAU2A:** This RAU consists of the 21 small arms range areas (Figure 1-26).
  - **RAU2B:** This RAU consists of Demolition Areas (DA) 2 and 3 (Figure 1-27).
  - **RAU2C:** This RAU consists of the Landfill 4 area (Figure 1-28).
- **RAU 3:** This RAU consists of any area where military munitions may have come to be located (Figure 1-29).

Additionally, the enforcement order dictated the work and work schedule to be performed in each of the RAUs.

1.2.3.17 Expanded Site Inspection – Landfill 4

In 2003, URS Corporation completed an expanded site inspection (ESI) in Landfill 4 for the Corps. The ESI was conducted in response to the discovery of hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) above screening criteria in two monitoring wells that were installed during the 1999 SWI Multi-Sites investigation. During the ESI, a total of eight new monitoring wells (L4-MW01B, L4-MW02B, L4-MW03A, L4-MW03B, L4-MW04A, L4-MW05A, L4-MW06A, and L4-MW07B) were installed at the landfill (Figure 1-30). One of these wells (L4-MW06A) was not developed due to lack of water. Other activities associated with the ESI included: well slug tests, a topographic survey from the landfill to North Fork Lacamas Creek, and ground water sampling from the new monitoring wells as well as two previously existing monitoring wells. Ground water sampling of the new wells was conducted approximately 2 weeks after installation and in July 2001, October 2001, January 2002, and April 2002. Additionally, monitoring wells L4-MW01A and L4-MW02A, previously installed in 1999, also were sampled in these months (URS 2003).

Ground water data from this investigation was compared to MTCA Method A (for TPH only) and Method B cleanup levels for ground water, National Ambient Water Quality Criteria, EPA Region 9 Preliminary Remediation Goals (PRGs), and EPA Region 10 risk-based concentrations (RBCs). The ground water samples were analyzed for VOCs (EPA SW-846 Method 8260B), SVOCs (EPA SW-846 Method 8270C), herbicides (EPA SW-846 Method 8151A), total and dissolved metals (EPA SW-846 Method 6010B), TPH-Gx (Method NWTPH-Gx), TPH-Dx (Method NTWPH-Dx), water quality (alkalinity – SM 2320; sulfate, chloride, nitrite and nitrate – EPA Method 300.0; total cyanide – EPA Method 335.2; total suspended solids – EPA Method 160.2; and total and dissolved TOC – EPA Method 415.1), explosives (EPA SW-846 Method 8330A), nitroguanidine (EPA SW-846 Method 8330A modified), and ammonium perchlorate (Method 314.0; URS 2003).

Analytical results for water samples from monitoring well MW-01A indicated the presence of perchlorate above regulatory criteria in January 2002; and total arsenic, total copper, and total lead above regulatory criteria in October 2001. Although there were detections above the method detection limits, there were no other results above regulatory criteria. Analytical results for water samples from monitoring well MW-01B did not indicate concentrations above the regulatory criteria during any of the sampling events (URS 2003).

Analytical results for water samples from monitoring well MW-02A indicated RDX and perchlorate above regulatory criteria in all sampling rounds. No other analytes were detected above the regulatory criteria. Analytical results for water samples from monitoring well MW-02B indicated the presence of 2,4-Dinitrotoluene, RDX, perchlorate, 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE) and dichlorofluoromethane, above regulatory criteria for all sampling rounds. Additionally the following analytes were detected above the regulatory criteria on the specified sample dates: benzene in July 2001; tetrachloroethene in July 2001, October 2001, and April 2002; total arsenic, total copper, and total lead in July 2001 and April 2002; and dissolved arsenic in October 2001 (URS 2003).

Analytical results for water samples from monitoring well MW-03A indicated RDX and perchlorate were detected above the regulatory criteria in all sampling rounds. Total iron was detected above the regulatory criteria in the sample collected in January 2002; and dissolved lead was detected above the regulatory criteria in the sample collected in October 2001. Analytical results for water samples from monitoring well MW-03B indicate that perchlorate was detected above regulatory criteria in all sampling rounds; RDX was detected above the regulatory criteria in all but the sample collected in July 2001; total arsenic was detected above the regulatory criteria in the samples collected in October 2001 and January 2002; total copper was detected above the regulatory criteria in all the samples collected except for July 2001; total iron was detected above the regulatory criteria in the samples collected in January and April 2002; and total lead was detected above the regulatory criteria in the sample collected in April 2002 (URS 2003).

Analytical results for water samples from monitoring well MW-04A indicated RDX, perchlorate, total iron, and total copper were detected above the regulatory criteria in all sampling rounds. Total arsenic was detected above the regulatory criteria in the samples collected in July and October 2001; and total lead was detected above the regulatory criteria in the sample collected in April 2002.

Analytical results for water from monitoring well MW-05A indicated RDX and perchlorate were detected above the regulatory criteria in all sampling rounds. Also, total copper was detected above the regulatory criteria in the sample collected in October 2001.

Analytical results for water samples from monitoring well MW-07B indicated the presence of total and dissolved arsenic above the regulatory criteria in the sample collected in January 2003 (URS 2003).

1.2.3.18 Small Arms Range Site Inspection

In September 2003, Atlanta Environmental Management, Inc. (AEM) conducted a site inspection of the small arms ranges for the Corps. The locations of the small arms ranges that were part of this investigation are presented in Figure 1-31. The purpose of the investigation was to (AEM 2003):

- Determine the concentration of lead residues in the top 0–6 inches of soil at 307 one-half acre grids within the firing ranges;
- Determine the background concentrations of lead in the top 0–6 inches of soil at 20 undisturbed/unused locations within Camp Bonneville;
- Determine the concentrations of explosive residues, including picric acid and PETN, in soil in the muzzle blast area of the firing ranges where the firing location is known; and
- Determine the concentrations of explosive residues, perchlorate residues, and metals in soil samples from Demolition Areas 2 and 3.

The sample results were compared to MTCA cleanup levels (the report does not specify Method A or Method B) and EPA Region 9 PRGs. Additionally, a total of 20 background soil samples were collected. Sampling grids that measured approximately 80 feet by 80 feet were created at each of the small arms ranges. Soil samples were collected from the center of the grid and one each from locations approximately 40 feet north, south, east, and west of the center. A total of 1,535 soil samples were collected from the grids and submitted to an off-site fixed laboratory for analysis of lead using EP Method 7420. Ten locations randomly selected from the range grids and from two randomly selected background locations from Demolition Area 2 and Demolition Area 3 were submitted for off-site fixed laboratory analysis of Priority Pollutant Metals by EPA Method 6010.

Arsenic and barium were detected at concentrations that exceeded at least one of the regulatory criteria. Additionally, samples were analyzed for explosive residues using EPA Method 8330 modified. The numbers of samples submitted for this analysis are not indicated in the report. Explosive residues were detected in the samples collected from the muzzle blast zone at the 25-meter and machine gun ranges but not above the regulatory criteria. Samples were collected from Demolition Area 2 and Demolition Area 3 (the number of samples is not specified in the report) and were submitted for off-site fixed laboratory analysis of perchlorate using EPA Method 314. Perchlorate was not detected above the method detection limit in any of the samples. No conclusions were included in the report prepared by AEM.

1.2.3.19 Interim Removal Action – Landfill 4/Demolition Area 1

In 2004, Tetra Tech, Inc. conducted an interim removal action at Landfill 4/Demolition Area 1 for the U.S. Department of the Army. The primary purpose of the removal action was to remove source contamination (2.5-acre footprint) within the landfill that was impacting downgradient ground water. The secondary objective was the removal and disposal of OB/OD ordnance and landfill materials and associated contaminated soils to meet regulatory requirements to gain a declaration of “no further action” from Ecology for the landfill debris/soils. Cleanup action levels were established in accordance with MTCA Cleanup Regulations for the protection of ground water. Part of the removal action included a report that provided a compilation of ground water monitoring data and historical ground water information related to Landfill 4. The report consisted of a review of ground water monitoring data at Landfill 4 and established a baseline concentration for the primary ground water contaminants at the site. These contaminants included RDX, perchlorate, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, total chromium, total copper, and total zinc. It was recommended that ground water monitoring continue at the landfill following the removal of the 2.5 acre foot-print (Tetra Tech 2006).

The removal action at Landfill 4 was completed from May through December 2004. In designing the removal action, it was assumed that Landfill 4 was constructed using normal landfill characteristics which typically do not include excavation below the water table. For this reason, it was assumed that contaminated soil would not be present below the saturated zone. Likewise, it was assumed that demolition activities which were conducted after landfill operations ceased were unlikely to have included excavation through landfill debris to the water table for the purpose of destroying munitions. Based on these assumptions, the removal action was designed to terminate excavation activities once native soil was encountered. (Tetra Tech 2006)

Prior to the removal of contaminated soils, UXO avoidance was conducted. Munitions discovered during the avoidance were removed from the area and staged near the Camp Bonneville cantonment for off-site disposal. One phase of this removal included a “mag and dig” (the process of manually clearing smaller areas with the aid of shovels and handheld metal detectors) phase of MEC support work. During this work, a total of 21 pits/trenches were excavated. The locations of these pits/trenches are depicted on Figure 1-32. (Tetra Tech 2006)

It was discovered that four of the pits (pits 6, 11, 15, and 16) were used for open burn disposal of MC. These pits contained remnants of burned military flares and rocket mortars along with practice ordnance, ammunition, casings, and other munitions debris (MD). Blackened soil and/or fuel-related odors were noted at each of these pits. Six additional pits (pits 7 through 10, 12, and 17) contained MC, MD, and scrap metal that had been disposed of by burial. These pits were classified as disposal pits rather than burn pits because there was no visual or olfactory signs of burning. These pits contained bomb casings, empty or inert material filled projectiles, rocket pods and tubes, missile sections, empty casings of various sizes, practice landmines, and practice rockets. These pits were generally located near the outer estimated boundary of the landfill. Finally, seven of the pits (pits 1, through 5, 13, and 14) were used for open burn disposal of civilian fireworks and other ordnance-like items. The fireworks disposal areas were generally clustered in the central portion of the landfill and sometimes overlapped. The areas used to burn fireworks were characterized by a black layer of waste containing items such as whole bottle rockets, star shells, and whirligigs, along with civilian flares, and tear gas/mace canisters. All of the fireworks burn pits/trenches exuded a diesel fuel odor indicating the use of an initiating fuel for the burn. The maximum depth of all of the trenches was between 13 feet bgs and 18 feet bgs. (Tetra Tech 2006)

Following completion of MEC/MC removal activities, excavation of contaminated soil and other debris was conducted. Soil was removed until confirmation samples indicated that perchlorate was at concentrations below MTCA Method B soil cleanup levels for protection of ground water of 0.5 mg/kg (or 500 μg/kg). In one area, on the western boundary of the landfill, excavation continued to approximately 27 feet bgs where saturated soils were encountered, and sample results indicated that perchlorate levels continued to exceed the cleanup criteria. Excavation at this location was ceased due to safety concerns. Ecology determined that residual contamination remaining at this depth would be remediated during a ground water remediation phase of work. The areas where perchlorate contamination remained in soils are presented in Figure 1-33. It was estimated that 13,333 cubic yards of material were removed from the landfill. (Tetra Tech 2006)

1.2.3.20 Remedial Investigation/Feasibility Study of Remedial Action Unit 3

In 2004, Parsons Infrastructure and Technology Group conducted a remedial investigation/feasibility study (RI/FS) for the Corps of RAU3, which was any area where military munitions may have come to be located. The purpose of the RI/FS was to document and present munitions and explosives of concern (MEC); site characterization processes and findings; development of appropriate MEC risk assessment methods and results; develop MEC remediation levels; identification and screening of various cleanup actions; and rationale for selection of proposed cleanup action(s) for the different areas investigated. A total of six alternatives for cleanup were developed during this investigation. The cleanup alternative, or remedy, recommended for each area investigated was based on the specific characteristics of the area. The alternatives were as follows (Parsons 2004):

- **Alternative 1 – No Further Action:** No cleanup action would be implemented to reduce the potential explosive safety risk posed by different areas located within Camp Bonneville. This alternative, if implemented, would involve the continued use of the areas in their current condition.
- **Alternative 2 – Institutional Controls:** Institutional Controls (ICs) are measures undertaken to limit public exposure to residual explosives materials at Camp Bonneville. These preventive measures may include educational awareness and training programs, legally enforceable restrictions on future land use, and physical access controls.
- **Alternative 3 - Surface Clearance with Institutional Controls:** Surface clearance would require clearance of MEC items located on the ground surface. Prior to performing any MEC clearance activities at the site, control points would be established by a land surveyor for the areas that would undergo surface clearance. UXO-qualified personnel would perform a magnetometer-assisted surface sweep to locate metallic objects. The sweep would be performed in fixed width intervals. During the surface sweep, metallic objects located on the ground surface would be identified as either benign metallic scrap or MEC items and removed.
- **Alternative 4 - Clearance to Frost Depth (14 inches) with Institutional Controls:** Clearance to frost depth would require clearance of MEC items located on the ground surface and within 14 inches bgs. Clearance to the published frost penetration depth of 14 inches was determined to be necessary due to the potential for frost heave to push buried items at or above this depth to the surface. Based on the minimal amount of UXO recovered to date, all being less than 18 inches bgs, it was anticipated that the majority of remaining UXO at the site was within this frost depth interval. During MEC clearance activities at the site, control points would be established by a land surveyor for the areas that would undergo surface clearance. Brush clearing crews would clear sufficient undergrowth so that the MEC clearance crews could adequately perform their work. The brush clearance crews would be accompanied by UXO-qualified safety personnel.
- **Alternative 5 - Subsurface Clearance with Institutional Controls:** Subsurface clearance would require clearance of MEC items to a specified depth based on the projected end use of the site and the resulting potential for exposure to MEC. Under this alternative, each anomaly would be intrusively investigated until the anomaly was identified or until the site-specific risk-based specified depth was reached. Implementation of this alternative would involve land surveying and brush clearing operations. This alternative would also involve a magnetometer-assisted surface sweep to remove all surface clutter which includes benign metallic scrap items and MEC items. The surface sweep would be performed by experienced UXO-qualified personnel.
- **Alternative 6 – Subsurface Clearance and Restoration:** Subsurface clearance and restoration would require excavation of the complete area in order to remove all metallic and MEC items located at the area. Under this alternative, prior to excavating any site soils all existing vegetation, including

tree cover, would be cleared. No geophysical survey would be performed for this alternative. All the soils located at the site would be excavated to a depth of 10 feet and would be sifted to identify MEC items for proper disposal (based on the reuse of the site as being recreational). The soils free of any MEC items would be reused at the site for backfilling the excavations. As a result of the process, this alternative would require extensive repair of all ecological damages during the MEC removal action.

The remedy (cleanup alternative) recommended for selection by Parsons for each area within RAU3 is discussed in the following subsections along with the rationale for making the selection.

1.2.3.20.1 Target Areas

The five Target areas investigated included the 3.5-inch Rocket Range Target, the Rifle Grenade Range Target, the HE Range Target, the M203 HE Range Target, and the 2.36-inch Rocket Range Target (Figure 1-34). Of these areas, the 3.5-inch Rocket Range Target, the Rifle Grenade Range Target, the HE Range Target, and the 2.36-inch Rocket Range Target were deemed to have the highest relative explosive safety risk based on the type and likelihood of MEC occurrence. For all areas except the M203 HE Target area, alternative 4 (clearance to frost depth and institutional controls) was selected. For the M203 HE Target Area, alternative 2 (institutional controls) was selected. The clearance action was recommended to be conducted in the footprint of each of the target areas. The area and extent of the targets was based upon prior characterization and reconnaissance efforts. It was recommended to begin at the presumed center of the areas and proceed outward in a grid-based manner. The calculated total area for the removal action was approximately 10.6 acres and the total area of ICs was approximately 14.6 acres (Parsons 2004).

