ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

CAMP BONNEVILLE MILITARY RESERVATION
CLARK COUNTY, WASHINGTON

EPA FACILITY ID: WAN001002030

SEPTEMBER 22, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Additional copies of this report are available from:
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PUBLIC HEALTH ASSESSMENT

CAMP BONNEVILLE MILITARY RESERVATION
CLARK COUNTY, WASHINGTON

EPA FACILITY ID: WAN001002030

Prepared by:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. Congress established this agency in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste areas. The U.S. Environmental Protection Agency (EPA) and the individual states regulate the investigation and clean up of the areas.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the areas on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at an area, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data. Instead, it reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicological, and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and occasionally scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by an area. In its public health action plan, the report recommends ways to stop or reduce exposure. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory to warn people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies, or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the area and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near an area, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for comment. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us. Letters should be addressed as follows:

Attention: Manager, ATSDR Records Center
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, NE
MS F-09
Atlanta, GA 30341

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List of Abbreviations

AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BCRRT	Bonneville Conservation, Restoration, and Renewal Team
bgs	below ground surface
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CITA	Central Impact Target Area
CREG	cancer risk evaluation guide
DOD	U.S. Department of Defense
ED	exposure duration
EF	exposure frequency
EMEG	environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
FUDS	Formerly Used Defense Site
IR	intake rate
IRIS	Integrated Risk Information System
LF	landfill
LTHA	lifetime health advisory
mg/kg/day	milligrams per kilogram per day
MCL	maximum contaminant level
MEC	munitions and explosives of concern
MRL	minimal risk level
NTIS	National Technical Information Service
OB/OD	Open Burn/Open Detonation
PAH	polycyclic aromatic hydrocarbon
ppm	parts per million
RAB	Restoration Advisory Board
RDX	Royal Demolition explosive; 1,3,5-trinitro-1,3,5-triazine
RfD	reference dose
RMEG	reference dose media evaluation guide
SVOC	semi-volatile organic compound
UXO	unexploded ordnance
VOC	volatile organic compound
WDNR	Washington State Department of Natural Resources
WDOE	Washington Department of Ecology

Summary

Camp Bonneville is located approximately 12 miles northeast of Vancouver, Washington in the western foothills of the Cascade Mountain Range. In 1909, the property was established as a drill field and rifle range for Vancouver Barracks. In 1912, the facility was expanded to include target ranges and a road leading to the installation. Two cantonments, Camp Bonneville and Camp Killpack, were built during the 1920s and 1930s. The mission of Camp Bonneville was to provide a training camp for active, reserve, and guard units of the United States (U.S.) Army, Navy, Marine Corps, and Coast Guard. The facility was closed in 1995 by the Base Realignment and Closure (BRAC) commission.

ATSDR is required by law to conduct a public health assessment (PHA) at each of the sites on the National Priorities List (NPL). ATSDR also conducts PHAs when petitioned (i.e., requested) by concerned individuals. Camp Bonneville is not on the NPL; rather, ATSDR was petitioned by a citizen to conduct a PHA at the site. From talking with the petitioner and other community members, ATSDR identified the following issues of concern:

1. Potential physical hazards from exposure to unexploded ordnance (UXO).
2. Exposure to soil and groundwater contamination for residents living within the Artillery Impact Fan and Range Safety Fan areas.
3. Exposure to groundwater contamination (specifically, perchlorate and Royal Demolition Explosive [RDX; 1,3,5-trinitro-1,3,5-triazine] plumes).
4. Exposure to contaminated soil (specifically, at the sewage pond/lagoon areas and the small arms firing areas).
5. Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River.
6. Exposure to runoff water and standing rainwater, particularly near the Open Burn/Open Detonation (OB/OD) sites.
7. Inhalation exposure to past chemical warfare testing and training activities.
8. Hunting and eating wildlife (e.g., deer, elk, bear, rabbits, squirrels, game birds, and raccoons) on Camp Bonneville.
9. Early property transfer as a public regional camping facility and potential exposures to future site users.
10. Fire response and suppression at Camp Bonneville.

After thoroughly evaluating the concerns, ATSDR concluded the following.

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

  UXO is present on Camp Bonneville. There are several factors that limit the public's access to the ordnance, including fencing and removal efforts. However, 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.

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

  Historical maps were found to erroneously indicate that the Artillery Impact Fan and Range Safety Fan areas extended into the community. 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 groundwater contamination.

- *Concern 3. Exposure to groundwater contamination* (specifically, perchlorate and RDX plumes)

  Groundwater has been sampled from 18 sites at Camp Bonneville. The only area found to contain groundwater contamination was Landfill 4 (LF4). The plume at LF4 contains RDX, perchlorate, and 1,1-dichloroethene. However, no one is drinking water from this area. The contaminants have not migrated, and are not expected to migrate, to areas where exposure would occur. Therefore, exposure to groundwater contamination is not occurring and is not expected to occur in the future.

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

  Soil at the Former Sewage Pond and Landfill 2(LF2) 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 Central Impact Target Area (CITA) because the area is currently, and will remain, fenced. Further, remediation is being conducted to remove soil containing elevated levels of lead around the former targets in the small arms firing areas.

- *Concern 5. Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River*

  In 1998, a surface water investigation was conducted on Lacamas Creek and its tributaries at Camp Bonneville. This investigation concluded that, in general, site activities have not impacted the water quality of Lacamas Creek. Due to the 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.

- *Concern 6. Exposure to runoff water and standing rainwater, particularly near the Open Burn/Open Detonation (OB/OD) sites*

  Even though standing water is sometimes seen in and around the OB/OD sites, exposure to it would be short-term and infrequent. Further, soil, groundwater, and surface water at the OB/OD sites have been sampled and no chemicals were detected at levels of health concern.

- *Concern 7. Inhalation exposure to agents used during past chemical warfare testing and training activities*

  2-chlorobenzalmalononitrile (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.

- *Concern 8. Hunting and eating wildlife on Camp Bonneville*

  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.

- *Concern 9. Early property transfer as a public regional camping facility and potential exposures to future site users*

  Camp Bonneville was transferred from the U.S. Department of Defense (DOD) to Clark County, Washington in October 2006, prior to the completion of environmental cleanup (i.e., early transfer). The Bonneville Conservation, Restoration, and Renewal Team (BCRRT) is responsible for continuing the cleanup of Camp Bonneville, with oversight by the Washington Department of Ecology (WDOE). 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 (WDOE 2006).

- *Concern 10. Fire response and suppression at Camp Bonneville*

  Even though UXO is present on Camp Bonneville, the Washington Department of Natural Resources (WDNR) will respond to wildfires at the property in close coordination with BCRRT. There may be some areas (e.g., 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.

Background

Site Description and Operational History

Camp Bonneville is located on 3,840 acres in the western foothills of the Cascade Mountain Range. Of this, 820 acres are leased from the Washington State Department of Natural Resources (WDNR). The site is approximately 12 miles northeast of Vancouver, Washington in Clark County (see Figure 1). Lacamas Creek, a tributary of the Columbia River, flows through the property (see Figure 2). The western portion of the site consists of low hills and the low plain of the Lacamas Creek valley. The rest of the site is made up of well-dissected hills of the Cascade Mountain foothills.