1.2.3.20.2 Central Impact Target Area

The Central Impact Target Area (CITA) Ordnance and Explosive Area is located in the central portion of Camp Bonneville (Figure 1-35) and is comprised of three adjacent target areas known as the West Impact Area Car Target 2, Combined Impact Area 1, and Combined Impact Area 2. This CITA was deemed to have a high relative explosive risk based on the type and likelihood of MEC occurrence. There are no future reuse activities planned for this area. Alternative 2 (institutional controls) was selected for this area and included the construction of signage to inform the public of previous uses, and land use controls in the form of restrictive covenants to prohibit any future development and/or forestry activities in the area. The implementation of this alternative was recommended for the footprint of the area for a total of 83 acres (Parsons 2004).

1.2.3.20.3 Open Burn/Open Detonation Areas

The Open Burn/Open Detonation (OB/OD) MEC source area consists of three OB/OD areas known as Demolition Area 1, Demolition Area 2, and Demolition Area 3 (Figure 1-36). A wide range of explosives and ordnance were reportedly disposed of in the OB/OD areas. Demolition Area 1 is a low future reuse area as it is located in the proposed Wildlife Management Area. Demolition Area 2 is a high future reuse area since Clark County is proposing a “Logging Camp” for this area. Intrusive activities may be conducted in the logging camp. Demolition Area 3 is a medium future reuse area as it is near to the planned Environmental Study Area.

No subsurface clearance cleanup was recommended for Demolition Area 1 since it is co-located with Landfill 4 and the entire 2.5 acre footprint had been removed. Alternative 5 (subsurface clearance with institutional controls) was recommended for Demolition Areas 2 and 3 because it would eliminate substantially all of the explosive exposure risk. In addition, Alternative 3 was recommended as a “buffer area” surrounding all three OB/OD areas to address the potential from kick-out (which is the unintended dispersal of explosives during disposal activities and/or the inadvertent release of submunitions). The subsurface clearance was recommended to be performed in a 300-foot by 300-foot grid centered over the Demolition Areas 2 and 3. The removal was proposed to begin in the center and proceed outward in a grid-based manner. The total area of subsurface clearance for Demolition Areas 2 and 3 was estimated to be two acres each for a total of four acres (Parsons 2004).

1.2.3.20.4 Firing Points

The Firing Points MEC source area consist of six mortar firing positions, seven artillery firing positions, one rifle grenade range firing point, one 3.5-inch rocket range firing point, and one M20340-mm HE range (Figure 1-37). These areas have a medium relative explosive safety risk based on the type and likelihood of MEC occurrence. The firing points are accessible based on their proximity to roads and trails. The activities proposed for future reuse are surficial and non-intrusive. Alternative 2 (institutional controls) was selected for these areas because it would substantially eliminate the explosive exposure risk. The implementation of institutional controls would also provide the necessary public awareness of the former military use of the site to park visitors. The clearance action would be conducted in the footprint of each of the firing points. Although Alternative 2 does not include clearance actions, they were recommended for the firing points in addition to Alternative 2. The total area for the removal would be approximately 19 acres (Parsons 2004).

1.2.3.20.5 Training Areas

One training area (the M203 Practice Range co-located with the Mortar Practice Range) was determined to pose a potential MEC risk. Alternative 2 (institutional controls) was determined to be appropriate for this area. No further information regarding the recommendations for the implementation of this alternative in this area is provided in the report (Parsons 2004).

1.2.3.20.6 Range Safety Fans

The Range Safety Fans (RSF) Ordnance and Explosive (OE) area consists of a total of 16 range safety fans associated with each of the 16 Firing Point Locations. The majority of Camp Bonneville is overlain by one or more RSFs. The RSFs are designed to contain those single event items that fall at some distance from their intended targets. The likelihood of encountering UXO in an RSF is negligible, because of the infrequency of historical artillery firing practices and the large size of the RSFs. The report indicates that most of the proposed future reuse of the areas is considered low, except those areas that overlie a High Reuse Intensity Area. For these areas, Alternative 5 (subsurface clearance with institutional controls) was selected (Parsons 2004).

1.2.3.20.7 Storage Magazine/Transfer Points

The solitary Storage Magazine/Transfer Point MEC source is Building 2950 (Figure 1-38), consisting of three bunkers located approximately 1,000 feet northeast of the Bonneville cantonment. The likelihood of any non-deployed military munitions in this area is remote; therefore, it has a low relative explosive safety risk. Alternative 2 (institutional controls) was selected for this area (Parsons 2004).

1.2.3.20.8 Maneuver Areas

The Maneuver Areas MEC sources are those areas that were not specifically identified as troop training areas. Maneuver Areas overlay the vast majority of the site and included the roads and trails, bivouac, and maneuver areas, including the Camp Killpack and Bonneville cantonments. These areas were determined to have a very low relative explosive safety risk. Alternative 2 (institutional controls) was selected to remediate these areas (Parsons 2004).

1.2.3.20.9 Central Impact Target Area

The Central Impact Area is approximately 458 acres and comprised of the 83 acre CITA and 375 acres of associated RSFs. The area is fenced with a three-strand barbed wire fence encircling the entire area. Additionally, signage warning of the potential danger to trespassers is in place. People are not expected to venture into this area due to the fencing, signage, and steep terrain; therefore, the number of potential human receptors was determined to be negligible. Alternative 2 (ICs) was determined appropriate for remediation in this area (Parsons 2004).

1.2.3.20.10 Roads and Trails

There are approximately 46 miles of roads and trails throughout the site, of which 25 miles are located within the proposed Regional Park (Figure 1-39). The roads and trails have the same munitions related historical use and characteristics as the Maneuver Areas. The roads and trails have a low relative explosive safety risk. Alternative 4 (clearance to frost depth and institutional controls) was determined to be the most appropriate remediation. The clearance was recommended to include geophysical mapping of roads and trails. Area-specific institutional controls that were recommended included signs along the roads and trails to inform the public about past military use of the site (Parsons 2004).

1.2.3.20.11 High Intensity Reuse Areas

Areas of the proposed Regional Park that are High Intensity Reuse Areas comprise approximately 210 acres. It was assumed that the future visitors would conduct a wide range of recreational and educational activities within the footprint of the High Intensity Reuse Areas. Alternative 5 (subsurface clearance with institutional controls) was selected as the best remediation method for these areas, with some locations being cleared to 14 inches and some to 4 feet. The total area estimated for conducting the 14-inch clearance is approximately 160 acres. The area estimated for requiring the 4-foot clearance is approximately 50 acres and includes the following proposed future uses within the park: Rustic Retreat Future Expansion, Logging Camp, Tent and Yurt Camping sites, and an estimated additional 5 acres for other construction areas (Parsons 2004).

1.2.3.20.12 High-Accessible Medium Intensity Reuse Areas

Areas of the proposed Regional Park that are High-Accessible Medium Intensity Reuse Areas comprise those areas that are located between the High Intensity Reuse Areas, have a gentle topographic slope and low vegetative cover, and therefore provide the opportunity to draw people together for informal recreational activities. These areas cover approximately 180 acres along the Lacamas Creek valley floor. Alternative 4 (clearance to frost depth and institutional controls) was selected for remediation efforts in these locations. The clearance action was recommended to be conducted in the footprint of the High-Accessible Medium Intensity Reuse Areas. The total area for conducting the clearance is approximately 180 acres (Parsons 2004).

1.2.3.20.13 Remaining Medium Reuse Intensity Areas

The remaining Medium Reuse Intensity Areas of the proposed Regional Park consist of those areas that are located between specific designated reuse areas, and do not have the high accessibility characteristics of gentle slope and low vegetation. These remaining Medium Reuse Intensity Areas comprise approximately 770 acres. Alternative 2 (institutional controls) was selected for these areas, including signage that would serve to inform visitors of the past military history of the site (Parsons 2004).

1.2.3.20.14 Wildlife Management Area

The Wildlife Management Area is comprised of approximately 2,000 acres in the eastern portion of the site and includes the Washington State Department of Natural Resources (DNR) leased lands (Figure 1-9). The Wildlife Management Area does not include the Central Impact Area nor the roads and trails located in the Wildlife Management Area. The majority of the Wildlife Management Area was used as maneuver areas and, therefore, has a low relative explosive safety risk. Alternative 2 (ICs) was recommended for remediation in this area (Parsons 2004).

1.2.3.21 Cultural and Historical Resources Protection Plan

In November 2006, Michael Baker Jr. Inc. (Baker) prepared a cultural and historical resources protection plan for the BCRRT. The goals and objectives of the protection plan included protecting and preserving the cultural resources at the site; implementation of cultural resource preservation as a regular component of site planning; identification of procedures to follow in the event that conservation actions have the potential to adversely affect cultural resources; and ensure that the identification of previously unidentified cultural resources at the site is comprehensive and consistent with state and federal regulations. The Cowlitz Indian Tribe declared the presence of a series of historic and prehistoric Indian villages, burial ground, and trails on or near the site that are considered sacred ground. The Cultural and Historical Resources Protection Plan indicated that any actions in these areas would not be endorsed by the Cowlitz Indian Tribe to take place without consultation with the tribe. The plan also concluded that the buildings associated with the Camp Bonneville and Killpack cantonments were not eligible for listing in the National Register of Historical Places (Baker 2006c).

1.2.3.22 Remedial Investigation Demolition Areas 2 and 3

In 2006, Baker conducted a remedial investigation (RI) at Demolition Areas 2 and 3 for the BCRRT. The purpose of the remedial investigation was to determine the presence or absence of contamination in ground water discharging from Camp Bonneville at the base's boundary and at locations downgradient from Demolition Areas 2 and 3; to determine the presence or absence of contamination in ground water in the vicinity of Demolition Areas 2 and 3; to determine the presence or absence of soil contamination in Demolition Areas 2 and 3; and to determine the geologic/hydrogeologic conditions in the investigation areas (Figure 1-40). To meet these stated objectives, the investigation included the installation and sampling of 16 monitoring wells located in three areas and soil sampling in Demolition Areas 2 and 3. Three wells were installed in the shallow alluvium/weathered bedrock in a line normal to the direction of flow from Demolition Area 2 (Figure 1-41). One well pair (shallow and deep) and three shallow wells were installed at four compass points surrounding the Demolition Area 3 crater (Figure 1-42). In addition, four well pairs (shallow and deep) were installed in a transect across the Lacamas Creek valley near the boundary of Camp Bonneville and downgradient of Demolition Area 3 (Figure 1-43). Surface and subsurface soil samples were collected from Demolition Areas 2 and 3 (Baker 2006b).

1.2.3.22.1 Demolition Area 2

The ground water from three shallow wells in Demolition Area 2 were sampled and analyzed for explosives, perchlorate, total and dissolved metals, and water quality parameters [chloride sulfate, total alkalinity, dissolved organic carbon (DOC), nitrite/nitrates as nitrogen, TOC and total suspended solids (TSS)]. Additionally, five soil samples at the ground surface, two feet bgs, and five feet bgs were collected (one from the center of DA 2 and one each from approximately 100 feet north, south, east, and west of the center) and were submitted for analysis of explosives, perchlorate, and metals. Sample results were compared to MTCA Method A cleanup levels for residential land use, MCLs, and EPA PRGs (Baker 2006b).

No explosives, perchlorate, or total and dissolved metals were detected at concentrations at or above the regulatory criteria in the ground water samples. No explosives or perchlorate were present in the soil samples above the reporting limit. Arsenic was detected at concentrations that exceeded the regulatory criteria in all 15 of the soil samples; however, they were below the background concentration established for Clark County, Washington (Baker 2006b).

1.2.3.22.2 Demolition Area 3

Five wells were installed in this demolition area, four shallow and one deep. Ground water samples were analyzed for explosives, perchlorate, total and dissolved metals, and the same water quality parameters as stated in the previous subsection. Soil samples were collected during the drilling of wells in Demolition Area 3. The soil samples were collected at the ground surface and at depths of two feet, five feet, and 15 feet bgs; however, the 15 foot interval was not sampled in one of the monitoring wells. Soil samples were analyzed for explosives, perchlorate, and total metals. Sample results were compared to MTCA Method A cleanup levels for residential land use, MCLs, and EPA PRGs (Baker 2006b).

No explosives or total metals were detected at concentrations at or above the regulatory criteria in the ground water samples. Perchlorate and nitrate were detected above the regulatory criteria in one of the wells. As perchlorate may produce a false negative, additional samples were collected and submitted to two different laboratories for reanalysis. These analyses did not indicate the presence of perchlorate or nitrate above the regulatory criteria. It was determined that the initial analysis had reported a "false positive". Results for the soil samples did not indicate the presence of explosives, perchlorate, or metals at concentrations above the regulatory criteria (Baker 2006b).

In addition, four well pairs (shallow and deep) were installed in a transect across the Lacamas Creek valley near the boundary of Camp Bonneville and downgradient of Demolition Area 3. Sample results did not indicate the presence of any metals or perchlorate at concentrations that exceeded the regulatory criteria.

During the RI, an area where corroded drums and shell debris had been encountered was excavated. Samples were collected from the sidewalls and bottom of the excavation area. The samples were analyzed for explosives, perchlorate, and picric acid. None of these constituents were detected in the excavation samples. (Baker 2006b)

1.2.3.22.3 Remedial Investigation Conclusions and Recommendations

The constituents detected in ground water and soils in Demolition Areas 2 and 3 were deemed to be present at "relatively low concentrations that do not pose a threat to human health or the environment". It was recommended that Demolition Areas 2 and 3 be considered for no further action (Baker 2006b).

1.2.3.23 Remedial Investigation/Feasibility Study – Small Arms Ranges

In 2006, Baker conducted an RI/FS for 17 small arms ranges at Camp Bonneville for the BCRRT. The RI was conducted to characterize soils at 17 Small Arms Ranges in order to provide data upon which to base decisions for further actions. Based on the results of the RI, the feasibility study (FS) was conducted to identify and evaluate cleanup action alternatives and select a cleanup action for the Small Arms Ranges (Baker 2006a).

Surface soil samples were collected from half-acre grids across the Small Arms Ranges. All range samples were analyzed for lead by EPA Method 7420. A total of 307 half-acre plots were samples. Each of the grids consisted of five grab soil sample collected from 0 to 6 inches bgs. Samples were collected from near the center of each grid and at 40 feet from the center of four compass points. A total of 1,535 soil samples were collected from the grids. At ten of the Small Arms Range grid locations, ten samples were randomly selected from the range soils and analyzed for Priority Pollutant Metals by EPA Method 6010B (Baker 2006a).

For ranges where the firing line had been determined, a muzzle blast zone was designated as a strip in front of and parallel to the firing line. Samples were collected along the strip at approximately 30-foot intervals and within 10 feet of the firing line. These samples were analyzed for explosive residues including picric acid and PETN by EPA Method 8330 Modified. Twenty soil samples were collected and analyzed to identify the background levels of lead in the soil by EPA Method 6010. The soil samples collected from the Small Arms Ranges were compared to MTCA Method A cleanup criteria. Sample results indicated the presence of lead above the regulatory cleanup level at 14 of the 17 ranges. Approximately 12 percent of the samples collected had concentrations that exceeded the cleanup criteria. None of the samples collected from the muzzle blast zone contained concentrations of explosive residues at concentrations that exceeded the EPA Region 9 PRGs (there are no established MTCA criteria for explosive residues; Baker 2006a).