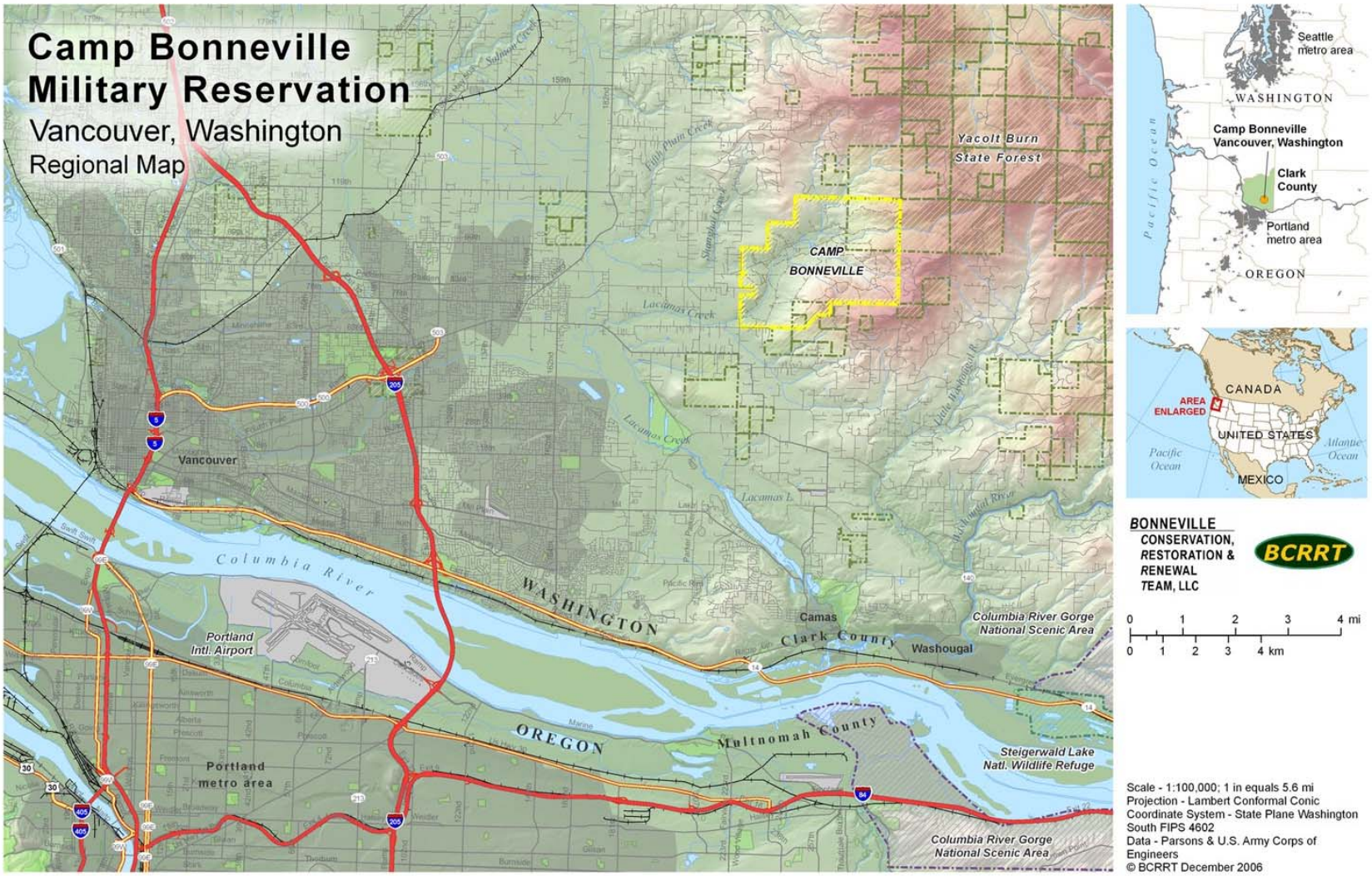
The U.S. War Department and its successor agency, the Department of Defense (DOD), has owned and operated Camp Bonneville for military training since 1909. The site was initially established as a drill field and rifle range for Vancouver Barracks (Camp Bonneville is a sub-installation of Vancouver Barracks). In 1912, the facilities were expanded to include target ranges and a road leading to the installation. Two cantonments, Camp Bonneville and Camp Killpack, were built on the property during the 1920s and 1930s and include 49 buildings. In 1959, Vancouver Barracks, including Camp Bonneville, became a sub-installation of Fort Lewis, Washington.

Between 1909 and 1995, live and practice munitions including artillery and mortar rounds, shoulder-fired rockets, land mines (practice only), grenades, and small-arms ammunition were stored and used at Camp Bonneville. Units practiced at Camp Bonneville for two to three weeks at a time and were never permanently assigned to Camp Bonneville. They fired from surveyed firing points for accuracy.

In the 1980s, the property was used for non-military purposes such as religious retreats, picnicking, camping, educational purposes, and pistol training for the state police. The site was selected for transfer and reuse in 1995 by the Base Realignment and Closure (BRAC) Commission. The Federal Bureau of Investigation (FBI) currently operates a small-arms range at the site, but is planning to cease operations in the near future.

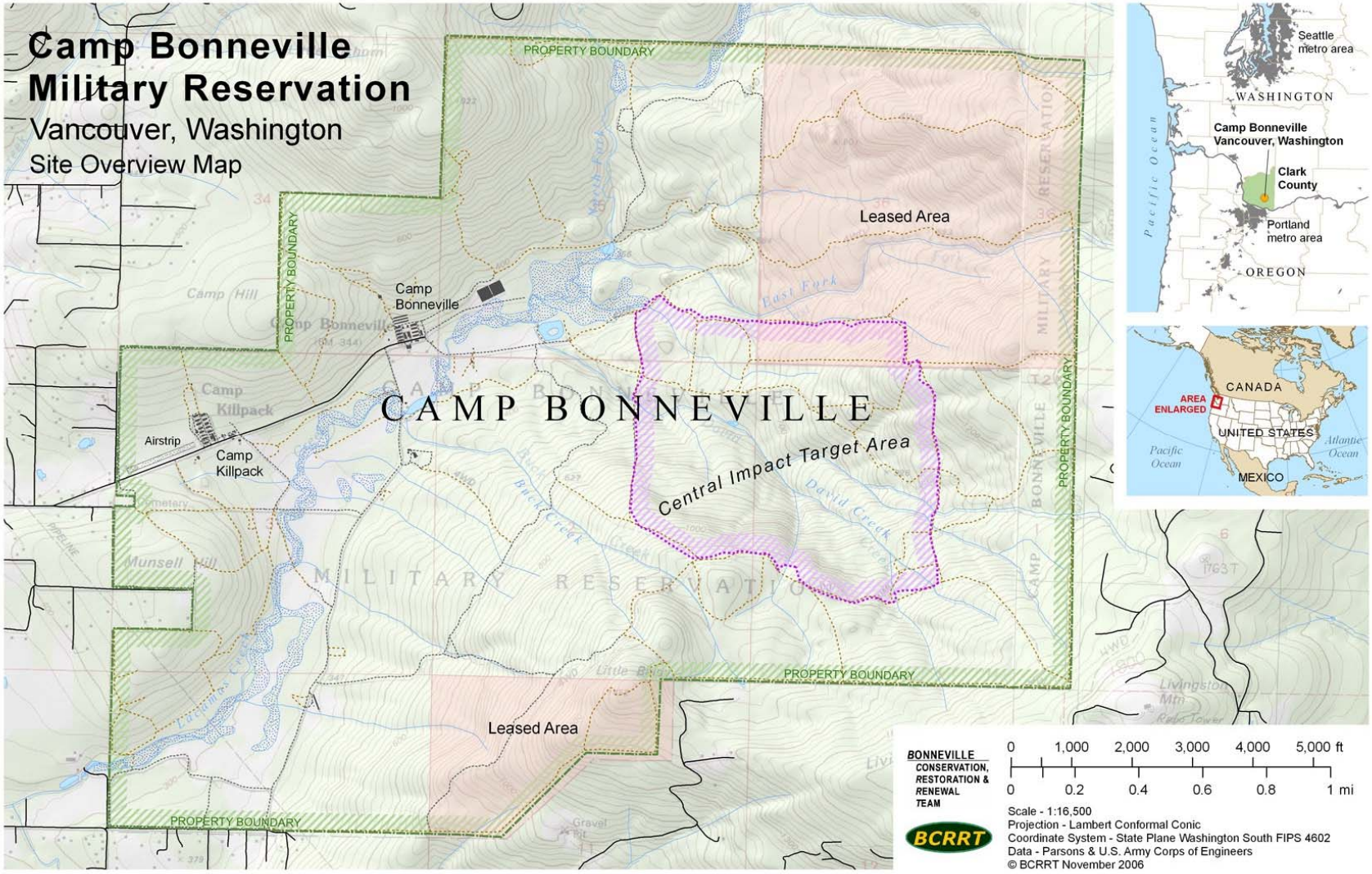
Camp Bonneville was transferred from DOD to Clark County in October 2006. The transfer was conducted prior to the completion of environmental cleanup (i.e., deemed “early transfer”). As part of the agreement, DOD is providing funds to the county to cover the cost of the remaining cleanup. The Washington Department of Ecology (WDOE) is overseeing the cleanup work, which is being conducted by Clark County and the Bonneville Conservation Restoration & Renewal Team (BCRRT). Once the site is cleaned up, the county plans to convert about one third of the site into a regional park (about 1,000 acres along the western portion of the site) and retain about two thirds of the site as open space and for wildlife and habitat conservation. Additional information about the reuse of Camp Bonneville can be found at http://www.co.clark.wa.us/public-works/campbonn/.

Figure 1. Location of Camp Bonneville



Source: BCRRT Web site (http://www.bcrrt.org/index.asp?page=maps)

Figure 2. Camp Bonneville Overview Map



Source: BCRRT Web site (http://www.bcrrt.org/index.asp?page=maps)

Remedial and Regulatory History

The Army identified five remedial action units (RAUs) as potential sources of contamination at Camp Bonneville (U.S. Army 2006).

- RAU-1 consists of 20 areas where hazardous substances or petroleum products were found. These sites have been thoroughly evaluated and all active remediation is completed (U.S. Army 2006).

- RAU-2A consists of 21 small arms ranges. Soil samples were collected at the ranges and sampled for arms by-products. Metals (primarily lead) were detected above regulatory limits for some ranges. The final remedial investigation/feasibility study was completed in August 2007 (BCRRT 2007d). The recommended cleanup alternative is soil excavation in areas exceeding regulatory limits and off-site disposal or recycling.

- RAU-2B consists of two demolition areas (DA2 and DA3) where ammunitions were either burned or detonated. In 2004, approximately 5,000 cubic yards of soil were excavated and removed off site (U.S. Army 2006). Quarterly groundwater sampling was conducted from 2002 to 2006. The final remedial investigation was completed in June 2007 (BCRRT 2007c). No further action was recommended since the constituents detected in the groundwater do not pose a threat to human health or the environment.

- RAU-2C covers a landfill area (LF4)/demolition area (DA1) that was also used to burn or detonate ammunition. In 2004, soil above action levels and all fill material were removed from the area (Camp Bonneville 2006). Since this is the only location on Camp Bonneville with known groundwater contamination (perchlorate, RDX, and volatile organic compounds [VOCs]), continuing groundwater monitoring is recommended for the area (Camp Bonneville 2006).

- RAU-3 includes munitions response sites that are known or suspected to contain munitions and explosives of concern (MEC). Several site characterization studies and remedial actions have been conducted on over 2,400 acres at Camp Bonneville, including all existing trails and roads and the future regional park area (U.S. Army 2006). In 2006 and 2007, emergency actions (brush clearance, MEC surface clearance, fence repairs and replacement, installation of new warning signs for the property perimeter and CITA) were performed to reduce the threat to human health and safety (BCRRT 2007a, 2007b).

U.S. Environmental Protection Agency (EPA) was part of the Base Closure Team until 2003, when they withdrew their involvement due to concerns regarding data gaps (EPA 2003). This site has not been fully characterized, however, significant groundwater and soil sampling has occurred at Camp Bonneville and very little contamination has been detected. After EPA's withdrawal, WDOE remained as the primary oversight and enforcement agency for Camp Bonneville.

A Restoration Advisory Board (RAB) with representatives from the Army, EPA, WDOE, Clark County, Cowlitz Indian Tribe, and the community was established in 1996 to review

recommendations for, and monitor progress of, the investigation and remedial activities at Camp Bonneville. The RAB was formed to establish a forum for communication between the decision makers and the community. The RAB ended when the property was transferred from DOD to Clark County. The last meeting was held in October 2006.

ATSDR Involvement

A request from a concerned individual to evaluate a site is received through a written document known as a petition.

In May 2006, a private citizen petitioned (see text box for definition) the Agency for Toxic Substances and Disease Registry (ATSDR) to assess potential human exposures to remaining contamination at Camp Bonneville. This public health assessment (PHA) documents ATSDR's response to the petition. Through the public health assessment process, ATSDR examines what chemicals enter the environment, how they move through the environment, whether people are being exposed to these chemicals, and the levels of chemicals that people might encounter. ATSDR uses this information to determine whether people are exposed to levels of contamination that might cause health problems.

After receiving the petition letter and speaking with the petitioner, ATSDR made a site visit to Camp Bonneville on November 14–15, 2006. ATSDR staff toured the site and met with representatives from the U.S. Army; EPA; BCRRT; WDOE; Clark County Public Works; and Clark County Public Health. ATSDR also met with individual community members and with members of the Summit at Autumn Hills Home Owners Association. ATSDR has also corresponded via telephone and electronic mail with concerned citizens regarding Camp Bonneville.

Demographics and Land Use

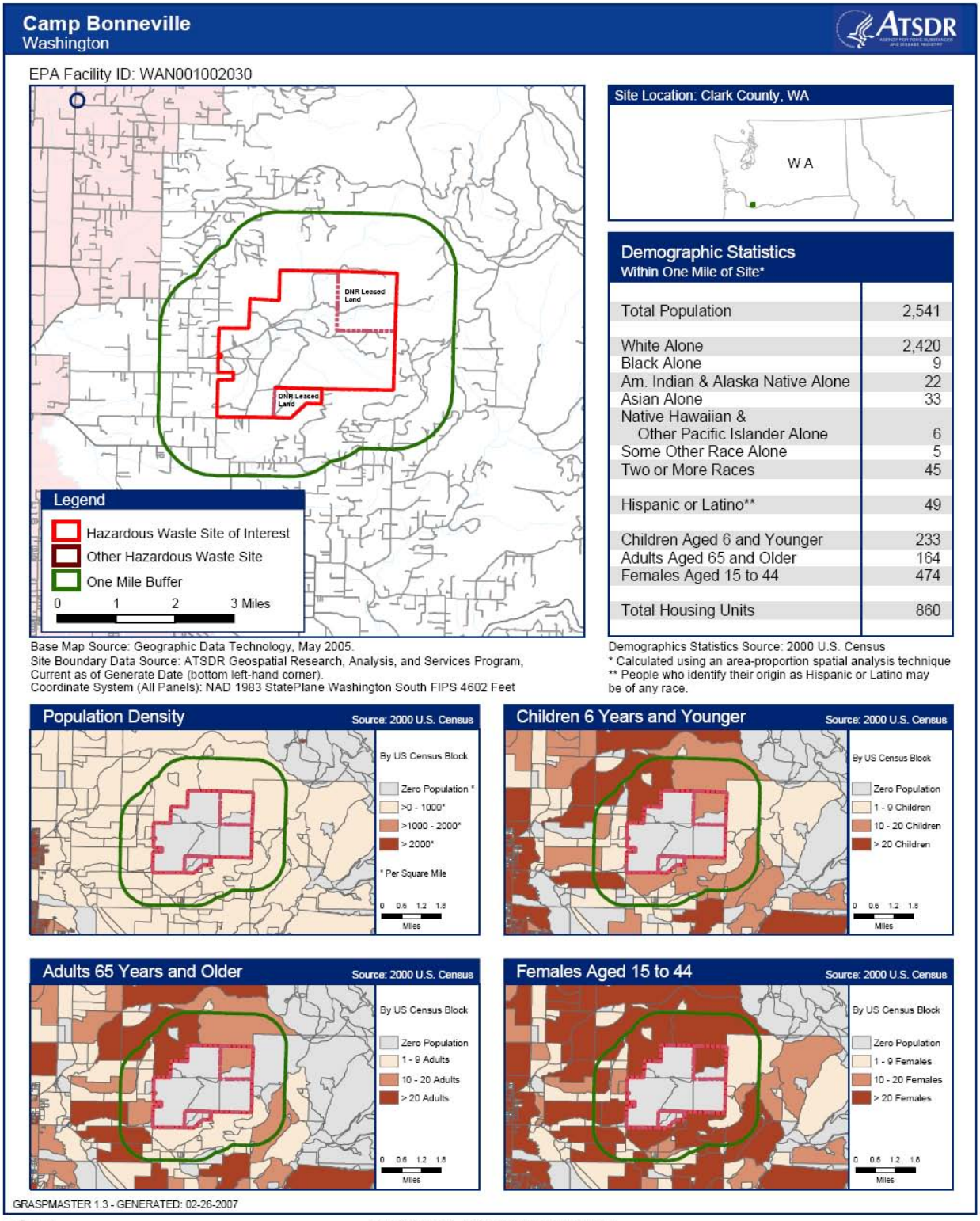
ATSDR examines demographic and land use data to identify sensitive populations, such as young children, the elderly, and women of childbearing age, and to determine whether these sensitive populations are exposed to any potential health risks. Children are of particular interest in this PHA because children are impacted by UXO more frequently than adults. Demographics also provide details on population mobility and residential history in a particular area. This information helps ATSDR evaluate how long residents might have been exposed to contaminants.