As part of the investigation, five remedial alternatives were developed. The alternatives included no further action (Alternative 1), implementation of institutional controls such as signage (Alternative 2), capping (Alternative 3), consolidation and capping (Alternative 4), and excavation and off-site disposal or recycling (Alternative 5). Alternative 5 was recommended as the most permanent solution for the contaminated soils at the Small Arms Ranges (Baker 2006a).

1.2.3.24 Soil and Sediment Investigation – Artillery/Mortar Firing Points, Artillery/Mortar Impact Areas, and "Pop-up" Pond

In October 2007, Baker conducted a soil and sediment investigation of the artillery/mortar firing point, the artillery/mortar impact areas, and the "pop-up" pond for BCRRT. The report generated as an outcome of this work was reviewed by Ecology. The objectives of the artillery points and target areas were to determine the presence or absence of explosive constituents in surficial soil and to determine the likelihood that these contaminants are impacting site ground water. The objective of the "pop-up" pond was to determine the presence or absence of lead in sediments within the pond for the purpose of determining if cleanup actions are necessary. The pop-up pond was used in the 1970s for live-fire training with 30- and 50-caliber weapons in an automated pop-up target course.

A total of 435 soil samples were collected from 15 firing points. The samples were analyzed for explosives by EPA Method SW-8330. Additionally, the samples from the 3.5-inch Rocket Range Firing Point were analyzed for perchlorate by EPA Method 314.0. The sample results were compared to MTCA Method A, and when no value for a constituent was available, then the results were compared to the EPA Region 3 RBCs. No analytes were detected at concentrations that exceeded the regulatory criteria for any of the soil samples. Based on the samples results, a determination of "No Further Action" was recommended for all of the artillery/mortar firing points and the artillery/mortar impact areas sampled.

A total of 10 sediment samples were collected from the pop-up pond. The samples were analyzed for lead by EPA Method SW-846 6010. The sample results were compared to the MTCA Screening Level for the Ecological Indicator Soil Concentrations for protection of Terrestrial Plants and Animals. Lead was detected above instrument detection limits in all 10 of the samples; however, only one sample's result exceeded the most conservative screening criteria. Based on the sample results, a determination of "No Further Action" was recommended for the pop-up pond.

1.2.3.25 Environmental Study Area Interim Action

In November 2007 and February 2008, an interim action was performed in the Environmental Study Area. The objectives of the action were to locate and remove MEC and MD. During the action, a total of four MEC items (all 3-inch Stokes mortars, fired and unfuzed) were identified and demilitarized. The MEC were disposed of by detonation. A total of 32 MD findings were recorded and were relocated to on-site storage to be consolidated with other MD found at the site for future disposal. During the MEC surface clearance activities, several items were discovered that indicated the presence of a former homestead. These items were collected and submitted to the Clark County staff archeologist. (BCRRT 2009c)

1.2.3.26 Public Health Assessment

In 2008, the Agency for Toxic Substances and Disease Registry (ATSDR) completed a public health assessment for the site as a result of a public petition. As part of the assessment, ATSDR met with the petitioner and community members. Based on these meetings, ten areas of concern were identified. These concerns are presented in the Public Health Assessment report for the Camp Bonneville Military Reservation prepared by ATSDR and are discussed below:

- **Concern 1 – Potential physical hazards from exposure to UXO**

The Public Health Assessment states "UXO is present on Camp Bonneville. However, there are several factors that limit the public's access to the ordnance, including the location of the UXO, fences with warning signs, and UXO removal. Despite these efforts there is a small potential for people to encounter UXO. Therefore, it is very important to educate those who visit the future regional park about the dangers posed by UXO." (ATSDR 2008)

- **Concern 2 – Exposure to soil and ground water contamination for residents living within the Artillery Impact Fan and Range Safety Fan areas**

  The Public Health Assessment states "There was some discrepancy regarding the location of range safety fans at Camp Bonneville. Current maps do not show safety fan areas extending beyond Camp Bonneville's property line. However, older maps show safety fans extending offsite onto the property of residents living to the east of Camp Bonneville. Understandably, this has caused confusion and concern for the residents neighboring Camp Bonneville to the east. According to the WDOE, the historical maps showing range safety fans extending offsite contain cartographical errors and the safety fans never extended offsite. Therefore, there are no residents living within the Artillery Impact Fan and Range Safety Fan areas. In addition those residents to the east of Camp Bonneville are upgradient of any known ground water contamination." (ATSDR 2008)

- **Concern 3 – Exposure to ground water contamination (specifically, perchlorate and RDX plumes)**

  The Public Health Assessment states "Ground water was sampled from 18 sites at Camp Bonneville. The only area found to contain ground water contamination was Landfill 4. The plume at Landfill 4 contains RDX, perchlorate, and 1,1,-dichloroethene. However, no one is drinking water from this area. Therefore, exposure to ground water contamination is an incomplete pathway." (ATSDR 2008)

- **Concern 4 – Exposure to contaminated soil (specifically, at the sewage pond/lagoon areas and the small arms firing areas)**

  The Public Health Assessment states "Soil at the Former Sewage Pond and Landfill 2 was sampled in 1998. None of the contaminants were detected at levels of health concern. People are not being exposed to the soil at the CITA because the area is fenced. Further, remediation is being conducted to remove soil containing elevated levels of lead around the former targets at the small arms firing ranges." (ATSDR 2008)

- **Concern 5 – Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River**
  The Public Health Assessment states "In 1998, a surface water investigation was conducted on Lacamas Creek and its tributaries at Camp Bonneville. The investigation concluded that, in general, site activities have not impacted the water quality of Lacamas Creek. Due to limited use of the creek and the minimal contamination found, ATSDR does not expect harmful health effects to result from exposure to surface water and sediment in Lacamas Creek." (ATSDR 2008)
- **Concern 6 – Exposure to runoff water and standing rainwater, particularly near the Open Burn/Open Detonation sites**
  The Public Health Assessment states "Even though standing water is sometimes seen in and around the Open Burn/Open Detonation (OB/OD) sites, exposure to it would be short-term and infrequent. Further, soil, ground water, and surface water at the OB/OD sites have been sampled and no chemicals were detected at levels of health concern." (ATSDR 2008)
- **Concern 7 – Inhalation exposure to agents used during past chemical warfare testing and training activities**
  The Public Health Assessment states "CS gas was the only chemical warfare agent used during training. It decomposes quickly and has no persistent metabolites. Therefore, ATSDR does not expect that past inhalation exposure to CS gas occurred off site. Further, the building and soil surrounding the gas chambers were sampled and no residual hazardous substances were detected." (ATSDR 2008)
- **Concern 8 – Hunting and eating wildlife on Camp Bonneville**
  The Public Health Assessment states "Hunting may have occurred on Camp Bonneville in the past, but is not expected to occur currently or in the future. Because of the lack of site data, it is indeterminate whether eating wildlife from Camp Bonneville in the past is expected to have caused harmful health effects. However, based on studies conducted at Army ammunition plants, it is unlikely that the wildlife at Camp Bonneville would have accumulated harmful levels of contaminants." (ATSDR 2008)
- **Concern 9 – Early property transfer as a public regional camping facility and potential exposures to future site users**
  The Public Health Assessment states "Camp Bonneville was transferred from DOD to Clark County, Washington in October 2006, prior to the completion of environmental cleanup (i.e., early transfer). BCRRT is responsible for continuing the cleanup of Camp Bonneville, with oversight by Ecology. The redevelopment or reuse of the facility is not likely to contribute to any existing release or threatened release, interfere with any remedial actions, or increase health risks at or in the vicinity of the site." (ATSDR 2008)
- **Concern 10 – Fire response and suppression at Camp Bonneville**
  The Public Health Assessment states "Even though UXO is present on Camp Bonneville, the Washington State Department of Natural Resources

will respond to wildfires at the property in close coordination with BCRRT. There may be some areas (e.g., the CITA) that are too dangerous for fire fighters to enter, however, in those cases, the fires will be carefully monitored and other methods of fire suppression may be employed." (ATSDR 2008)

Based on the health evaluation of each of these concerns, the recommendations by ATSDR state:

- "ATSDR recommends that Clark County educate future visitors to the regional park about the appearance of UXO and what to do if they encounter it. It should be emphasized that UXO should never be handled."
- "ATSDR recommends that ground water in the vicinity of ground water contamination at Landfill 4 not be used for drinking water in the future, and that ground water monitoring in the area continue. ATSDR also recommends continued monitoring of sentinel wells to prevent contamination of off-site drinking water wells."
- "Because hunting was not recommended as a future use of Camp Bonneville in the reuse plan, ATSDR recommends that "No Hunting" signs be posted on the Camp Bonneville property."
- "ATSDR does not recommend firing ranges as a future use in the regional park." (ATSDR 2008)

1.2.3.27 RI/FS for Remedial Action Unit 3

In 2008, BCRRT prepared an RI/FS for RAU 3. The report deals exclusively with explosives safety of MEC resulting from prior actions at the site. As part of this investigation, a total of 207 MEC sampling grids, covering approximately 40 acres, were geophysically mapped and sampled. During previous investigations, over 2,400 acres of the site had been characterized for the presence of MEC-related activities including all of the known and suspected MEC source sites; all of the proposed regional park reuse areas; all of the existing trails and roads, and the entire 1,200-acre area of the proposed future regional park. (BCRRT 2008)

The RI/FS subdivided the MEC concerns into eight Remedial Work Areas (RWAs) requiring MEC surface and/or subsurface clearance cleanup. The RWAs are depicted on Figure 1-44 and include:

- Target Areas;
- CITA targets and Non-Target Zone;
- OB/OD areas;
- Firing Points;
- Roads and Trails;
- Central Valley Floor (CVF);
- Regional Park Western Slopes Area; and
- Wildlife Management Area.

Five cleanup action alternatives were evaluated for each of the MEC source types and proposed reuse areas:

- ICs;

- Surface clearance with ICs;
- Clearance to frost depth (14 inches) with ICs;
- Subsurface clearance (24 to 48 inches) with ICs; and
- Excavation and Restoration.

The recommended cleanup actions presented were based on the potential degree to which a MEC source and receptor interaction was likely to occur. A remediated MEC site generally means that a site is cleaned to a point that the likelihood for MEC source and receptor interaction is negligible. For each of the site types, a preferred alternative was selected as the most “practicable permanent solution” to reduce the explosive hazard. The cleanup actions recommended are as follows:

- Target Areas – Frost depth clearance;
- Firing Points – Subsurface clearance;
- OB/OD Areas – Surface clearance (approximately 5 acres at each area);
- High Intensity Reuse Areas – Subsurface clearance and frost depth clearance depending on the proposed future reuse; and
- Medium Intensity Reuse Areas – Confirmatory investigation via surface clearance transects.

In addition to clearance activities, site-specific ICs consisting of signage and/or fencing were recommended.

1.2.3.28 EPA Preliminary Assessment

In 2009, EPA conducted a Preliminary Assessment (PA) of the Camp Bonneville site. The PA was conducted under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). During the PA, historical documents were reviewed, a site visit was conducted, and a PA report was prepared. The objectives of the PA were to determine if the site was releasing or has the potential to release hazardous substances into the environment; identify potential public health and/or environmental threats posed by the site; assess the need for additional investigation and/or response action; and determine the potential for placement of the site on the National Priorities List (NPL). Based on the review of available information and an evaluation of migration pathways and receptors, further investigation of the site was recommended. (E & E 2010)

1.2.3.29 Remedial Action Unit 3 Supplemental RI/FS

In May 2009, BCRRT prepared a supplemental RI/FS for RAU 3 (BCRRT 2009b). The Supplemental RI/FS addresses the additional MEC and MD findings since the RI/FS was finalized in 2008. During the MEC and MD removal, new remedial work areas were discovered. The discovery of these additional work areas resulted in either changing the area’s classification and associated MEC cleanup requirements, or identifying additional areas requiring MEC cleanup. The cleanup actions for the newly discovered areas included:

- MEC subsurface clearance for the entire CVF and associated wetlands (previously designated as the Accessible High and Medium Intensity Reuse Area in the Final RI/FS). This decision was based on the determination that the CVF and associated wetlands are an extensively used direct and indirect fire weapon target area, and an extensively used training area due to the number of subsurface anomalies and surface MEC and MD discovered. The MEC and MD discovered are depicted on Figure 1-44 and include:
    - Stokes Mortar Target Area;
    - MEC Disposal Area (burial pit);
    - OB/OD Area;
    - 37-mm Artillery Stokes Mortar Target Area;
    - Rifle Grenade Target Area; and
    - 2.36-inch Rocket Target Area near the Former Sewage Lagoons.
- MEC surface clearance, access limitations based on steep slopes, and ICs are being required for the Regional Park Western Slopes Area. The Western Slopes had been designated as the Limited Access Medium Intensity Reuse in the Final RI/FS.
- Expansion of the CITA fence line northward to encompass an additional 107 acres believed to have been impacted by artillery and mortar firing.
- MEC surface clearance of Demolition Area 1/Landfill 4 kick-out area encompassing 104 acres.

This work has not been conducted as yet. A Cleanup Action Plan (CAP) has been prepared and submitted for public review. The final CAP describes details and next steps for cleanup within each of the RAU-3 RWAs and includes MEC and MD findings to date; accessibility, reuse, and hazard ranking considerations; cleanup action evaluation and selection; and the recommended cleanup action(s).

1.2.4 Migration/Exposure Pathways and Targets

This subsection discusses the ground water migration, the surface water migration, the soil exposure, and the air migration pathways and potential targets within the site's range of influence (Figures 1-45 and 1-46).

1.2.4.1 Ground Water Migration Pathway

The target distance limit (TDL) for the ground water migration pathway is a 4-mile radius that extends from the sources at the site. Figure 1-45 depicts the ground water 4-mile TDL.

1.2.4.1.1 Geologic Setting

Camp Bonneville lies within the Willamette Lowland portion of the Willamette Valley and Puget Sound Physiographic Province. The Willamette Lowland lies between the Cascade Mountains to the east and the Coast Range to the west. The Willamette Valley is part of an elongate alluvial plain whose elevation is near sea level in Portland, Oregon and at the Columbia River.

Camp Bonneville is located along the eastern edge of the Willamette Lowland near the foothills of the Cascade Mountains. The U.S. Geological Survey published a geologic map of the Lacamas Creek 7.5-minute quadrangle in 2006 (Evarts 2006). This map provides a more detailed description of the geology in the Camp Bonneville area. The following geologic units are present at Camp Bonneville in order from oldest to youngest: Basaltic Andesite of the Elkhorn Mountain, Sandy River Mudstone, Lower (Conglomerate) member of the Troutdale Formation, Landslide Deposits, and Alluvial Sediments.

The geologic history of the area includes the accretion of a submarine oceanic island archipelago (Orr and Orr 1999) as evidenced through the presence of Oligocene age tholeiitic basaltic andesite and basalt flows and flow breccia (Basaltic Andesite of Elkhorn Mountain; Evarts 2006). The Basaltic Andesite of the Elkhorn Mountain unit is present as bedrock throughout Camp Bonneville. The uppermost bedrock is severely weathered as characterized by clay-rich materials described in boring logs from throughout the site.