Camp Bonneville is located in Clark County; the fastest growing county in Washington. Clark County occupies about 628 square miles and has a population of about 345,238 (Bureau of the Census 2000). Vancouver is the largest city in the county. According to the 2000 census, Vancouver is home to approximately 143,560 people—8 percent of whom are under the age of 5 years, 44.1 percent are women of childbearing age (15-44 years), and 10.7 percent are over 65 years. The unincorporated community of Proebstel, located about 2 miles west, is the closest town to Camp Bonneville.

The surrounding land uses are predominantly agricultural farming, rural residential, and forestry (Camp Bonneville Local Redevelopment Authority 2003). Residential development near Camp

Bonneville has expanded as the county has grown. Figure 3 shows the demographics within one mile of Camp Bonneville. Yacolt Burn State Forest, which is managed by WDNR, borders Camp Bonneville on the northeastern boundary. Livingston Quarry, a gravel mining operation, is located adjacent to the site's southern boundary.

Figure 3. Demographics Within 1 Mile of Camp Bonneville



Climate

The climate at Camp Bonneville is mild with an average annual temperature ranging from 34° Fahrenheit in the winter to 80° Fahrenheit in the summer. The average rainfall is approximately 41 inches per year, with the highest amount of rain falling in December. The average snowfall is approximately 6.5 inches per year.

Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the CERCLA program must meet standards for quality assurance and control measures for chain-of-custody, laboratory procedures, and data reporting. The environmental data presented in this PHA come from site characterization and remedial investigation reports prepared by Camp Bonneville and its contractors under CERCLA, the National Contingency Plan, and state regulation and guidance, mainly the Washington State Model Toxics Control Act (U.S. Army 2006). ATSDR has found that the quality of environmental data available for Camp Bonneville is adequate for making public health decisions.

Evaluation of Environmental Contamination and Potential Exposure Situations

Introduction

What is meant by exposure?

ATSDR's PHAs are driven by exposure to, or contact with, environmental contaminants. Contaminants released into the environment have the potential to cause harmful health effects. Nevertheless, *a release does not always result in exposure.* People can only be exposed to a contaminant if they come in contact with that contaminant. If no one comes in contact with a contaminant, then no exposure occurs, and thus no health effects could occur.

> An exposure pathway has five elements: (1) a source of contamination, (2) an environmental media, (3) a point of exposure, (4) a route of human exposure, and (5) a receptor population. The source is the place where the chemical was released. The environmental media (such as groundwater, soil, surface water, or air) transport the contaminants. The point of exposure is the place where people come into contact with the contaminated media. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. The people actually exposed are the receptor population.

The route of a contaminant's movement is the pathway. ATSDR identifies and evaluates exposure pathways by considering how people might come in contact with a contaminant. An exposure pathway could involve air, surface water, groundwater, soil, dust, or even plants and animals. Exposure can occur by breathing, eating, drinking, or by skin contact with a substance containing the chemical contaminant.

How does ATSDR determine which exposure situations to evaluate?

ATSDR evaluates site conditions to determine if people could have been, are, or could be exposed (i.e., exposed in a past scenario, a current scenario, or a future scenario) to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, sediment, water, air, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation.

If exposure was, is, or could be possible, ATSDR considers whether contamination is present at levels that might affect public health. ATSDR selects contaminants for further evaluation by comparing them to health-based comparison values (CVs). These are developed by ATSDR from available scientific literature related to exposure and health effects. CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

Comparison values are not thresholds for adverse health effects. ATSDR CVs establish contaminant concentrations many times lower than levels at which no effects were observed in experimental animals or human epidemiologic studies. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency of exposure), the toxicology of the contaminant, other epidemiology studies, and the weight of evidence for health effects.

You can find out more about ATSDR's evaluation process by consulting Appendix B, contacting ATSDR at 1-800-CDC-INFO (1-800-232-4636), or reading ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html.

If someone is exposed, will they get sick?

Exposure does not always result in harmful health effects. The type and severity of health effects a person can experience because of contact with a contaminant depend on the exposure concentration (how much), the frequency (how often) and/or duration (how long) of exposure, and the route or pathway of exposure (breathing, eating, drinking, or skin contact). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the exposed individual influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics determine the health effects that may occur.

In almost any situation, there is considerable uncertainty about the true level of exposure to environmental contamination. To account for this uncertainty and to be protective of public health, ATSDR typically uses worst-case exposure level estimates as the basis for determining whether adverse health effects are possible. These estimated exposure levels usually are much higher than the levels that people are really exposed to. If the exposure levels indicate that adverse health effects are possible, ATSDR performs a more detailed review of exposure and consults the toxicological and epidemiologic literature for scientific information about the health effects from exposure to hazardous substances.

What potential exposure situations were evaluated for Camp Bonneville?

Responding to community health concerns is an essential part of ATSDR's overall mission and commitment to public health. ATSDR actively gathered comments and other information from the people who live and work near Camp Bonneville. From talking with the petitioner and other community members, ATSDR identified the following issues of concern. They are listed below and addressed in detail in this PHA:

1. Potential physical hazards from exposure to unexploded ordnance (UXO).
2. Exposure to soil and groundwater contamination for residents living within the Artillery Impact Fan and Range Safety Fan areas.
3. Exposure to groundwater contamination (specifically, perchlorate and RDX plumes).
4. Exposure to contaminated soil (specifically, at the sewage pond/lagoon areas and the small arms firing areas).
5. Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River.
6. Exposure to runoff water and standing rainwater, particularly near the Open Burn/Open Detonation (OB/OD) sites.
7. Inhalation exposure to past chemical warfare testing and training activities.
8. Hunting and eating wildlife (e.g., deer, elk, bear, rabbits, squirrels, game birds, and raccoons) on Camp Bonneville.

9. Early property transfer as a public regional camping facility and potential exposures to future site users.
10. Fire response and suppression at Camp Bonneville.

Table 1 provides a summary of potential exposure situations evaluated in this PHA.

Table 1. Potential Exposure Pathways Evaluated at Camp Bonneville

Pathway	*Exposure Pathway Elements*					*Comments*
	Potential Sources of Contamination	*Environmental Media*	*Point of Exposure*	*Route of Exposure*	*Exposed Population*	
Potential physical hazards from exposure to UXO	UXO from training activities	Soil	Mainly CITA, but potentially other areas	Physical contact	Future visitors to the regional park	Visitors should be educated about the dangers posed by UXO.
Exposure to soil and groundwater contamination for residents living within the Artillery Impact Fan and Range Safety Fan areas	Camp Bonneville activities	Soil Groundwater	None	None	None	There are no residents living within the Artillery Impact Fan and Range Safety Fan areas. These residents are upgradient of known groundwater contamination.
Exposure to groundwater contamination	Landfill 4 (LF4)	Groundwater	None	None	None	The groundwater at LF4 has not been, and will not be, used for drinking water.
Exposure to contaminated soil	Landfill 2 (LF2) Former Sewage Pond Artillery Impact Fan and Range Safety Fan areas Small Arms Firing Areas	Soil	Future regional park	Incidental ingestion Dermal contact	Future visitors to the regional park	Sampling indicates that there are no chemicals present at levels of health concern at LF2 and the Former Sewage Pond. Remediation is being conducted to remove soil containing elevated levels of lead around the former targets. CITA is and will continue to be fenced.
Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River	Camp Bonneville activities	Surface water Sediment	Lacamas Creek Lacamas Lake Columbia River	Incidental ingestion Dermal contact	Future visitors to the regional park	Exposure would be short-term and infrequent. Site activities have not impacted the water quality of Lacamas Creek.
Exposure to runoff water and standing rainwater near the OB/OD sites	Historic Burn Area Demolition Area 2 (DA2) Demolition Area 3 (DA3)	Surface water	OB/OD sites	Incidental ingestion Dermal contact	Future visitors to the regional park	Exposure would be short-term and infrequent. Sampling indicates that there are no chemicals present at levels of health concern.

Pathway	Exposure Pathway Elements					Comments
	Potential Sources of Contamination	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Inhalation exposure to past chemical warfare testing and training activities	Two gas chambers Mustard training area	Air	Adjacent off-site neighborhoods	Inhalation	Neighboring residents	No reported releases to the environment are known to have occurred. Further, CS gas decomposes quickly and has no persistent metabolites.
Hunting and eating wildlife on Camp Bonneville	Camp Bonneville activities	Biota	Camp Bonneville in the past	Ingestion	People who ate wildlife caught on Camp Bonneville in the past	It is unknown whether eating wildlife from Camp Bonneville in the past is expected to have caused harmful health effects. However, it is unlikely that the wildlife at Camp Bonneville would have accumulated harmful levels of contaminants.
Early property transfer as a public regional camping facility and potential exposures to future site users	Camp Bonneville activities	Soil Surface water Sediment	Future regional park	Incidental ingestion Dermal contact	Future visitors to the regional park	Institutional controls limit access to the site until after cleanup is completed.
Fire response and suppression at Camp Bonneville	NA	NA	If a wildfire was to spread to adjacent off-site neighborhoods	Physical contact Inhalation	Neighboring residents	WDNR is responsible for wildfire protection within the boundaries of Camp Bonneville.

Notes:
CITA Central Impact Target Area
CS 2-chlorobenzalmalononitrile
NA not applicable
OB/OD Open Burn/Open Detonation
UXO unexploded ordnance
WDNR Washington State Department of Natural Resources

Public Health Implications

Introduction

ATSDR evaluated groundwater and soil contamination at Camp Bonneville. To do so, ATSDR evaluated available data to determine whether contaminants were above ATSDR's CVs. CVs are derived for each environmental media (e.g., water, soil) and reflect an estimated contaminant concentration that is not expected to cause harmful health effects, assuming a standard daily contact rate (for example, the amount of water or soil consumed) and representative body weight. For chemicals above CVs, ATSDR derived exposure doses (see text box for definition) and compared them against health-based guidelines. Health guidelines are estimates of daily human exposure to substances that are not expected to result in health effects over a specified duration. They have built in "uncertainty" or "safety" factors that make them much lower than levels at which health effects have been observed. ATSDR also reviewed relevant toxicological data to obtain information about the toxicity of the chemicals of interest.

An exposure dose is the amount of chemical a person is exposed to over time.

Concern 1. Potential physical hazards from exposure to UXO

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 efforts to prevent contact, 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.

Health evaluation

UXO poses a physical hazard because it is possible for it to detonate and cause harm. Three circumstances must occur for an accident to result: 1) ordnance must be present, 2) the public must have access to the ordnance, and 3) a person's actions must detonate the ordnance. All three of these elements must take place in order for an accident to result.

1. Camp Bonneville was used as a small arms (e.g., rifle, pistol, and machine gun) training area. In addition, rifle grenades, mortars, howitzers, rockets, and practice and live grenades were used at the camp. Therefore, UXO is present. The majority of UXO is contained within the fenced Central Impact Target Area (CITA), however, it is possible that UXO is present in other parts of the camp as well.

The CITA is not slated for reuse; it will remain off-limits and fenced.

2. There are several factors that influence the public's access to UXO: density, depth, and size of UXO, property use, accessibility, topography, vegetation and ground cover, soil type, climate, UXO fuse type and sensitivity,

If UXO is found at any location, "step-out clearance" will be performed. This means a 100-foot by 100-foot grid surrounding the point of discovery will be surface cleared.

and activities on the site (FACDIC 1996). The topography of the CITA is remote with rugged terrain and the vegetation and ground cover is heavy, which prevents exposure to UXO. Further, BCRRT is installing a new fence along the perimeter of the property, with signs every 50 feet. The signs read, "Danger, No Trespassing, Possible Unexploded Military Munitions." Along with the fence installation, BCRRT is conducting brush clearing and surface clearance of UXO within 10 feet of the interior of the property fence line and within 10 feet of the interior of the CITA perimeter fence line. Additionally, the areas that are slated for reuse will first be swept for UXO. Therefore, after the characterization and cleanup, it is unlikely that the public will encounter UXO.

3. Because removal efforts tend to be 75 percent effective, UXO sites are still considered contaminated by ordnance even after removal (Wilcox 1997). A site which contained UXO at one point can never be deemed 100 percent free of UXO due to limitations of UXO removal technology. For this reason, it is very important for people who visit the future regional park to be educated about what to do if they encounter UXO. If UXO is discovered:

    - Never touch UXO,
    - Do not move closer to it,
    - Do not move objects near it,
    - Do not use communication or navigation devices near it,
    - Clearly mark the area where it was first seen, and
    - Leave and call 911 to report the UXO.

While it is essential to note these cautions, it is also important to recognize that few ordnance-related deaths occur in the United States (Wilcox 1997). The majority of accidents occurred when the item was picked up. Additionally, most accidents occur when an attempt is made to disassemble UXO or it is thrown. It is highly unlikely that an accident would occur at Camp Bonneville. BCRRT is taking steps to prevent exposure to UXO, but it is not possible to guarantee that the site will be completely free of UXO. Therefore, it is very important to take precautions and to educate those who may visit the future regional park, particularly children, about the dangers posed by UXO at the site.

Public access is prohibited on the Camp Bonneville property while BCRRT is conducting cleanup.

Concern 2. Exposure to soil and groundwater contamination for residents living within the Artillery Impact Fan and Range Safety Fan areas

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.

Artillery Impact Fan and Range Safety Fan areas are located onsite at Camp Bonneville. The greatest concentration of overlap of these fans is in the CITA. The CITA contained 13 targets. Acre grids will be cleaned around each target to a depth of 14 inches. These grids are 200 by 200 feet around each target. The CITA is not slated for reuse. It consists of 485 acres which will remain off-limits and fenced.

Concern 3. Exposure to groundwater contamination (specifically, perchlorate and RDX plumes)

Groundwater has been sampled from 18 sites at Camp Bonneville. The only area found to contain groundwater contamination was Landfill 4 (LF4). The closest drinking water well to LF4 is three miles away. The plume at LF4 contains RDX, perchlorate, and 1,1-dichloroethene. However, no one is drinking water from this area. Therefore, exposure to groundwater contamination is an incomplete pathway.

Hydrogeology

LF4 is located in the northwestern portion of the site. Groundwater flows towards Lacamas Creek and follows the creek off site to the southwest. Sentinel wells are in place along the southwestern boarder of Camp Bonneville to ensure that contaminants are not traveling off site. These wells have been monitored quarterly for explosives and propellants, metals, semi-volatile organic compounds (SVOCs), water quality parameters, and gas, diesel, and soil range petroleum hydrocarbons since 2003. They are also monitored intermittently for VOCs. No contaminants of concern have been detected in the boundary wells.

Water supply wells in the area surrounding Camp Bonneville are primarily placed in the Troutdale Formation or the underlying bedrock. Most of the wells near Camp Bonneville obtain groundwater from depths of 150 to 500 feet below ground surface (bgs).

The community expressed concern about the Troutdale aquifer. The Troutdale is designated as a sole-source aquifer and is, therefore, protected from federally funded projects that may pose a risk to aquifer contamination. As a result of that concern, the EPA Region 10 sole source aquifer manager attended ATSDR's site visit to Camp Bonneville to investigate the BCRRT's cleanup project. EPA determined that the Camp Bonneville project does not pose a risk to aquifer contamination because it is a cleanup program.

Nature and extent of contamination

An exhaustive groundwater sampling effort was completed in 2000. The Multi-Site Investigation sampled for VOCs, SVOCs, polycyclic aromatic hydrocarbons (PAHs), metals, explosives, pesticides, herbicides, and other contaminants from 18 sites at Camp Bonneville. The overwhelming majority of compounds were not detected at all. Of those that were detected, most were naturally-occurring metals detected below CVs for drinking water. Arsenic and copper were detected above ATSDR's most conservative CVs, but were consistent with levels found in background samples in the area.