The Sandy River Mudstone unconformably overlies the basaltic andesite and was formed when the Portland Basin was a lake fed by the ancestral Columbia and Willamette Rivers (Orr and Orr 1999; Evarts 2006). The mudstone is characterized in boring logs from throughout Camp Bonneville by clayey siltstone and fine-grained sandstone. At Camp Bonneville, the Sandy River Mudstone is present in a small valley that extends between Camp Killpack and Camp Bonneville cantonments (Figure 1-3; BCRRT 2009a).

The Troutdale Formation is the result of deposition of western flowing streams that crossed the Cascade Range; including the ancestral Columbia River. An older conglomerate member of the Troutdale Formation is present along the west - southwest portion of Camp Bonneville (Evarts 2006). In addition, a remnant of the conglomerate is present in the Landfill 4/Demolition Area 1. At Camp Bonneville, the conglomerate is deeply weathered. It is described as a weakly to moderately cemented pebble and cobble conglomerate with lenses of coarse sandstone (BCRRT 2009a).

Recent alluvium and landslide deposits are present along Lacamas Creek, East Fork Lacamas Creek, North Fork Lacamas Creek, and David Creek (Evarts 2006). The alluvial deposits consist of unconsolidated silt, sand, and gravel. Well-rounded quartzite pebbles from the Troutdale Formation are present in these deposits (BCRRT 2009a). Recent landslide deposits consist of diamictons of bedrock and surficial material that has been transported downslope. These landslide deposits are located in areas of steep bedrock terrain and appear to be the result of failed weathered, clay-rich, flow breccias (BCRRT 2009a).

1.2.4.1.2 Aquifer System

Camp Bonneville lies within the Portland Basin portion of the Willamette Lowland Aquifer System. The Portland Basin is bounded to the east by the

Cascade Mountains, to the north by the Lewis River, and to the west by the Coast Range.

The Basaltic Andesite of the Elkhorn Mountain unit generally has little capacity to store or transmit water. Where water is present, it is located at the soil/rock interface or in fractured zones within the rock (McFarland and Morgan 1996). At Camp Bonneville this unit is not considered to be a productive aquifer with some exceptions where potable water has been encountered in fracture zones.

The Sandy River Mudstone is a low permeability unit. As described in the Geology section above, this unit is only present in a small valley that extends between Camp Killpack and Camp Bonneville cantonments. It is not present at Landfill 4/Demolition Area 1.

The Troutdale Conglomerates generally are considered excellent water-bearing units and commonly serve as water sources for municipal, industrial, and irrigation supplies (McFarland and Morgan 1996). In 2006, EPA designated the Troutdale aquifer a sole-source aquifer in the Clark County, Washington area. This aquifer system provides approximately 99 percent of the available drinking water to the residents living over it. No other drinking water sources are available that would be economically feasible to supply these residents (EPA 2006). At Camp Bonneville the Conglomerate Member of the Troutdale Formation is present along the west - southwest portion of Camp Bonneville (Evarts 2006). In addition, a remnant of the conglomerate is present in the Landfill 4/Demolition Area 1. The remnant is disconnected/isolated from the Troutdale Conglomerate located at the west – southwest property line of Camp Bonneville. The remnant was most likely isolated from the rest of the unit to the west - southwest by the downcutting of Lacamas Creek. Camp Bonneville lies within the Streamflow Source Area of the Troutdale Aquifer. The Streamflow Source Area is defined by EPA as "the upstream headwaters area of streams that flow into the recharge area of the aquifer" (EPA 2006).

Movement of ground water in the Portland Basin is primarily controlled by topography (Morgan and McFarland 1996). Topography also appears to control ground water flow at Camp Bonneville (BCRRT 2009a). Ground water typically discharges to Lacamas Creek and its tributaries. However, EPA has described ground water pumping in the Lacamas Creek watershed that has resulted in a lowering of the potentiometric surface. This lowering of ground water levels has resulted in losing reaches of Lacamas Creek and its tributaries (EPA 2006).

1.2.4.1.3 Troutdale and Unconsolidated Alluvium Aquifer System Sole Source Aquifer Designation

In November 2005, a petition was submitted to EPA to designate the Troutdale and Unconsolidated Alluvium Aquifer as a sole source of drinking water in the area of Clark County, Washington. The petitioners included: Columbia Riverkeeper, Rosemere Neighborhood Association, and eight independent Clark County citizens.

The Sole Source Aquifer Program is authorized by the Safe Drinking Water Act of 1974. EPA defines a sole or principal source aquifer as "an aquifer or aquifer system which supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer, and for which there is no alternative source or combination of alternative drinking water sources which could physically, legally, and economically supply those dependent upon the aquifer. For convenience, all EPA designated sole or principal source aquifer systems are often referred to simply as "sole source aquifers".

The aquifer system boundaries that were originally petitioned were slightly extended in the south, east, and northern sections of the area as recommended by EPA during their review of the petition. The final boundaries are presented in Figure 1-47. The Columbia River forms the southern and western boundaries of the Troutdale aquifer system. The northern boundary follows the North Fork of the Lewis River from its confluence with the Columbia River, east to the confluence of Cedar Creek. Cedar Creek is used as the northeast boundary between the Troutdale unit and the older rocks unit, and the creek also most likely acts as a local ground water divide for the upper parts of the aquifer system. The aquifer boundary follows Cedar Creek east where the boundary turns southeast and follows the mapped geologic contact between the Troutdale Formation and the older rock unit. The eastern boundary follows the geologic contact south to the Little Washougal River, then follows the Little Washougal River to its confluence with the Washougal River. The boundary then follows the Washougal River south to Woodburn Hill, where it turns northwest and follows the geologic contact along a small outcrop of the older rocks unit. The boundary follows the geologic contact through the City of Camas, and meets the Columbia River. In the northern part of the area, the aquifer system boundary is drawn around Bald Mountain, which is excluded from the aquifer system because it is composed of the older rocks unit (EPA 2006).

Based on the information included in the petition and findings during its review, the EPA concluded "A sole source aquifer system must supply at least 50 percent of the drinking water consumed within the natural boundaries of the aquifer system, and there can be no economically or legally available alternative source that could supply the entire population living in the area. The Troutdale Aquifer System supplies over 99% of the drinking water to people living in the petitioned area, and there are no economical and legally available alternative sources of water. The political and legal constraints on available water supplies in the area cause even potentially adequate volumes to be unattainable within any reasonable timeframe. Given these conditions, the Troutdale Aquifer System meets the criteria or EPA designation as a sole or principle source aquifer under Section 1424(e) of the Safe Drinking Water Act." (EPA 2006)

1.2.4.1.4 On-Site Ground Water Monitoring

Twenty-seven monitoring wells exist at Camp Bonneville. Of these 27 wells, 19 are currently monitored. Monitoring wells at Demolition Area 2 and Demolition

Area 3 are no longer sampled after previous quarters sampling events resulted in no exceedances of MTCA cleanup levels for site contaminants of concern. The majority of these wells are located in the valley that follows Lacamas Creek through Camp Bonneville (Central Valley). As described in Ground Water Sampling and Analysis Report for Camp Bonneville for the 4th quarter of 2006 (PBS 2007), the following wells are currently monitored at the site:

- Base Boundary at Lacamas Creek
    - Paired wells: LC-MW01S and LC-MW01D
    - Paired wells: LC-MW02S and LC-MW02D
    - Paired wells: LC-MW03S and LC-MW03D
    - Paired wells: LC-MW04S and LC-MW04D
- Landfill 4/Open Burning/Demolition Area 1 (A – shallow, B – deep)
    - Paired wells: L4-MW01A and L4-MW01B
    - Paired wells: L4-MW02A and L4-MW02B
    - Paired wells: L4-MW03A and L4-MW03B
    - L4-MW04A
    - L4-MW05A
    - L4-MW07B
    - L4-MW17 (bedrock)
    - L4-MW18 (alluvium)

Quarterly ground water sampling at Camp Bonneville includes well depth data as well as static water-level data in each monitoring well. In addition, ground water samples collected from Base Boundary at Lacamas Creek monitoring wells are analyzed for:

Field measurements (pH, specific conductance, temperature, and total dissolved solids), TPH-Gx (gasoline), TPH-Dx (diesel), VOCs, SVOCs, explosive compounds [including HMX, RDX, NG, and PETN], picric acid, perchlorate, priority pollutant metals (total and dissolved), TOC, DOC, TSS, alkalinity, and inorganic ions.

Ground water samples collected from Landfill 4/Open Burning/Demolition Area 1 monitoring wells are analyzed for:

Field measurements (pH, specific conductance, temperature, and total dissolved solids), VOCs, explosive compounds (including HMX, RDX, NG, and PETN), and perchlorate.

Based on the quarterly monitoring report (PBS 2007) for Base Boundary wells at Lacamas Creek, metals concentrations have decreased over the period of monitoring. Petroleum hydrocarbons have not been detected in any samples over the period of monitoring with the exception of a single detection of diesel range petroleum hydrocarbons (0.14 milligrams per liter in January 2006). Perchlorate concentration trends in ground water samples has been variable despite Interim Removal Actions that have occurred at Landfill 4/Open Burning/Demolition Area 1.

Based on the 4th quarter 2006 monitoring report (PBS 2007), depth to ground water in the area of Landfill 4/Demolition Area 1 ranged from approximately 11 to 30.8 feet (note: all depths to ground water are described from top of casing rather than the land surface). Depth to ground water in monitoring well L4-MW07B located downstream of the landfill was approximately 30.32 feet. Depth to ground water in monitoring wells L4-MW17 and L4-MW18, along North Fork Lacamas Creek at the base of the stream ravine and downgradient of Landfill 4/Demolition Area 1 was 9.63 feet and 10.14 feet, respectively.

1.2.4.1.5 Drinking Water Targets

Approximately 9,627 people use ground water for drinking water purposes within the 4-mile TDL. A combination of Group A and Group B community water systems; and domestic wells are present. The Washington Administrative Code (WAC) defines the group designation for community water systems. The definitions as provided by the Washington state Department of Health are:

> **Group A:** (WAC 246-290) Group A water systems are those with fifteen or more service connections, regardless of the number of people; or systems serving an average of twenty-five or more people per day for sixty or more days within a calendar year, regardless of the number of service connections. Group A water systems do not include systems serving fewer than fifteen single-family residences, regardless of the number of people.
> **Group B:** (WAC 246-291) Group B water systems serve less than 15 residential connections and less than 25 people per day; or 25 or more people per day fewer than 60 days per year. Group B water systems are those public water systems that do not meet the definition of a Group A water system.

DOH maintains records of all active public water systems. Public water systems, regardless of group designation, indicate the total number of wells in the system, number of connections, and total population served. A search of the DOH Sentry Internet database revealed the presence of 18 Group A community wells serving a total population of 830 people and 182 Group B community wells serving a total population of 1,083 people (WDOH 2009).

Domestic drinking water well logs are maintained by Ecology. A search of the Ecology well log database revealed the presence of a total of 3,269 domestic wells within the 4-mile TDL. Domestic wells do not record the actual number of people served by each well; therefore, each well is assigned the average number of people per household for Clark County, Washington of 2.36 for a total population served by domestic wells of 7,715 people (DOC 2001; Ecology 2009). Population figures were rounded the neared whole integer for reporting purposes. The number of drinking water wells and associated population within the 4-mile TDL by distance ring is presented in Table 1-3.

Given the surrounding land use, it is assumed that ground water is used for the irrigation of commercial livestock within the TDL. A wellhead protection area is present within the 4-mile TDL.

1.2.4.2 Surface Water Migration Pathway

The surface water migration pathway TDL begins at the probable point of entry (PPE) of surface water runoff from the site to a surface water body and extends downstream for 15 miles. Figure 1-46 depicts the surface water migration TDL.

The average annual precipitation for Vancouver, Washington is 39.48 inches (WRCC 2009). The 2-year 24-hour rainfall event for Vancouver, Washington is 2.5 inches (NOAA 1973). Portions of the site are located in a 100 year flood plain (FEMA 1991).

Soils at the site consist of Hesson clay loam (0 to 8 percent slopes) and McBee silty clay loam (0 to 3 percent slopes). The Hesson clay loam is the predominant soil type in the county. In a typical soil profile, the surface layer is a reddish-brown clay loam approximately 8 inches thick. The subsurface layer is dark reddish-brown clay loam approximately 4 inches thick. Below this layer is friable, dark reddish-brown clay loam approximately 10 inches thick. The next layer to a depth of approximately 91 inches is reddish-brown clay. The Hesson clay loam is well drained and has moderately slow permeability. The McBee clay loam occurs on depressions that are sometimes subject to flooding from nearby streams. In a typical profile, the surface layer is a silty clay loam approximately 11 inches thick. It is very dark brown in the upper portion and dark brown lower portion. The next layer is approximately 41 inches thick and is comprised as follows: 10 inches of friable very dark reddish-brown silty clay loam; 11 inches of firm dark brown silty clay loam and the lower 20 inches is firm grayish-brown and dark yellowish-brown silty clay loam. The underlying material to a depth of approximately 65 inches is gray and brown clay. The McBee silty clay loam is somewhat poorly drained and moderately permeable (USDA 1972).

1.2.4.2.1 Overland Route

Overland flow from sources at the site enters Lacamas Creek in the central valley floor. Lacamas Creek exits the site in the southwest corner of the post and flows for approximately 12.61 miles (through Lacamas Lake) to its confluence with the Washougal River, and then continues approximately 1.43 miles downstream to the confluence with the Columbia River. The 15-mile TDL concludes approximately 0.96 miles downstream in the Columbia River. Flow rates are not available for Lacamas Creek or Lacamas Lake. The flow rate for the Washougal River as measured at Washougal, Washington (near the confluence of Lacamas Creek and the Washougal River) is 800.5 cubic feet per second (cfs) and the flow rate for the Columbia River at Vancouver, Washington is reported to be 215,900 cfs (USGS 2009). Flow rates for Lacamas Creek and Lacamas Lake are estimated to be between 10 and 100 cfs.

1.2.4.2.2 Drinking Water Targets

Surface water is not used for drinking water purposes within the TDL. The Columbia River is a major recreation area.

1.2.4.2.3 Human Food Chain Targets
Two artificial impoundments on Lacamas Creek were created to support a trout sports fishery (WC 1997). These impoundments are no longer fished; however, they were actively used when the site was in operation. Fish catch is not reported for Lacamas Creek or Lacamas Lake; however, it was reported that these water bodies are known fishing locations for human consumption (Reynolds 2009). It is estimated that greater than 1 to 100 pounds of fish are caught annually from the creek or the lake for human consumption. Fishing is not known, nor expected, to occur above Lacamas Lake due to the presence of a dam which does not contain fish ladders to allow the passage of fish from the lake to the creek.

The most current sport catch data are from 2000 to 2001 (WDFW 2005). Fishing is reported for the entire Washougal River, of which approximately 1 percent lies within the TDL. Fish catch data is presented in numbers of fish caught; therefore, the average weight of each fish is used to determine the pounds of fish caught within the TDL. The total pounds of each fish species is then multiplied by 1% to determine the pounds of fish caught within the TDL. Fish catch for the Columbia River is reported from the Bonneville Dam to the Columbia River, of which approximately 0.5% is within the TDL. The same process for determining pounds of fish within the TDL as discussed above is used here. Fish catch data is presented in Table 1-4. In this table, fish catch estimates have been rounded to the nearest whole number.