The only known groundwater contamination at Camp Bonneville is at LF4, which was the primary landfill for Camp Bonneville and was also utilized by Clark County. It contained military exploded munitions, fireworks, debris, and garbage. In 2004, soil was excavated to 27 feet over a one-acre area at LF4. Confirmatory sampling verified that this removal action eliminated the source of contamination in the soil. However, some residual contaminants remain in the groundwater. The groundwater plume, which contains perchlorate, RDX, and low levels of solvents, appears to be small (about 2 acres) and slow-moving. There are 13 monitoring wells around LF4. Groundwater underlying LF4 has been sampled for explosives and propellants, VOCs, and metals quarterly since 2001. The main contaminants of concern are RDX, perchlorate, and 1,1-dichloroethene. However, the concentrations of these contaminants have been decreasing over time.

- The maximum concentration of RDX detected was 82 ppb. The cancer risk evaluation guide (CREG) for RDX is 0.3 ppb. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) after 70 years of continuous exposure through drinking water.

- The maximum concentration of perchlorate detected was 200 ppb. The environmental media evaluation guide (EMEG) for chronic exposures to perchlorate is 7 ppb for a child and 20 ppb for an adult. Chronic exposures mean the individual has been exposed to the contaminant continuously for 365 days or more.

- The maximum concentration of 1,1-dichloroethene detected was 23 ppb. This does not exceed ATSDR's CVs, however it does exceed EPA's maximum contaminant level (MCL) for drinking water of 7 ppb.

ATSDR uses comparison values such as CREGs, EMEGs, and MCLs as screening tools only. These screening tools are intended for use as drinking water comparison values. Groundwater at LF will not be used as drinking water. Long-term exposures to groundwater at LF4 would not occur because it is not a residential or occupational setting. Therefore, these screening values are extremely conservative and health effects are not expected from short-term, incidental exposure to groundwater at LF4.

Health evaluation

The groundwater at LF4 (the only known area of groundwater contamination at Camp Bonneville) has not been, and will not be, used for drinking water. For people to suffer ill effects from contamination they must come in contact with the contaminants. Therefore, a completed exposure pathway to groundwater does not exist at LF4. Further, monitoring wells upgradient and downgradient from LF4 do not contain harmful levels of contaminants. The closest drinking water well to LF4 is three miles away. Sentinel wells have been, and will continue to be, monitored to insure that contamination is not traveling off-site to drinking water wells where people could come into contact with it.

Groundwater use is restricted on the Camp Bonneville property while BCRRT is conducting cleanup.

Residents living to the east of Camp Bonneville expressed a specific concern about groundwater contamination in their neighborhood. However, they are located upgradient of the only known groundwater contamination at Camp Bonneville (LF4). Since it is not possible for groundwater contaminants to travel upgradient, exposure to groundwater contamination at Camp Bonneville is an incomplete pathway for these residents also.

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

Soil at the Former Sewage Pond and Landfill 2(LF2) was sampled in 1998. None of the contaminants were detected at levels of health concern. People are not being exposed to the soil at CITA because the area is fenced. Further, remediation is being conducted to remove soil containing elevated levels of lead around the small arms firing ranges.

History

The areas with soil contamination that are of greatest concern to the petitioner are the sewage pond/lagoon areas (Former Sewage Pond and LF2) and the Artillery Impact Fan and Range Safety Fan areas (mainly in CITA).

- The Former Sewage Pond is located in the Camp Bonneville cantonment area. However, its exact location and dimensions are unknown. The pond was reported to be unlined. It was used for a short period of time ending in 1978, when the sewage lagoon was constructed. The sewage lagoon is also known as LF2 because the landfill was discovered during the construction of the lagoon.

- Between 1909 and 1995, live and practice munitions were used and stored at Camp Bonneville (U.S. Army 2006). At least 25 firing ranges were used for small arms, large-caliber machine guns, rifles, grenades, light anti-tank weapon rockets, and subcaliber weapons training (Camp Bonneville Local Redevelopment Authority 2003).

Nature and extent of contamination

Soil sampling for metals, pesticides, VOCs, SVOCs, and other contaminants was conducted at LF2 and the Former Sewage Pond in 1998, as well as several other sites, as part of the Multi-Sites Investigation. Most of these contaminants were not detected. No contaminants at LF2 or the Former Sewage Pond exceeded ATSDR's CVs. The concentrations of metals detected in soil at LF2 and the Former Sewage Pond are consistent with those found in background samples surrounding Camp Bonneville. Chloroform was detected at a maximum of 6 nanograms (ng) in soil gas at LF2 (Shannon & Wilson 1999). ATSDR does not have CVs for soil gas, but the chloroform is believed to be a possible sampling or analytical procedure contaminant.

Soil in the small arms firing range areas contained lead from bullets. As part of the Multi-Site Investigation, the top 2 to 6 inches of soil on the firing range floors (the area from the firing point to the berms) were sampled. Five samples per grid point were taken. This amounted to 1,503 samples, few of which exceeded WDOE's cleanup goal of 50 parts per million (ppm) for lead.

The berms are scheduled for removal and 200-foot by 200-foot grids will be cleaned around each target to a depth of 14 inches. Confirmatory sampling will be conducted after the excavation is complete.

Health evaluation

No contaminants exceeded ATSDR CVs, therefore exposure to soil at LF2 and the Former Sewage Pond is not expected to cause adverse health effects. Further, areas with elevated lead contamination are being cleaned up.

Concern 5. Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River

In 1998, a surface water investigation was conducted on Lacamas Creek and its tributaries at Camp Bonneville. This investigation concluded that, in general, site activities have not impacted the water quality of Lacamas Creek. Due to the 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.

Hydrology

Lacamas Creek begins at the confluence of the North and East Forks and flows through Camp Bonneville before exiting the southwest corner of the site. It is also fed by David Creek and Buck Creek, which drain the southeast portion of the site. Lacamas Creek discharges in Lacamas Lake, which drains into the Columbia River. In most areas the creek cuts through Quaternary floodplain and stream channel alluvium and lacustrine deposits. These deposits are comprised mainly of clay, silt, and sand with some gravel. Recharge to Lacamas Creek is possible through groundwater migration through this alluvium as well as precipitation and surface runoff (HartCrowser 1999).

Use

Once a portion of Camp Bonneville is converted to a regional park, people will have access to Lacamas Creek during recreational activities. However, exposure to the surface water and sediment would be infrequent and short-term. Lacamas Creek is not and will not be used as a source of drinking water.

Nature and extent of contamination

Surface water sampling was conducted at six locations along Lacamas Creek and its tributaries in 1998. Very few contaminants were found above detection limits. The only compound detected above ATSDR's CVs for drinking water was arsenic (the maximum concentration of 0.2 ppb exceeded the CREG of 0.02 ppb). Arsenic is likely naturally occurring in Lacamas Creek (HartCrowser 1999). Further, the CREG is designed for a lifetime exposure to drinking water, rather than incidental ingestion and dermal contact with surface water. Therefore, the CREG is a highly conservative screening tool.

Health evaluation

The water at Lacamas Creek is not and will not be used for drinking water. Exposure to the surface water and sediment during recreational activities in the regional park will be infrequent and short-term. Therefore the minimal contamination of the creek will not affect human health. Camp Bonneville has not added to the contamination in the Columbia River via Lacamas Creek.

Concern 6. Exposure to runoff water and standing rainwater, particularly near the Open Burn/Open Detonation (OB/OD) sites

Even though standing water is sometimes seen in and around the OB/OD sites, exposure to it would be short-term and infrequent. Further, soil, groundwater, and surface water at the OB/OD sites have been sampled and no chemicals were detected at levels of health concern.

Nature and extent of contamination

The Historic Burn Area and Demolition Areas 2 (DA2) and 3 (DA3) are sometimes collectively referred to as the OB/OD sites.

The Historic Burn Area was used to burn wood and debris. There is no record of the length of use or the exact materials burned. The area has not been used since the 1980s. A UXO avoidance/screening survey was performed at the Historic Burn Area. In December 1997, surface and near-surface soil samples were collected in and near the area. No contaminants were found above regulatory or background levels (Army 2006).

The exact location of DA2 is not known. Site workers reported that DA2 was historically used for destruction of unwanted ordnance. Three monitoring wells were installed in the general area of DA2. No explosives, perchlorate, or metals were detected at concentrations at or above screening or regulatory criteria. Nitrite/nitrate was initially detected above drinking water standards, but confirmatory sampling could not verify this. Soil samples were collected from the estimated center of the site, 100 feet from the estimated center, and from a berm along the south side of DA2 and were tested for explosives, perchlorate, and metals. Arsenic was the only compound detected above screening levels. It was detected in 15 soil samples ranging from 20.7 ppm to 30.1 ppm. ATSDR's chronic EMEG for children is 20 ppm. All samples were below Clark County's background level of 60.8 ppm; therefore, the arsenic present at DA2 is most likely naturally occurring and not harmful (Army 2006).

Demolition Area 3 (DA3) is a surface depression that is approximately 20 feet in diameter and 10 feet deep. It may have been used for detonation of unwanted ordnance. Four monitoring wells were installed around DA3. Perchlorate and nitrate were initially detected above regulatory levels, but confirmatory sampling did not support this finding. Dissolved arsenic was detected at 9.86 ppb. Soil samples were collected in and around the depression. Explosives were detected, but below EPA's risk-based concentration (RBC) of 4.7 ppm. Metals were detected at background levels and/or below screening or cleanup levels. A surface water sample was collected from standing water within the depression. No explosives, perchlorate, or metals were detected in this sample (Army 2006).

Health evaluation

The average of all contaminants found in DA2 was below health-based screening levels. Nitrite/nitrate, although once detected above drinking water standards, were well below levels which would be expected to cause health effects. No contaminants were detected in a sample of standing water taken from DA3. Soil and groundwater samples collected from the OB/OD sites did not detect contaminants at levels of concern. Therefore, there is no reason to believe that short-term, infrequent exposure to runoff and standing water would pose a health hazard.

Concern 7. Inhalation exposure to agents used during past chemical warfare testing and training activities

2-Chlorobenzalmalononitrile (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.

History of chemical warfare testing

Camp Bonneville had two gas chambers and a 100 yard by 100 yard mustard training area. The "old gas chamber" was burned in the 1970s (USACE 1997). Its exact location is unknown, but this chamber was somewhere in the vicinity of Firing Range 7 (Army 2006). The other gas chamber was located at Building 1834 in the Camp Bonneville cantonment area. These buildings were used to train troops in using gas masks against chemical warfare agents. Only CS gas was used and no reported releases to the environment are known to have occurred (Woodward-Clyde 1997). Chemical warfare testing was conducted inside Building 1834 while troops wore protective gear. When the training exercise ended the doors were opened and the gas dissipated to the ambient air. Over the years, a visible residue adhered to the interior building surfaces.

CS is used as a military or police riot-control and incapacitating agent (HartCrowser 1997).

Nature and extent of contamination

Five soil samples were collected in the vicinity of the "old gas chamber." CS gas and cyanide were not detected in soil. The only compound detected above regulatory criteria was lead (Army 2006). In July 1998, lead was detected in one sample at 674 ppm (Shannon & Wilson 1999). EPA's screening level for lead in residential soil is 400 ppm because it is believed that daily ingestion of lead at 400 ppm, or greater, could result in an increase in the blood lead levels of children. This site has not been, and will not be, used as residential property. Contaminated soil was excavated to three feet below ground surface in June 2000. Confirmatory sampling indicated that all analyte concentrations were below regulatory criteria. The excavation was backfilled and all contaminated soil was disposed of off-site (Army 2006). In 1996, HartCrowser sampled building materials, as well as soil beneath and downwind of Building 1834. Neither CS gas nor its breakdown products were detected at or above detection limits (HartCrowser 1997).

Health evaluation

No residual hazardous substances are expected to remain at the "old gas chamber" because CS gas decomposes quickly and has no persistent metabolites when it is burned and exposed to water. No hazardous substances were present either on the building materials of Building 1834 or in the surrounding surface soils (Woodward-Clyde 1997).

Concern 8. Hunting and eating wildlife on Camp Bonneville

Hunting may have occurred on Camp Bonneville in the past, but is not expected to occur currently or in the future. Hunting was not recommended as a future use of Camp Bonneville in the Reuse Plan. 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.

Nature and extent of contamination

Data are not available to indicate whether wildlife at Camp Bonneville have accumulated harmful levels of contaminants. Deer at U.S. Army Aberdeen Proving Ground in Aberdeen, Maryland were found to have elevated levels of lead. However, it was not clear whether this contamination was from site activities or other sources. An elevated level of lead was also observed in an off-site deer sample from Gunpowder Falls State Park. The source of elevated lead was unclear and additional sampling to assess lead levels in deer was recommended (CHPPM 1995). Deer would have to be ingested daily, at the levels found near Aberdeen, in order for blood lead levels to rise significantly.

Available information suggests that explosive compounds are not typically found in deer meat or other wildlife. Studies conducted at the Alabama Army Ammunition Plant in Childersburg, Alabama, and Joliet Army Ammunition Plant in Joliet, Illinois, analyzed deer tissue for residue levels of explosive compounds, including trinitrotoluene (TNT), cyclotetramethylene-tetranitramine (HMX), RDX, 2,4-dinitrotuluene (DNT), and/or 2,6-DNT (Shugart et al. 1991; U.S. AEHA 1994). No detectable levels of explosive compounds were found in either test, even though high levels of contaminants may have been present in soil, surface water, or waste water. A human health risk assessment at the Joliet Plant concluded no significant explosive-related risks were associated with eating the deer meat. Considering this information, ATSDR does not expect past consumption of wildlife from Camp Bonneville to cause harmful health effects for hunters or other past wildlife consumers.

Health evaluation

Fish and game are not expected to accumulate harmful levels of site-related contaminants. People who ate these foods in a varied diet in the past are therefore not likely to experience adverse health effects. According to the *Camp Bonneville Reuse Plan*, hunting will not be allowed on Camp Bonneville in the future, therefore, people will not be exposed to

contamination through ingestion of deer meat in the future (Camp Bonneville Local Redevelopment Authority 2003).

Concern 9. Early property transfer as a public regional camping facility and potential exposures to future site users

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 WDOE. 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 (WDOE 2006).

Potential exposures

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) allows federal agencies to transfer property before all necessary cleanup has occurred. The intent of this early transfer option is to assist communities in expediting the reuse of former defense facilities. There are several interim institutional controls on the Camp Bonneville property while BCRRT is conducting cleanup—public access is prohibited, groundwater use is restricted, digging is limited to qualified MEC personnel, and preservation of cultural and archeological sites is required (WDOE 2006).

The property was transferred under a conservation conveyance. The *Camp Bonneville Reuse Plan* identified the property reuse as recreational with nine specific components: regional park, law enforcement training center, rustic retreat center/outdoor school, Native American cultural center, Clark College environmental education, trails and nature area, FBI firing range, timber resource management area, and habitat restoration. Approximately 1,000 of the 3,020 acres at Camp Bonneville will be used as a regional park (Army 2006). None of the reuse areas will be located near the CITA. The CITA will remain fenced, and will not be used in the future. The FBI will cease use of the firing range by summer 2008, and Clark County is not planning to utilize Camp Bonneville for firing ranges in the future.

Health evaluation

Any exposure to contaminants at the future regional park would be intermittent and short-term since Camp Bonneville will not be used for occupational or residential purposes. The levels of contamination detected in soil, groundwater, and surface water at Camp Bonneville are below levels at which health effects are expected from *long-term, daily exposure*. Therefore, the type of exposure expected from utilizing the future regional park for recreational activities such as camping would not cause a health hazard.

Although BCRRT is conducting cleanup in the areas most likely to contain UXO, it is very important for people to take precautions should they ever come in contact with UXO at the future regional park. The most important thing to remember is to never touch UXO and call 911 immediately if UXO is discovered.

Concern 10. Fire response and suppression at Camp Bonneville

Despite the fact that UXO is present on Camp Bonneville, WDNR will respond to wildfires at the property in close coordination with BCRRT. There may be some areas (e.g., 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.

Health evaluation

The neighboring Summit at Autumn Hills community expressed concern over who would respond to a fire on Camp Bonneville, given the presence of UXO. They heard conflicting reports as to the fire fighting plan—in some instances; they were told that firefighters would not fight fires on Camp Bonneville property.

WDNR has fire protection responsibilities within the boundaries of Camp Bonneville, specifically the forest and unimproved lands.[1] In March 2007, they developed a *Pacific Cascade Region Fire Operations Guide*, part of which specifically deals with wildfire suppression on Camp Bonneville (WDNR 2007). Due to the high potential for UXO, in the event of a fire, WDNR will contact and coordinate closely with a BCRRT representative to determine the best and safest fire fighting strategy, specific to each fire situation. Fire fighters can and will fight fires on Camp Bonneville property, as long as a BCRRT representative has been consulted. This step is taken to protect the lives of the fire fighters, while still protecting other human life and property.