1.2.4.2.4 Environmental Targets
State and Federal-listed threatened and endangered species are present within the TDL. The Federal-listed threatened Lower Columbia River Evolutionarily Significant Unit (ESU) Steelhead (*Oncorhynchus mykiss*), the Lower Columbia River ESU Chinook salmon (*Oncorhynchus tshawytscha*), and the Lower Columbia River ESU Chum salmon (*Oncorhynchus keta*) are present within Lacamas Creek, the Washougal River, and the Columbia River. The Federal-listed endangered Bradshaw's Lomatium (*Lomatium bradshawii*) is present within Lacamas Creek. Additionally, the State-listed threatened Dense Sedge (*Carex densa*), Hall's aster (*Aster hallii*), the Oregon coyote thistle (*Eryngium petiolatum*), and the Western Wahoo (*Euonymus occidentalis*) are present on Lacamas Creek (Maguire 2009). Table 1-5 provides a summary of the environmental targets within the TDL.

A total of 15.81 miles of wetland frontage are present along the TDL (Maguire 2009). Wetland frontages by surface water body within the TDL are as follows:
- Lacamas Creek – 15.08 miles (of which 6.84 miles are within the boundaries of the site);
- Washougal River – 0.61 mile, and
- Columbia River – 0.12 mile.

In 1998, Hart Crowser performed a limited surface water investigation of Lacamas Creek and its tributaries. A total of six surface water samples (HC-H1 though HC-H5 and HC-D1) and one blind duplicate sample (HC-D10) were collected during the investigation. Five samples were collected from near the headwaters of various tributaries to Lacamas Creek near their entry points to the post to determine concentrations upstream of the post: sample HC-H1 was collected from East Fork Lacamas Creek, sample HC-H2 was collected from an unnamed tributary to David Creek, sample HC-H3 was collected from David Creek, sample HC-H4 was collected from North Fork Lacamas Creek, and sample HC-H5 was collected from an unnamed tributary to the North Fork Lacamas Creek (see Figure 1-8). Samples HC-H1 through HC-H5 were composited at the laboratory into one sample. One sample was collected from Lacamas Creek downstream of the post (HC-D1) just before the creek exits the post. Sample results indicate that the dissolved metal barium and the total metals arsenic, barium, cadmium, chromium, copper, silver, and zinc were detected at concentrations above the composited up-post sample concentrations. (HC 1998)

Based on sample results from this investigation, a zone of actual contamination is present along Lacamas Creek within the boundaries of the site.

1.2.4.3 Soil Exposure Pathway

The soil exposure pathway is evaluated based on the threat to resident and nearby populations from soil contamination within the first two feet of the surface.

1.2.4.3.1 Site Setting and Exposed Sources

The site is surrounded by a maintained fence and security. The current use of the site does not include any recreational use.

1.2.4.3.2 Targets

A total of 2,780 people reside within a 1 mile travel distance of the site (Maguire 2009). The nearest residence is located on site. This residence is populated by two people. A total of between 2 and 30 people work at the site. Table 1-6 provides a summary of the population within the TDL.

The site is not used for commercial agriculture, commercial silviculture, commercial livestock production, or commercial livestock grazing.

The State-listed endangered Hairy-stemmed checker-mallow (*Sidalcea hirtipes)* is present on site (Maguire 2009).

1.2.4.4 Air Migration Pathway

The air migration pathway TDL is a 4-mile radius that extends from the sources at the site (Figure 1-44).

1.2.4.4.1 Human Targets

A total of 29,873 people reside within the 4-mile TDL. The population by distance ring is presented in Table 1-6. Additionally, five schools with a total population of students and teachers of 3,319 people are present from 3 to 4 miles of the site.

Commercial agriculture, commercial silviculture, or a major or designated recreation area is not present within the TDL.

1.2.4.4.2 Environmental Targets:

Federal- and State-listed threatened and endangered species and wetlands are present within the 4-mile TDL. The Federal-listed threatened Lower Columbia River ESU Steelhead (*Oncorhynchus mykiss*), the Lower Columbia River ESU Chinook salmon (*Oncorhynchus tshawytscha*), the Lower Columbia River ESU Chum salmon (*Oncorhynchus keta*), and the Federal-listed endangered Bradshaw's Lomatium (*Lomatium bradshawii*) are present within the TDL. Additionally, the State-listed threatened Dense Sedge (*Carex densa*), Hall's aster (*Aster hallii*), the Oregon coyote thistle (*Eryngium petiolatum*), the Western Wahoo (*Euonymus occidentalis*), the Western Gray Squirrel (*Sciurus griseus*), and the State-listed endangered Hairy-stemmed checker-mallow (*Sidalcea hirtipes)* are present within the TDL (Maguire 2009). Table 1-5 provides a summary of the environmental targets within the TDL.

A total of 1,489.77 acres of wetlands are present within the TDL (Maguire 2009). Wetland acreage by distance ring is presented in Table 1-6.

1.2.5 Areas of Potential Contamination

Sampling under the Camp Bonneville SI will be conducted at and/or surrounding those areas considered potential contamination sources and at areas that may have been contaminated through the migration of CERCLA-regulated hazardous substances from sources on site. Based on a review of background information, a number of areas or features have been identified for inspection under the Camp Bonneville SI. Section 2 of this document includes a discussion of sample locations and rationale.

1.3 Project/Task Description and Schedule

This subsection provides the project description (subsection 1.3.1) and proposed schedule (subsection 1.3.2).

1.3.1 Project Description

This subsection defines the objectives and scope for performing the SI activities at Camp Bonneville. The main goals for the SI activities are as follows:

- Collect and analyze samples to characterize the potential sources discussed in Section 2;
- Determine potential for off-site migration of contaminants;
- Provide the EPA with adequate information to determine whether the site is eligible for placement on the NPL;
- Document a threat or potential threat to public health or the environment posed by the site; and
- Install monitoring wells and piezometers near Landfill 4 to fill data gaps regarding the perchlorate and RDX plume associated with the landfill.

1.3.2 Schedule

The schedule for implementing the Camp Bonneville SI is intended to be used as a guide. Adjustments to the implementation dates and the estimated project duration may be necessary to account for variable unforeseen or unavoidable conditions that the field team may encounter. Examples include inclement weather, difficulties in accessing a sampling site, unforeseen site conditions, or additional time needed to complete a task. Significant schedule changes that arise in the field will be discussed with the TM at the earliest possible opportunity.

The START-3 will be conducting SI sampling activities in a phased approach. Work will be conducted during daylight hours only. The proposed schedule of project work is provided in Table 1-7. The sampling phases are outlined below. Section 2.1.1. of this report provides greater detail, including the number of samples and sample depths, for each phase described below. The installation of up to 15 temporary well points along the bank of Lacamas Creek adjacent to Landfill 4; installation of up to three hand-installed, permanent monitoring wells; collection of ground water samples from existing monitoring wells; collection of surface water and sediment samples in Lacamas Creek; and collection of surface soil and sediment samples associated with the “pop-up” pond will be conducted in two phases as outlined below. The collection of surface soil samples may be conducted as part of the second phase of work or as a separate phase of work. The collection of the surface soil samples will be at the discretion of the TM.

The work proposed for Phase I includes:

- **Landfill 4:** Collection of ground water samples from existing monitoring wells.
- **Lacamas Creek:** If flow in Lacamas Creek permits, up to 15 temporary well points will be installed and sampled in Lacamas Creek and up to 3 permanent monitoring wells will be installed based on field screening results.
- **Background and QA/QC Samples:** Background surface soil, subsurface soil, and ground water samples will be collected. Investigation–derived waste samples and rinsate samples from drilling equipment, and will be collected.

The work proposed for Phase II includes:

- **Landfill 4:** Ground water samples may be collected from the monitoring wells installed during Phase I and from the six existing monitoring wells.
- **Lacamas Creek:** Collection of surface water and sediment samples from Lacamas Creek. If monitoring wells could not be installed during Phase I then they will be installed and sampled during Phase II.
- **Pop-up Pond:** Collection of sediment samples from the perimeter of the pond. Collection of surface soil samples from areas near the pond.
- **Background Samples:** Background ground water, surface water, and sediment samples will be collected based on target/source sample media types collected during this phase of work.

The work proposed for tentative Phase III or in conjunction with Phase II includes:

- **Firing Ranges:** Grab surface soil samples will be collected from several of the firing points and ranges at the site. Firing points and ranges will be selected for sampling based on, but are not limited to, proximity to surface water bodies, past use, and visual observations. Collection of grab and/or multi-increment sampling (MIS) surface soil samples at some of the firing ranges.
- **Central Impact Target Area:** Collection of grab and/or MIS surface soil samples in the vicinity of the CITA.
- **OB/OD Areas:** Collection of grab and/or MIS surface soil samples from the three OB/OD areas.
- **Background and QA/QC Samples:** Background surface soil and MIS samples may be collected depending on the type of source samples collected. If MIS samples are collected, rinsate samples will be collected from the MIS sampling tool.

1.4 Quality Objectives and Criteria for Measurement Data

The project data quality objectives (DQOs) are to provide valid data of known and documented quality to characterize sources, to determine off-site migration of contaminants, to determine whether the site is eligible for placement on the NPL, and to document threat(s) or potential threat(s) to public health or the environment posed by the site. The DQO process applied to this project follows that described in the document *Guidance for the Data Quality Objectives Process* (EPA 2000). See subsection 2.5 for a detailed measurement criteria discussion.

1.4.1 DQO Data Categories

All samples collected under this SQAP will be analyzed using definitive analytical methods. All definitive analytical methods employed for this project will be methods approved by the EPA. The data generated under this project will comply with the requirements for this data category as defined in *Data Quality Objectives Process for Superfund* (EPA 2000).

1.4.2 Data Quality Indicators

Data quality indicators (DQI) representativeness, comparability, completeness, precision, and accuracy goals for this project were developed following guidelines presented in the EPA *Guidance for Quality Assurance Project Plans*, EPA QA/G-5 (EPA 2002).

The basis for assessing each of the elements of data quality is discussed in the following subsections. Subsection 2.5 presents the QA objectives for measurement of analytical data and quality control (QC) guidelines for precision and accuracy. Other DQI goals are included in the individual Standard Operating Procedures (SOPs) in Appendix A and in the Laboratory Statement of Work (SOW).

1.4.2.1 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represents a population, including a sampling point, a process condition, or an environmental condition. Representativeness is the qualitative term that should be evaluated to determine that measurements are made, and physical samples collected, at locations and in a manner resulting in characterizing a matrix or media. Subsequently, representativeness is used to ensure that a sampled population represents the target population and an aliquot represents a sampling unit. This SQAP will be implemented to establish Representativeness for this project. Further, all sampling procedures detailed in the SQAP will be followed to ensure that the data will be representative of the media sampled. The SQAP describes the sample location, sample collection, and handling techniques that will be used to avoid contamination or compromise sample integrity, and ensure proper chain-of-custody of samples. Additionally, the sampling design presented in the SQAP will ensure that there are a sufficient number of samples and level of confidence that analysis of these samples will detect the chemicals of concern, if present.

1.4.2.2 Comparability

Comparability is the qualitative term that expresses the measure of confidence that two data sets or batches can contribute to a common analysis and evaluation. Comparability with respect to laboratory analyses pertains to method type comparison, holding times, stability issues, and aspects of overall analytical quantitation. The following items are evaluated when assessing data comparability:

- Determining if two data sets or batches contain the same set of parameters.
- Determining if the units used for each data set are convertible to a common metric scale.
- Determining if similar analytical procedures and quality assurance were used to collect data for both data sets.
- Determining if the analytical instruments used for both data sets have approximately similar detection levels.
- Determining if samples within data sets were selected and collected in a similar manner.

To ensure comparability of data collected during this investigation to other data that may have been or may be collected for each property, standard collection and measurement techniques will be used.

1.4.2.3 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not rejected through data validation. The requirement for completeness is 95% for aqueous samples and 90% for soil and sediment samples.

The following formula is used to calculate completeness:

$$\% \text{ completeness} = \frac{\text{number of valid results} \times 100}{\text{number of possible results}}$$

For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.
For this investigation, all samples are considered critical. Therefore standard collection (as defined in the sampling SOPs of Appendix A) and measurement methods will be used to achieve the completeness goal.

1.2.4.4 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. *Analytical* precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. The laboratory control sample (LCS) determines the precision of the analytical method. If the recoveries of the analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch. Rather, the comparison is between the sample and samples analyzed in previous batches.

Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results.

The following formula is used to calculate precision:

$$RPD = (100) \times \frac{(S1 - S2)}{(S1 + S2)/2}$$

where:

S1 = original sample value
S2 = duplicate sample value

In general, precision less than or equal to 35% relative percent difference will fulfill the DQOs.

1.4.2.5 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike and standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For pesticide, PCB, volatile, and semivolatile organic compounds, system monitoring compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples may also be used to provide additional information for assessing the accuracy of the analytical data being produced. In general, accuracy between 50% and 150% will fulfill the DQOs.

1.5 Special Training Requirements/Certification

No special training requirements or certifications are required for this project except for the 40-hour Hazardous Waste Operations and Emergency Response class and annual refreshers. Health and safety procedures for E & E personnel are addressed in the E & E site-specific Health and Safety Plan. This document is maintained in E & E's Seattle office. Included in the plan are descriptions of anticipated chemical and physical hazards, required levels of protection, health and safety monitoring requirements and action levels, personal decontamination procedures, and emergency procedures. Safety monitoring for this site will include surveying for potential presence of radiation. Additionally, an EPA-contracted, certified UXO technician will be present during all sampling activities. The UXO technician will clear all sampling locations prior to sample collection. The guidance for UXO clearing, as provided by the EPA-contractor, is located in Appendix B.

1.6 Documentation and Records

This document is meant to be combined with information presented in E & E's (2005b) *Region 10 START-3 Quality Assurance Project Plan*. This information is covered by the SOPs found in Appendix A, and the supplemental forms found in Appendix C. A copy of the START QAPP is available in E & E's Seattle office. Standards contained in the SOPs, the START QAPP, and the QMP will be used to ensure the validity of data generated by E & E for this project.

Following the completion of field work and the receipt of analytical data, a report summarizing project findings will be prepared. Project files, including work plans, reports, analytical data packages, correspondence, chain-of-custody documentation, logbooks, corrective action forms, referenced materials, and photographs, will be provided to the EPA TM at the close of the project. Further, a CD-ROM deliverable containing the final report will be provided.

E & E will assemble and fully document a digital data set including all project sampling, analysis, and observation data. This digital data will be made available in a Microsoft-Access format.

E & E will transfer this data set and documentation to EPA, or if requested, to any other EPA contractor, and shall ensure that any data transferred is received in an uncorrupted, comprehensible, and usable format. Specific data deliverable elements are presented below.

Data
A summary description of the tables, the sources of information and other comments are provided below.

Field-Info
The field information table contains all sample collection related information. A Microsoft Access application (Sample Information System, SIS) will be used to input and store the data. The SIS provides the user with "smart" data input forms that will only allow for the entry of acceptable data field values. For each sampling event, the SIS will be updated to reflect the new samples collected. Once entered, the information will be checked and corrected where necessary. The table structure is presented below.

Field Name	Type	Size	Description
Sample-Num	Character	10	Sample Number
Station	Character	10	Station Identifier
Date	Date	8	Sample Date
Time	Numeric	4	Sample Time (24-Hour clock)
Sampler	Character	25	Person Name
Matrix	Character	6	Sample Matrix – (i.e., soil boring, ground water, sediment)
Water Depth	Numeric	5.1	Depth of water as sediment sample
Description	Character	40	Sample Description
Comments	Character	40	Comments

Location
The location table contains sample location coordinate information. The sample locations will be determined using Trimble Pro-XR GPS units. E & E personnel have been trained and have utilized these units in similar projects. For each day or half-day in the field that GPS sample location data is to be collected, the GPS user will create a single file that contains the locations of each sample station. A unique station label will be entered for each sample location. This unique station identifier will be used to link the "Location" table with the "Field-Info" table. This information will be downloaded from the GPS unit and imported into the "Location" table of the Sample Data Management System (SDMS). All locational data for this project will be stored in decimal degrees, and will be referenced to the World Geodetic System (WGS) 1984 horizontal datum. Differential corrections will be made real-time. The table structure is presented below.

Field Name	Type	Size	Description
Station	Character	10	Station Identifier
X-Coord	Numeric	12.6	X-Coordinate, Decimal Degrees
Y-Coord	Numeric	12.6	Y-Coordinate, Decimal Degrees

Lab Analytical

The Lab Analytical table will hold all of the sample analysis results provided by each laboratory analyzing samples. The integrity of each data file received from the labs will be checked and verified. Once the files are received, they will be appended into the SDMS Lab Analytical table. The "Sample-num" field will be used to link the "Lab Analytical" table with the "Field-Info" table. The table structure is presented below.

Field Name	Type	Size	Description
Sample-num	Character	10	Sample Number
Lab-id	Character	10	Laboratory Sample Identifier
Method	Character	25	Analytical Method Used
L-Matrix	Character	10	Laboratory Matrix
Cas-num	Character	15	Chemical Abstracts
Analyte	Character	40	Analyte Name
Result	Numeric	12.6	Analysis Result
Qual	Character	6	Sample qualifier
Quantitation-Limit	Numeric	12.6	Sample quantitation limit
Units	Character	10	Results unit
Date	Date	8	Date analyzed
Lab	Character	40	Lab name

For any Geographic Information Systems (GIS) produced maps, E & E shall provide the maps to EPA in hard copy and digital image (i.e. JPEG) formats.

2 Measurement/Data Acquisition

2.1 Sampling Process Design (Experimental Design)

During the Camp Bonneville SI, samples will be collected from locations or features considered potential contamination sources, from selected potential hazardous substance migration pathways, and from potential targets in those pathways. The locations or features to be sampled have been determined based on information derived from a review of background data and interviews with site representatives and regulatory agencies. Table 2-1 provides information regarding the sampling design rationale and whether the measurement is considered critical or noncritical.

At the time of sampling, site-specific conditions (e.g., topography or visual evidence of contamination) will be evaluated and incorporated, when applicable, into the placement of sampling locations. Other conditions potentially contributing to deviations from the projected sampling locations include new observations or information obtained in the field that warrants an altered sampling approach, or difficulty in reaching a desired soil sampling depth caused by high-density soil, obstructions, or limited access to a sampling location. Significant deviations from the planned sampling locations or number of samples to be collected will be discussed with the EPA TM before implementation and will be documented on a Sample Plan Alteration Form (SPAF-Appendix D). Every attempt will be made to collect representative samples with the equipment being used.

Care will be taken for the protection of cultural/historical resources and will include:

- Protection of surface water bodies including streams, ponds, and wetlands by conducting clearing and excavation activities within specified buffer zones around these resources with hand tools and by implementing other appropriate measures to eliminate, minimize, or mitigate the impact of the sampling actions on these resources; and
- Implementation of specified measures to prevent erosion and sediment impacts on surface water bodies where and when excavation or other soil disturbing activities are necessary to implement this sampling investigation.

This subsection will describe sample locations (subsection 2.1.1), the GPS (subsection 2.1.2), logistics (subsection 2.1.3), cooler return (subsection 2.1.4), and coordination with federal, state, and local authorities (subsection 2.1.5).

2.1.1 Sample Locations

Sample locations will be selected to achieve the objectives discussed in subsection 1.3.1. Samples will be submitted for nitroaromatics and nitroamines (EPA Method SW-846 8330B), perchlorate (EPA Method SW-846 6860 or 332), and Metals (EPA SW-846 6010). Additionally, samples will be field-screened for perchlorate using the modified Corps screening method for perchlorate. Table 2-2 presents the types of samples, analytical methods, specific requirements for sample container size and type, sample preservation and holding times, special handling requirements for samples, and the number of QA/QC samples expected to be collected at the site.

A summary of sampling locations and rationale is provided below:

<u>Phase I and II Sampling Events -</u>
Potential Sources:
Landfill 4: A perchlorate and RDX plume is present at Landfill 4. In order to determine if the perchlorate and RDX plume is impacting Lacamas Creek, shallow ground water and soil samples will be collected. Shallow ground water samples will be collected by installing up to 15 temporary well points approximately every 100 feet along the eastern bank of Lacamas Creek between monitoring well L4-MW7B and the bridge north of Landfill 4 (Figure 2-1). Water samples collected from the temporary well points will be field screened for perchlorate. Locations of up to three hand-installed, permanent monitoring wells will be determined based upon field screening analytical results of ground water and subsurface soil (discussed below) samples. The newly installed permanent monitoring wells also will be field screened for perchlorate. The screening level for perchlorate at the site is 15 μg/L, which is the Interim Drinking Water Health Advisory Level. This is based on the recommendations of the National Research Council (NRC) of the National Academies as reported in the "Health Implications of Perchlorate Ingestions" (NRC 2005). The NRC recommended, and EPA adopted, a reference does of 0.7 μg/kg/day (EPA 2008a). Sample aliquots will be collected from all temporary well points and newly installed permanent monitoring wells for off-site fixed laboratory analysis of perchlorate (EPA Method SW-846 6860 or 332), nitroaromatics and nitroamines (EPA Method SW-846 8330B) SVOCs (EPA Method SW-8270), VOCs (EPA Method SW-8260), and metals (EPA Method SW-846 6010).

One subsurface soil sample will be collected prior to and adjacent to each temporary well point. The subsurface hand augured borings will be advanced to ground water, this depth to ground water information will be used to determine the depth for the temporary well points. The subsurface soil samples will be field screened for perchlorate using a modified Army Corps of Engineers method. Additionally, each subsurface soil sample will be submitted for off-site fixed laboratory analysis of perchlorate (EPA Method SW-846 6860 or 332), nitroaromatics and nitroamines (EPA Method SW-846 8330B), SVOCs (EPA Method SW-8270), VOCs (EPA Method SW-8260), and metals (EPA Method SW-846 6010).

Installing temporary well points and hand-installed, permanent monitoring wells will take place during Phase I. Additionally, select existing monitoring wells at Landfill 4 will be sampled. These samples will be analyzed for the same parameters as ground water samples from the newly installed temporary well points and hand-installed, permanent monitoring wells. During Phase II, ground water samples will be collected from the newly installed permanent monitoring wells and also from the same existing monitoring wells sampled for Phase I. These Phase II samples will analyzed for the same parameters as the Phase I samples. The following existing wells have been selected for sampling during Phase I and Phase II:

- L4-MW02A;
- L4-MW02B;
- L4-MW03A;
- L4-MW03B;
- L4-MW04A;
- L4-MW05A;
- L4-MW06A;
- L4-MW17; and
- L4-MW18.

- **Pop-up Pond:** A "pop-up" pond is present west of the CITA. Although this source has been previously sampled, the samples were not analyzed for all constituents of concern with regard to the site. A total of 15 sediment samples will be collected from the perimeter of the pond. Up to 15 surface soil samples will be collected from areas near the pond. The surface soil and sediment samples will be submitted for off-site fixed laboratory analysis of perchlorate (EPA Method SW-846 6860 or 332), nitroaromatics and nitroamines (EPA Method SW-846 8330B), SVOCs (EPA Method SW-8270), VOCs (EPA Method SW-8260), and metals (EPA Method SW-846 6010). These samples will be collected during Phase II.

<u>**Potential Targets:**</u>

- **Lacamas Creek and North Fork Lacamas Creek:** North Fork Lacamas Creek flows adjacent to Landfill 4 for approximately 1 mile to its confluence with East Fork Lacamas Creek. At the point where these two forks converge is the origin of Lacamas Creek which flows through the site for approximately 4 miles. It is possible that contamination from site sources is flowing overland and impacting Lacamas Creek. Wetlands are present on both riverbanks along the entire length of Lacamas Creek within the boundaries of the site. The proposed sample locations for this creek are presented on Figure 2-2. Samples will be collected from the most downstream location and working towards the landfill. Three sediment samples will be collected from one mile increments downstream from the site boundary. These samples will be collected from areas that are publically accessible. Co-located surface water/sediment sample sets will be collected from every mile on Lacamas Creek within the boundaries of the site (a total of 6 sample sets), in addition, sediment samples will be collected every ¼ mile within the boundaries of the site (a total of 8 samples). It is possible that sources of contamination are impacting Lacamas Creek from David Creek, Buck Creek, and East Fork Lacamas Creek. Sediment samples will be collected on these creeks immediately upstream of the confluence with Lacamas Creek and from Lacamas Creek both immediately upstream and immediately downstream of the confluence with these creeks and Lacamas Creek (total of 9 sediment samples). Co-located surface water/sediment sample sets will be collected from North Fork Lacamas Creek near Landfill 4 to the convergence with Lacamas Creek (6 sample sets). If easily determinable, up to ten probable points of entry sediment samples will be collected from Lacamas Creek or its tributaries. The samples will be analyzed for perchlorate (EPA Method SW-846 6860 or 332), nitroaromatics and nitroamines (EPA Method SW-846 8330B), SVOCs (EPA Method SW-8270), VOCs (EPA Method SW-8260), and metals (EPA Method SW-846 6010). Additionally, the surface water samples will be analyzed for dissolved metals in order to compare results to surface water benchmarks. Based on the EPA CLP Samplers Guide (EPA 2009a) each individual inorganic water sample may be analyzed for total metals or dissolved metals, but not both. Therefore, water samples collected for total metal and dissolved metal analyses from the same sampling location must be assigned separate (unique) CLP Sample Numbers. These samples will be collected during Phase II.

In addition, five temporary monitoring wells will be installed in the bed of Lacamas Creek near Landfill 4. These monitoring wells are intended to sample ground water discharging to the creek with limited dilution by surface water. Field-screening results from upland borings/monitoring wells will be used for determining the best placement of monitoring wells in the stream with the intent of intersecting the most likely ground water discharge locations from the Landfill 4 contaminant plume. Because these monitoring wells are being installed in the creek bed, they will be installed by hand. The depth of the monitoring wells is estimated to be approximately 5 feet bgs. If possible, the wells will be installed during the same time-frame as Landfill 4 monitoring well installation during Phase I. If heavy stream flow in Lacamas Creek prevents installation, the wells will be installed in during Phase II. The samples will be analyzed for perchlorate (EPA Method SW-846 6860 or 332), nitroaromatics and nitroamines (EPA Method SW-846 8330B), SVOCs (EPA Method SW-8270), VOCs (EPA Method SW-8260), and metals (EPA Method SW-846 6010).

Background:

- **Subsurface Soil:** Subsurface soil sample will be collected outside of the influence of Landfill 4. The subsurface soil samples will be collected from the same intervals from which source subsurface soil samples were collected. These background sample will be collected during Phase I. Up to two soil intervals will be sampled.

- **Surface Water/Sediment:** One surface water/sediment sample set will be collected from North Fork Lacamas Creek upgradient of Landfill 4, one from David Creek, one from Buck Creek, and one from wetlands upgradient of site sources (if wetlands samples are collected on Lacamas Creek). Locations of background samples are presented on Figure 2-2. These samples will be collected during Phase II.
- **Surface Soil:** One surface soil sample will be collected from an area outside the influence of site sources. The location of the sample will be determined in the field.
- **Ground Water:** Existing monitoring wells L4-MW01A and L4-MW01B at Landfill 4 will be used as the background wells. The location of these wells is presented on Figure 2-1. Additionally, one temporary well point will be installed near Lacamas Creek above Landfill 4 at a background location. These background ground water samples will be collected during Phase I and Phase II. Only the existing background monitoring wells will be sampled during Phase II.

QA/QC Samples:

- **Rinsate:** One sample will be collected from decontaminated well points and hand auger equipment. The samples will be analyzed for metals, perchlorate, nitroaromatics and nitroamines, and SVOCs, and VOCs. This sample will be collected during Phase I.
- **Investigation-Derived Waste:** One sample will be collected from the decontamination water used to decontaminate temporary well points and hand augers. This sample will be collected for purposes of characterizing the waste for disposal. The sample will be analyzed for metals, perchlorate, nitroaromatics and nitroamines, SVOCs, and VOCs. This sample will be collected during Phase I.
- **Trip Blanks:** One sample per VOC cooler will be collected. The samples will consist of deionized water. The samples will be analyzed for VOCs. It is estimated that seven trip blank samples will be collected during both Phase I and Phase II.

Proposed Future Soil Sampling Event: Additional samples may be collected as a part of the Phase II sampling event or as an individual Phase III sampling event. This sampling event will consist of surface soil sample collection at additional potential sources may be conducted at a yet to be determined future date. If this phase of work is initiated, an amendment to this SQAP will be submitted that will outline in greater detail the number and types of samples to be collected. Potential Phase III source areas are presented on Figure 2-3 and briefly discussed below.

- **OB/OD Areas:** There are three OB/OD areas at the site. It is possible that residual contamination is present at these areas. Grab surface soil samples may be collected from each of these areas. Based on samples results, MIS samples may be collected from some or all of these areas. The samples will be analyzed for nitroaromatics and nitroamines, SVOCs, and metals. MIS samples, if collected, would be analyzed for the same constituents.

- **Central Impact Target Area:** The CITA is a known source of deposited munitions, some of which may be unexploded. A total of 15 surface soil samples may be collected from the perimeter of the CITA at locations where overland flow from the CITA is anticipated to enter the East Fork Lacamas Creek and David Creek. Due to the high density of UXO in the CITA, the samples will be collected from the perimeter of the CITA and not from within the fenced area of the CITA. The samples would be analyzed for nitroaromatics and nitroamines, SVOCs, and metals.
- **Firing Ranges:** There are 31 firing ranges and/or points that are awaiting remediation. Grab surface soil samples may be collected from several of these firing points and ranges. Firing points and ranges will be selected for sampling based on, but are not limited to, proximity to surface water bodies, past use, and visual observations. The samples would be analyzed for nitroaromatics and nitroamines, SVOCs, and metals. Based on samples results, MIS may be collected from some or all of these areas. The analysis for the MIS samples, if collected, will be analyzed for SVOCs and metals.
- **Background**: One background grab surface soil sample will be collected from an area outside of the influence of site sources. Further, if MIS sampling is conducted, one background MIS sample will be collected from an area outside of the influence of site sources. Specific background sample locations will be determined in the future.
- **QA/QC Samples:** If MIS sampling is conducted, then two rinsate samples will be collected from the MIST™ sampling tool (see Section 2.2.1 below for a discussion of sampling equipment to be used).

2.1.2 Global Positioning System

GPS units with data loggers will be used to identify the location coordinates of every sample collected, as well as to delineate the boundaries of the potential source areas. GPS coordinates will be provided in the final Camp Bonneville SI report as an appendix. If real-time coordinates cannot be obtained for the site, the START-3 will obtain differential correction data from a local source prior to the start of the survey in order to improve the survey resolution.

2.1.3 Logistics

The Camp Bonneville site is accessible by NE Pluss Road. Field equipment will be transported with the field team. Access to the property will be obtained by the EPA Task Monitor.

Sample aliquots collected for fixed laboratory analysis will be delivered to the EPA Region 10 laboratory or an alternative laboratory as directed by the EPA. All fixed-laboratory samples will be shipped every other day by commercial carrier for express delivery. Sample control and shipping are discussed in subsection 2.3.

2.1.4 Cooler Return

For laboratories other than the EPA MEL, E & E will provide completed air bills accompanied by plastic envelopes with adhesive backs and address labels in the chain-of-custody bags taped to the inside of the cooler lids so the laboratory can return the coolers to E & E. The air bills will contain the following notation: Transportation is for the United States Environmental Protection Agency, and the total actual transportation charges paid to the carrier(s) by the consignor or consignee shall be reimbursed by the Government, pursuant to cost reimbursement contract number EP-S7-06-02. This notation will enable the laboratories to return the sample coolers to E & E's warehouse. The air bills will be marked for second-day economy service and will contain the appropriate TDD number for shipment.

For the EPA MEL or commercial laboratories, an arrangement by E & E for cooler return in this manner is not required.

2.1.5 Coordination with Federal, State, and Local Authorities

The START-3 will keep the EPA TM informed of field event progress and issues that may affect the schedule or outcome of the SI, will discuss problems encountered, will inform the EPA of unusual contacts with the public or the media, and will obtain guidance from the EPA regarding project activities when required. Additionally, the START-3 will notify the EPA RSCC with changes to the sampling schedule for MEL and/or CLP analyses and will provide shipping information on every sample shipment within 24 hours of shipment or before noon on Friday for Saturday delivery. All samples will be shipped to the laboratory within 24/48 hours of sample collection.

2.2 Sampling Method Requirements

This subsection describes sampling methodologies (subsection 2.2.1), sampling equipment decontamination (subsection 2.2.2), investigation-derived waste (IDW; subsection 2.2.3), and SOPs (subsection 2.2.4).

2.2.1 Sampling Methodologies

The START-3 PM and EPA TM will be responsible for ensuring that appropriate sample collection procedures are followed and will take appropriate actions to correct any deficiencies. All samples collected will be maintained under chain-of-custody and will be stored and shipped in iced coolers. Samplers will follow the MEC precautions and guidance as provided by the EPA-contracted UXO technicians. A general letter of guidance regarding these practices is provided in Appendix B.

- **Well Point Installation and Sampling:** A Solinst® Model 615 Drive-Point Piezometer (or similar device) will be used to collect shallow ground water samples. An EPA-contracted UXO technician will be present for the installation of each well point, and will continually monitor the site with a magnetometer to ensure a safe operation. Using a slide hammer, the well point will be advanced to a depth determined to be at least 1-foot below the surface of ground water (determined during subsurface soil sampling). Once in place, a peristaltic pump with dedicated Teflon lined polyethylene tubing will be used to collect a ground water grab sample. Water will be pumped directly into pre-labeled sample containers. The perchlorate aliquot will be filtered using a 0.2-micrometer (µm) polytetrafluoroethylene (PTFE) filter. Headspace will be left in the sample containers in order to prevent anoxic reduction after filtration.

- **Hand-Installed, Permanent Monitroing Well Installation:** All monitoring wells will be installed using a 4-inch diameter hand auger, and if necessary, a section of 4-inch inner diameter polyvinyl chloride (PVC) pipe as a temporary outer casing to prevent borehole wall sloughing. An EPA-contracted UXO technician will be present for the installation of each monitoring well, and will continually monitor the auger hole with a magnetometer to ensure a safe operation. Wells are expected to be completed between 8 and 10-feet bgs, depending on subsurface conditions. Wells will be constructed using 1-inch-inner-diameter, schedule 40 PVC threaded, flush-jointed riser pipes, screened with one 5-foot section of 1-inch, 0.01 inch factory-slotted PVC well screens that are certified clean by the manufacturer. A minimum annular space of 1.5-inches between the borehole and well casing will be maintained. The well casing and screen (fitted with an end cap) will be suspended in the center of the borehole. The filter pack will be placed after the well screen and riser assembly has been lowered into the borehole. The field geologist will pre-determine the volume of filter pack expected to fill the annular space in the filter pack interval and record this in a field logbook. The filter pack should extend from the bottom of the borehole to at least 1.5-feet above the top of the screen and consist of either 10/20, or 20/40 silica sand pack or equivalent, at the field geologists discretion. The top of the filter pack will be continuously sounded during the retraction of the temporary casing by the contactor to ensure the filter pack remains in place during removal of the casing. Before the bentonite seal is placed, the filter pack will be carefully re-measured to ensure correct installation of the sand pack. Additional material will be added to ensure that the position of the sand pack is correct. A minimum 2-foot-thick bentonite seal consisting of medium bentonite chips will be placed above the top of the sand pack. This bentonite seal shall extend to 1-foot bgs. The bentonite chips will be hydrated after placement. The above ground surface completion will not be installed within 24 hours of grout placement. Each new 1-inch monitoring well shall be completed above ground and will have an 6 to 8-inch diameter protective “stovepipe” casing set in a 2-foot by 2-foot by 4-inch sloping concrete apron. The outer protective casing will be 2.5 feet above grade. The monitoring well shall be centered within the protective casing and placed about 2 feet above grade. Concrete or silica sand will be placed between the casing and the stovepipe and prodded to settle the concrete and lock the joint in place. The casing, stovepipe and Sonotube shall be supported until the concrete has hardened. The outer protective casing shall have a lockable steel plate as the cover. The 1-inch diameter monitoring well will have a lockable well cap inside the protective casing. The outer and inner casing shall be vented near the top to prevent potential gas accumulation
- **Well Sampling.** Monitoring well samples will be collected in accordance with the SOP for ground water well sampling presented in Appendix A. The perchlorate aliquot will be filtered using a 0.2-micrometer (µm)

polytetrafluoroethylene (PTFE) filter. Headspace will be left in sample containers in order to prevent anoxic reduction after filtration.

- **Subsurface Soil Sampling.** Subsurface soil samples will be collected using a 2-inch diameter hand auger. An EPA-contracted UXO technician shall present for the collection of each subsurface soil sample and will continuously monitor the borehole with a magnetometer to ensure a safe operation. The hand auger will be used to advance a borehole to the depth at which first ground water is encountered. One subsurface soil sample will be collected from a 6-inch interval just above ground water. The contents of the auger will be emptied into a dedicated stainless steel bowl, thoroughly homogenized, and placed into pre-labeled sample containers using a dedicated stainless steel spoon.
- **Surface Water Sampling.** UXO avoidance will be conducted by the EPA-contracted UXO technician at each sampling location prior to sample collection. Samples will only be collected at locations approved by the EPA-contract UXO technician. Surface water samples will be collected either by hand-dipping the sample container into the water, if possible, or by creating a funnel with a dedicated 1-liter polyethylene sample bottle with the bottom of the bottle removed. Samples will be preserved as required upon sample collection completion. The perchlorate aliquot will be filtered using a 0.2-µm PTFE filter. Headspace will be left in the sample containers in order to prevent anoxic reduction after filtration. For the dissolved metals samples, the sample is filtered through a 0.45-µm filter at the time of collection and preserved with nitric acid.
- **Sediment Sampling.** UXO avoidance will be conducted by the EPA-contracted UXO technician at each sampling location prior to sample collection. Samples will only be collected at locations approved by the EPA-contract UXO technician. Sediment samples (0 to 6 inches bgs) will be collected using dedicated stainless steel spoons. Collected material will be homogenized thoroughly in dedicated stainless steel bowls and placed into pre-labeled containers. Sediment samples co-located with surface water samples will be collected after their corresponding surface water sample in order to avoid cross-contamination of water samples from agitated sediment.
- **Multi-Increment Sampling:** UXO avoidance will be conducted by the EPA-contracted UXO technician at each sampling location prior to sample collection. Samples will only be collected at locations approved by the EPA-contract UXO technician. MIS (0 to 6 inches bgs) samples will be collected using a MIST™ sampling tool. The aliquots will be placed into pre-labeled plastic, zip top bags. The MIST™ sample tool will be decontaminated between MIS locations. The location will be gridded off in equal portions. One increment will be collected from each grid box. Each sample will consist of 30 to 60 increments and weigh approximately 1 to 2 kilograms.
- **Surface Soil Sampling.** UXO avoidance will be conducted by the EPA-contracted UXO technician at each sampling location prior to sample collection. Samples will only be collected at locations approved by the EPA-contract UXO technician. Surface soil (0 to 6 inches bgs) samples will be collected using dedicated stainless steel spoons. Collected material will be

placed in a dedicated stainless steel bowl, thoroughly homogenized, and placed into pre-labeled containers.

2.2.2 Sampling Equipment Decontamination

To the greatest extent possible, disposable and/or dedicated personal protective and sampling equipment will be used to avoid cross-contamination. When required, decontamination will be conducted in a central location, upwind, and away from suspected contaminant sources. The following procedures are to be used for all nondedicated sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

1. Clean with tap water and nonphosphate detergent, using a brush if necessary to remove particulate matter and surface films. (Equipment may be steam cleaned [soap and high pressure hot water] as an alternative to brushing). Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.)
2. Air dry the equipment completely.

2.2.3 Investigation-Derived Waste

The START field team members will make every effort to minimize the generation of IDW throughout the field event. Attempts will be made to evaporate wastewater from decontamination operations on-site. Any wastewater that cannot be evaporated will be contained in 55-gallon drums, labeled, and disposed of at an approved facility based on analytical results from matrix samples.

Disposable personal protective clothing and sampling equipment generated during field activities will be rendered unusable by tearing (when appropriate), bagged in opaque plastic garbage bags, and disposed at a local municipal landfill.

2.2.4 Standard Operating Procedures

The START will utilize the following SOPs (Appendix A) while performing field activities:

- Field Activity Logbooks;
- Sample Packaging and Shipping;
- Sample Equipment Decontamination;
- Geologic Logging;
- Borehole Installation;
- Borehole Sampling;
- Well Development;
- Evaluation of Existing Monitoring Wells;
- Water Level Measurements;
- Ground Water Well Sampling;
- Monitoring Well Installation;
- Sediment Sampling;
- Soil Sampling;

- Surface Water Sampling; and
- MIS Sampling.

2.3 Sample Handling and Custody Requirements

This subsection describes sample identification and chain-of-custody procedures that will be used for the Camp Bonneville SI field activities. The purpose of these procedures is to ensure that the quality of the samples is maintained during collection, transportation, storage, and analysis. All chain-of-custody requirements comply with E & E's SOPs for sample handling. All sample control and chain-of-custody procedures will follow the EPA's (2004a) *Contract Laboratory Program Guidance for Field Samplers*.

Examples of sample documents used for custody purposes are provided in Appendix C (with the exception of field logbooks) and include the following:

- Sample identification numbers,
- Sample labels,
- Custody seals,
- Chain-of-custody records or traffic reports,
- Field logbooks,
- Sample Collection Forms, and
- Analytical request forms.

During the field effort, the site manager or delegate is responsible for maintaining an inventory of these sample documents. This inventory will be recorded in a cross-referenced matrix of the following:

- Sample location,
- Sample identification number,
- Analyses requested and request form numbers,
- Chain-of-custody record numbers,
- Bottle lot numbers, and
- Air bill numbers.

Brief descriptions of the major sample identification and documentation records and forms are provided below.

2.3.1 Sample Identification

All samples will be identified using the sample numbers assigned by the EPA RSCC. Each sample label will be affixed to the jar and covered with clear tape. A sample tracking record will be kept as each sample is collected. The following will be recorded: location, matrix, sample number, observations, and depth. In addition to the EPA-assigned sample number, samples will be tracked with a sample code system designed to allow easy reference to the sample's origin and type. The sample code key will not be provided to the laboratory. Table 2-3 summarizes the sample tracking and location codes.

2.3.1.1 Sample Tags and Labels

Sample tags attached to or fixed around sample containers will be used to identify all samples collected in the field. The sample tags will be placed on bottles so as not to obscure any QA/QC lot numbers on the bottles, and sample information will be printed legibly. Field identification will be sufficient to enable the information to be cross-referenced with the project logbook. For chain-of-custody purposes, all QA/QC samples will be subject to the same custodial procedures and documentation as site samples.

To minimize handling of sample containers, labels will be completed before sample collection to the extent possible. In the field, the labels will be filled out completely using waterproof ink, then attached firmly to the sample containers and protected with clear tape. The sample labels will provide the following information:

- Sample number,
- Sample location number,
- Date and time of collection,
- Analyses required, and
- pH and preservation (when required).

2.3.1.2 Custody Seals

Custody seals are preprinted gel-type seals, designed to break into small pieces if the seals are disturbed. Sample shipping containers (e.g., coolers, drums, cardboard boxes, etc., as appropriate) will be sealed in as many places as necessary to ensure security. Seals will be signed and dated before use. Clear tape will be placed over the seals to ensure that the seals are not broken accidentally during shipment. Upon receipt at the laboratory, the custodian will check (and certify by completing the package receipt log) that seals on shipping containers are intact.

2.3.1.3 Chain-of-Custody Records and Traffic Reports

For samples to be analyzed at the EPA MEL or at a CLP laboratory, the chain-of-custody records, analyses required forms, and/or analytical traffic report forms will be completed as described in the *Contract Laboratory Program Guidance for Field Samplers* (EPA 2004a). The EPA's FORMS II Lite software will be used to electronically enter information for the chain-of-custody and traffic report forms. The chain-of-custody record, analyses required forms, and analytical traffic reports will be completed fully at least in duplicate by the field technician designated by the site manager as responsible for sample shipment to the appropriate laboratory. Information specified on the chain-of-custody record will contain the same level of detail found in the site logbook, except that the on-site measurement data will not be recorded. The custody record will include the following information:

- Name and company or organization of person collecting the samples,
- Date samples were collected,
- Type of sampling conducted (composite or grab),
- Sample number (using those assigned by the EPA RSCC),

- Location of sampling station (using the sample code system described in Table 2-3),
- Number and type of containers shipped,
- Analysis requested, and
- Signature of the person relinquishing samples to the transporter, with the date and time of transfer noted and signature of the designated sample custodian at the receiving facility.

If samples require rapid laboratory turnaround, the person completing the chain-of-custody record(s) will note these or similar constraints in the remarks section of the custody record.

The relinquishing individual will record all shipping data (e.g., air bill number, organization, time, and date) on the original custody record, which will be transported with the samples to the laboratory and retained in the laboratory's file. Original and duplicate custody records, together with the air bill(s) or delivery note(s), constitute a complete custody record. It is the site manager's responsibility to ensure that all records are consistent and that they become part of the permanent job file.

2.3.1.4 Field Logbooks and Data Forms

Field logbooks (or daily logs) and data forms are necessary to document daily activities and observations. Documentation will be sufficient to enable participants to reconstruct events that occurred during the project accurately and objectively at a later time. All daily logs will be kept in a bound notebook containing numbered pages. All entries will be made in waterproof ink, dated, and signed. No pages will be removed for any reason.

Minimum logbook content requirements are described in the E & E SOP entitled *Field Activity Logbooks* found in Appendix A. If corrections are necessary, these corrections will be made by drawing a single line through the original entry (so that the original entry is legible) and writing the corrected entry alongside. The correction will be initialed and dated. Corrected errors may require a footnote explaining the correction.

2.3.1.5 Photographs

Photographs will be taken as directed by the team leader. Documentation of a photograph is crucial to its validity as a representation of an existing situation. The following information will be noted in the project or task log concerning photographs:

- Date, time, and location where photograph was taken,
- Photographer (signature),
- Weather conditions,
- Description of photograph taken,
- Reasons why photograph was taken,
- Sequential number of the photograph and the film roll number,
- Camera lens system used, and
- Direction.

2.3.2 Custody Procedures

The primary objective of chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is in custody when it is:

- In someone's physical possession,
- In someone's view,
- Locked up, or
- Kept in a secured area that is restricted to authorized personnel.

2.3.2.1 Field Custody Procedures

The following guidance will be used to ensure proper control of samples while in the field:

- As few people as possible will handle samples.
- Coolers or boxes containing cleaned bottles will be sealed with a custody tape seal during transport to the field or while in storage before use. Sample bottles from unsealed coolers or boxes, or bottles that appear to have been tampered with, will not be used.
- The sample collector will be responsible for the care and custody of collected samples until they are transferred to another person or dispatched properly under chain of custody rules.
- The sample collector will record sample data in the field logbook.
- The site team leader will determine whether proper custody procedures were followed during the field work and will decide if additional samples are required.

When transferring custody (i.e., releasing samples to a shipping agent), the following will apply:

- The coolers in which the samples are packed will be sealed and accompanied by two copies of the chain of custody record(s). When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on each of the chain of custody record(s). This will document sample custody transfer.
- Samples will be dispatched to the laboratory for analysis with separate chain of custody records accompanying each shipment. The chain of custody records will be signed by the relinquishing individual, and the method of shipment, name of courier, and other pertinent information will be entered in the chain of custody record before placement in the shipping container. Shipping containers will be sealed with custody seals for shipment to the laboratory.
- All shipments will be accompanied by chain of custody records identifying their contents. The original custody records kept in a zip-locking bag and taped inside the lid of the cooler will accompany each cooler shipment. The other copies will be distributed appropriately to the site team leader and site manager.
- If sent by common carrier, a bill of lading will be used. Freight bills and bills of lading will be retained as part of the permanent documentation.

2.3.2.2 Laboratory Custody Procedures

A designated sample custodian at the laboratory will accept custody of the shipped samples from the carrier and enter preliminary information about the package into a package or sample receipt log, including the initials of the person delivering the package and the status of the custody seals on the coolers (i.e., broken versus unbroken). The custodian responsible for sample log-in will follow the laboratory's SOP for opening the package, checking the contents, and verifying that the information on the chain-of-custody agrees with the samples received. The commercial laboratory will follow its internal chain-of-custody procedures as stated in the laboratory QA manual. The laboratory will check the temperature blank inside the cooler and document it in the sample log-in form. Should the temperature be greater than what is required by the Statement of Work or the method, the sample custodian will inform the region and proceed to follow the course of actions stipulated in the SOW or specified by the regional QAO.

2.4 Analytical Methods Requirements

This subsection discusses the analytical strategy (subsection 2.4.1) and the analytical methods (subsection 2.4.2).

2.4.1 Analytical Strategy

Analysis of samples collected during the SI will be performed by several possible means. The MEL (or alternative laboratory designated by the EPA) will perform all requested analyses.

The analyses to be applied to samples sent to the laboratory are listed in Table 2-2. These analyses were selected based on the probable hazardous substances used or potentially released to the environment, given the known or suspected site usage.

2.4.2 Analytical Methods

Samples designated for off-site analytical laboratory analyses will be submitted to the MEL or an alternative laboratory designated by the EPA and the START-3-subcontracted commercial laboratory. EPA and/or CLP laboratory analyses will take place within the standard three-week turnaround time period with validation by the EPA QA office for these analyses taking place within the standard three-week turnaround time period. Hardcopy results from the MEL and/or CLP laboratories will be delivered to the EPA upon completion of each sample delivery group. Electronic results from the MEL and/or CLP laboratories will be delivered to the EPA upon project completion. START-3 sub-contracted laboratory analyses will take place within the standard four-week turnaround time period with validation by START-3 chemists for these analyses taking place within the standard two-week turnaround time period. Hardcopy and electronic data results from the subcontracted commercial laboratory will be delivered to the START-3 upon completion of each sample delivery group. Table 2-2 summarizes laboratory instrumentation and methods to be used for the Camp Bonneville SI.

For cases in which laboratory results exceed QC acceptance criteria, reextraction and/or reanalysis will occur as indicated in the applicable analytical method. Commercial laboratory results (preliminary data) will be available within two weeks of sample receipt. Field laboratory results will be available within 24 hours. The respective laboratory analysts will be responsible for ensuring that appropriate sample analysis procedures are followed and for taking appropriate actions to ensure deficiency correction.

2.5 Quality Control Requirements

QC checks for sample collection will be accomplished by a combination of chain-of-custody protocols and laboratory QA procedures as prescribed in the sampling or analytical methods. No QC samples (i.e., double blind performance evaluation samples) are planned for this activity outside of the normal laboratory QC criteria outlined in the analytical methods. These QC samples include blanks, calibration verifications, spikes, duplicates, (for inorganics) interference check samples, and serial dilutions. Results from these samples will be compared to QC requirements listed in subsection 4.1.2. All of the analyses that will be performed for this project will produce definitive data. Data quality indicator targets for this project are specified in subsection 1.4 (Data Quality Objectives) and are summarized in Table 2-2 of this SQAP. Bias on estimated qualified data shall be determined by the validation process. In accordance with the objectives outlined in this document and the QA levels defined by the EPA (2000), the EPA has defined the DQOs and has determined that the sampling and analyses performed under this sampling effort will conform to the definitive data without quantitative error and bias determination criteria. The laboratories' DQOs for completeness and the field team's ability to meet the DQO for representativeness are set at 90%. Precision and accuracy requirements are outlined in Table 2-2.

One temperature blank consisting of a 40-milliliter glass vial of distilled water will be included in each cooler shipped to the analytical laboratories. Temperature blanks allow the laboratories to obtain a representative measurement of the temperature of samples enclosed in a cooler without disturbing the actual samples. The field team will package and label the temperature blank like a regular water sample, however the analytical laboratory will only measure the temperature of the blank. The temperature blank will not be analyzed for hazardous substances, will not be given a sample number, and will not be listed on the chain of custody form. The temperature blank will be clearly labeled: USEPA COOLER TEMPERATURE INDICATOR.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The field equipment used during this project includes the GPS unit and perchlorate field testing kits. Testing, inspection, and maintenance of these instruments will be performed in accordance with the manufacturers' recommendations and/or the SOPs listed in subsection 2.2.4. Spare parts for the field equipment will be available from the manufacturer generally within 24 hours. The parts will be available to the field team within 48 hours of ordering.

All field instruments and equipment used for analysis will be serviced and maintained only by qualified personnel. All instruments will be maintained by senior staff and/or electronics technicians. All repairs, adjustments, and calibrations will be documented in an appropriate logbook or on a data sheet that will be kept on file. The instrument maintenance logbooks will clearly document the date, the description of the problems, the corrective action taken, the result, and who performed the work.

All equipment used by E & E in the field is subject to standard preventive maintenance schedules established by corporate equipment protocols. When in use, equipment will be inspected at least twice daily, once before startup in the morning and again at the end of the work shift before overnight storage or return to the charging rack. Regular maintenance, such as cleaning of lenses, replacement of in-line filters, and removal of accumulated dust, is to be conducted according to manufacturers' recommendations and in the field as needed, whichever is appropriate. All performed preventive maintenance will be entered in the individual equipment's logbook and in the site field logbook.

In addition to preventive maintenance procedures, daily calibration checks will be performed at least once daily before use and recorded in the respective logbooks. Additional calibration checks will be performed as required. All logbooks will become part of either the permanent site file or the permanent equipment file.

2.7 Instrument Calibration and Frequency

All instruments and equipment used during fixed laboratory sample analyses will be operated, calibrated, and maintained according to the manufacturers' guidelines and recommendations, as well as criteria set forth in the applicable analytical methodology references and/or in accordance with the laboratory's QA manual and SOPs.

For the field instrumentation (GPS unit and other instrumentation discussed previously), calibrations will be performed in accordance with the manufacturers' recommendations and the SOPs listed in subsection 2.2.4.

2.8 Inspection/Acceptance Requirements for Supplies and Consumables

This information is covered by the SOPs, the START-3 QAPP (E & E 2005b), and the START-3 QMP (E & E 2005a). Standards contained in these documents will be used to ensure the validity of data generated by E & E for this project. Sample jars are pre-cleaned by the manufacturer; certification documenting this is enclosed with each box of jars. The START-3 will include this documentation as part of the site file. Non-dedicated equipment is demonstrated to be uncontaminated by the use of rinsate blanks.

2.9 Data Acquisition Requirements (Nondirect Measures)

No data will be used from other sources.

2.10 Data Management

This document is meant to be combined with information presented in E & E's QAPP and QMP for Region 10 START-3. Copies of the START QAPP and QMP are available in E & E's Seattle office. Standards contained in these documents will be used to ensure the validity of data generated by E & E for this project. Data validation will be performed as listed in subsection 4.1.2. Data tracking, storage, and retrieval are tracked through the TDD "pink sheet" which records where the paper and electronic data are located. All paper data is stored in locked file cabinets; access to these files is restricted to key START-3 personnel. Electronic data will be archived by TDD.

3 Assessment/Oversight

3.1 Assessment and Response Actions

The EPA QAO or designee may conduct an audit of the field activities for this project. The auditor will have the authority to issue a stop work order upon finding a significant condition that adversely would affect the quality and usability of the data. The EPA TM will have the responsibility for initiating and implementing response actions associated with findings identified during the site audit. The actions taken also may involve the EPA PO, contracting officer, and/or QAO. Once the response actions have been implemented, the EPA QAO or designee may perform a follow-up audit to verify and document that the response actions were implemented effectively. In-house audits performed by the START-3 may be conducted in accordance with the E & E START-3 *Quality Management Plan* (2005a). No audits are planned for the Camp Bonneville SI.

If major deviations from the QA requirements of the project and the CLP SOW were observed in the data validation process, the EPA QAO will contact the laboratory to correct the problem. If the laboratory is not responsive to the request, the QAO will inform the CLP Regional PO and the TM of the situation. A brief narrative will be written explaining the contract deviations and recommendations will be given based on the quality of the submitted data. Reduced payment and/or reanalysis at the laboratory's expense shall be pursued by the Regional CLP PO. Resampling and subsequent re-analysis will be decided by the TM. Additional sampling for corrective actions and/or any addendum to this SQAP shall be documented using the Corrective Action Form and the SPAF (Appendix D). Corrective actions will be conducted in accordance with E & E QMP specifications.

3.2 Reports to Management

Debriefing of the EPA TM occurs by the START-3 PM on a daily basis. Laboratory deliverables will be as specified in the CLP Organic and Inorganic Statements of Work (SOM01.1 and ILM05.3 or ISM01.2, respectively) for CLP data, CLP-equivalent deliverables for MEL data, as specified in the laboratory subcontract bid specification package for commercial laboratory data, and as specified in the Environmental Services Assistance Team contract for on-site analyses. Once the project is complete and the resulting data is obtained, the START-3 PM will prepare a final project report. The report will include a summary of the activities performed during the project and the resulting data (along with any statements concerning data quality). The report will be approved by the EPA TM prior to being forwarded to the individuals identified in the data distribution list located in the Table of Contents section of this SQAP.

The START-3 corrective action program is addressed in Section 3 of the QMP. Corrective actions will be conducted in accordance with these QMP specifications.

4 Data Validation and Usability

4.1 Data Review, Validation, and Verification Requirements

The data validation review of data packages will include an evaluation of the information provided on the analytical data sheets and required support documentation for all sample analyses; the supporting sample collection documentation, including chain-of-custody forms; and documentation of field instrument calibration, sample results, and/or performance checks (if required by the method). The QA review also will examine adherence to the procedures as described in the cited SOPs and the specified analytical methods in the SQAP.

4.1.1 Data Reduction

Data reduction includes all processes that change the numerical value of the raw data. All fixed-laboratory data reduction will be performed in accordance with the appropriate methodology and will be presented as sample results.

4.1.2 Data Validation

Analytical data generated through the CLP contract will be validated in a three week turn around time by the Region 10 QA office or its designee. Data generated by the MEL will be validated by the EPA TM designated validator (i.e., EPA QA office or contractor). Validation of data generated by subcontracted laboratories will be performed by E & E. All of the data validations will be performed in accordance with the QA/QC requirements specified in the SQAP, the technical specifications of the analytical methods, and the following documents:

- USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (2004b); and
- USEPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (2008).

The QC parameters of interest for the EPA organic and inorganic methods that will be used on the Camp Bonneville SI samples are presented in these documents. When applicable, QC criteria listed in the applicable analytical methods and/or the SOW will be used for validation.

Validation deliverables will include a QA memo discussing QA conformance and deviations issues which may have affected the quality of the data. Data usability, bases of application of qualifiers, and percentage of qualified data will also be discussed in the QA memo. The analysis data sheets (Forms I) with the applied validation qualifiers and bias determination for estimated-qualified values will also be a part of the validation deliverables. The following qualifiers shall be used in data validation:

- U = The material was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
- J = The associated numerical value is an estimated quantity because the reported concentrations were less than the sample quantitation limits or because quality control criteria limits were not met.
- UJ = The material was analyzed for, but was not detected. The reported detection limit is estimated because Quality Control criteria were not met.
- R = The sample results are rejected (analyte may or may not be present) due to gross deficiencies in quality control criteria. Any reported value is unusable. Resampling and/or reanalysis is necessary for verification.
- H = High bias.
- K = Unknown bias.
- L = Low bias.
- Q = Detected concentration is below the method reporting limit/Contract Required Quantitation Limit, but is above the method quantitation limit.

4.1.3 Data Assessment Procedures

Following data validation and reporting, all project-generated and -compiled data and information will be reconciled with the objectives specified in subsection 1.3.1 to assess the overall success of SI activities. This data assessment, including points of achievement and departure from project-specific objectives, will be discussed in the QA section of the SI report.

4.2 Data Verification

The analytical QA requirements and data validation requirements will be as specified in subsection 4.1.2 (EPA 2008b and 2004a).

The EPA TM will perform the final review and approval of the data. The EPA TM and/or QAO will look at matrix spike/matrix spike duplicates, laboratory blanks, and laboratory duplicates to ensure that they are acceptable. The EPA TM and/or designee also will compare the sample descriptions with the field sheets for consistency and will ensure that any anomalies in the data are documented appropriately.

Data QA memoranda reports will be generated as part of the Camp Bonneville SI if the START-3 is responsible for data validation. If the EPA Region 10 QA office or its designee performs the data validation, then additional reports regarding data usability will be generated by the START-3.

4.3 Reconciliation with Data Quality Objectives

The data quality indicators target for this project is discussed in subsection 1.4 of this SQAP. The data validation will be used as a tool to determine if these targets were met. Also, using the compiled data, E & E and the TM will determine the variability and soundness of the data and the data gaps that will need to be filled to meet the objectives of the project.

Once the data results are compiled, the EPA TM and/or the EPA QAO will review the sample results to determine if they fall within the acceptance limits as defined in this SQAP. Completeness also will be evaluated to determine if the completeness goal for this project has been met. If data quality indicators do not meet the project's requirements as outlined in this SQAP, the data may be discarded and resampling and reanalysis may occur. The TM will attempt to determine the cause of the failure (if possible) and make the decision to discard the data and resample. If the failure is tied to the analysis, calibration and maintenance techniques will be reassessed as identified by the appropriate laboratory personnel. If the failure is associated with the sample collection and resampling is required, the collection techniques will be reevaluated as identified by the START-3 PM.

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