A wildfire at the CITA requires special consideration because of the known presence of UXO. The area is fenced and access is denied, even for the WDNR fire fighters. Regardless, WDNR would closely monitor a fire at the CITA and could choose to employ aerial chemical retardants or helicopter bucket drops to manage the fire, rather than ground forces (Tom North, WDNR Pacific Cascade Region, personal communication, October 17, 2007).

[1] Clark County Fire Districts (Fire District #3, Vancouver Fire Department, and East County Fire and Rescue) are the responders for fires at the structures on Camp Bonneville.

Child Health Considerations

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity is the result of a number of factors. Children are more likely to be exposed because they play outdoors and they often bring food outside. Children are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, potentially resulting in higher doses of chemical exposure per unit body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. Therefore, ATSDR is committed to evaluating their special interests at sites such as Camp Bonneville.

Of the UXO accidents occurring at Formerly Used Defense Sites (FUDS) where the victim's age was known, 75 percent of the victims were children. Ninety-two percent of the incidents involved UXO being picked up (QuantiTech 2005). Although UXO cleanup is occurring at Camp Bonneville, it is not possible to ensure removal of 100 percent of UXO at any FUDS site. For this reason, it is very important for children, as well as the responsible adults who accompany them on visits to the future regional park, to be educated about what to do if they encounter UXO. The most important thing for children, and adults, to understand is that UXO is dangerous and it should never be handled.

Conclusions

On the basis of its evaluation of available environmental information, ATSDR has categorized exposures to contamination at Camp Bonneville as *No Apparent Public Health Hazard*. This means that exposure to site-related chemicals might have occurred in the past, or may occur in the future, but not at levels likely to cause adverse health effects. Currently, Camp Bonneville is closed to the public while cleanup activities are ongoing.

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

  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.

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

  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 groundwater contamination.

- *Concern 3. Exposure to groundwater contamination* (specifically, perchlorate and RDX plumes)

  Groundwater was sampled from 18 sites at Camp Bonneville. The only area found to contain groundwater contamination was Landfill 4 (LF4). The plume at LF4 contains RDX, perchlorate, and 1,1-dichloroethene. However, no one is drinking water from this area. Therefore, exposure to groundwater contamination is an incomplete pathway.

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

  Soil at the Former Sewage Pond and Landfill 2(LF2) was sampled in 1998. None of the contaminants were detected at levels of health concern. People are not being exposed to the soil at 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.

- *Concern 5. Exposure to surface water and sediment contamination in Lacamas Creek, Lacamas Lake, and the Columbia River*

In 1998, a surface water investigation was conducted on Lacamas Creek and its tributaries at Camp Bonneville. This investigation concluded that, in general, site activities have not impacted the water quality of Lacamas Creek. Due to the 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.

- *Concern 6. Exposure to runoff water and standing rainwater, particularly near the Open Burn/Open Detonation (OB/OD) sites*

  Even though standing water is sometimes seen in and around the OB/OD sites, exposure to it would be short-term and infrequent. Further, soil, groundwater, and surface water at the OB/OD sites have been sampled and no chemicals were detected at levels of health concern.

- *Concern 7. Inhalation exposure to agents used during past chemical warfare testing and training activities*

  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.

- *Concern 8. Hunting and eating wildlife on Camp Bonneville*

  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.

- *Concern 9. Early property transfer as a public regional camping facility and potential exposures to future site users*

  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 WDOE. 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 (WDOE 2006).

- *Concern 10. Fire response and suppression at Camp Bonneville*

  Even though UXO is present on Camp Bonneville, WDNR will respond to wildfires at the property in close coordination with BCRRT. There may be some areas (e.g., 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.

Recommendations

- 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 groundwater in the vicinity of groundwater contamination at LF4 not be used for drinking water in the future, and that groundwater 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.

Public Health Action Plan

The Public Health Action Plan (PHAP) for Camp Bonneville contains a description of actions taken and to be taken by ATSDR and the Army subsequent to the completion of this public health assessment. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, ongoing, or planned are listed below.

Completed Actions

- In 2000, the Army Corps of Engineers completed a Multi-Sites Investigation. This thorough investigation sampled groundwater and soil at 18 sites on Camp Bonneville.
- In 2004, an excavation took place at LF4 to remove contaminated soil.
- In 2006 Camp Bonneville was transferred from DOD to Clark County, who then temporarily transferred it to BCRRT for cleanup.

Ongoing and Planned Actions

- A cleanup project is underway by BCRRT to prepare Camp Bonneville for use as a regional park. This project includes sweeping for UXO and remediation of areas with high lead content.
- New fencing and signage is being installed around the perimeter of the property and surrounding the CITA.
- When the cleanup project is complete, approximately 1,000 acres of Camp Bonneville will be utilized as a regional park. The CITA will remain fenced and off-limits to the public.
- Berms in the small-arms firing ranges will be removed and the area around each target will be cleaned.

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Appendices

Appendix A. ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life ($t_{½}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)]

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
1-800-CDC-INFO (1-800-232-4636)

Appendix B. Overview of ATSDR's Methodology for Evaluating Potential Public Health Effects

Methodology

Comparing Environmental Data to Comparison Values

A comparison value is used by ATSDR to screen chemicals that require additional evaluation.

ATSDR uses the term "conservative" to refer to values that are protective of public health in essentially all situations. Values that are overestimated are considered to be conservative.

For this public health assessment, the Agency for Toxic Substances and Disease Registry (ATSDR) selected contaminants for further evaluation by comparing the maximum environmental contaminant concentrations against conservative health-based comparison values. Comparison values are developed by ATSDR from available scientific literature concerning exposure and health effects. Comparison values are derived for each environmental media (water, soil, and air) and reflect an estimated contaminant concentration that is not expected to cause harmful health effects, assuming a standard daily contact rate (for example, the amount of water or soil consumed) and representative body weight. Because the concentrations reflected in comparison values are much lower than those that have been observed to cause adverse health effects, comparison values are protective of public health in essentially all exposure situations. As a result, concentrations detected at or below ATSDR's comparison values are not considered for further evaluation.

ATSDR's comparison values include the cancer risk evaluation guides (CREGs), environmental media evaluation guides (EMEGs), and reference dose media evaluation guides (RMEGs). These are nonenforceable, health-based comparison values developed for screening environmental contamination for further evaluation. The U.S. Environmental Protection Agency's (EPA) comparison values include risk-based concentrations (RBCs) and maximum contaminant levels (MCLs). An RBC is a health-based comparison value developed to screen sites not yet on the National Priorities List, respond rapidly to citizens' inquiries, and spot-check formal baseline risk assessments. MCLs are enforceable drinking water regulations developed to protect public health.

Essential nutrients (e.g., calcium, magnesium, phosphorous, potassium, and sodium) are important minerals that maintain basic life functions; therefore, certain doses are recommended on a daily basis. Because these chemicals are necessary for life, screening guidelines do not exist for them. They are found in many foods, such as milk, bananas, and table salt.

While concentrations at or below the relevant comparison value can reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. Comparison values are not thresholds for harmful health effects. ATSDR comparison values represent contaminant concentrations that are many times lower than levels at which no effects were observed in studies on experimental animals or in human epidemiologic studies. The likelihood that adverse health outcomes will actually occur depends on site-specific conditions, individual lifestyle, and genetic factors that

affect the route, magnitude, and duration of actual exposure. If contaminant concentrations are above comparison values, ATSDR further analyzes exposure variables (such as site-specific exposure, duration, and frequency) for health effects, including the toxicology of the contaminant and other epidemiology studies.

Comparing Estimated Doses to Health Guideline Values

If chemical concentrations are above comparison values, ATSDR further evaluates the chemical and potential exposure. ATSDR does this by calculating exposure doses and comparing the doses to protective health guideline values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs). Estimated exposure doses that are less than health guideline values are not considered to be of health concern. ATSDR's MRLs and EPA's RfDs are estimates of the daily human exposure to hazardous substances that are likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure.

An exposure dose, expressed in milligrams per kilogram per day (mg/kg/day), represents the amount of contaminant that an individual is assumed to ingest (in milligrams), divided by the body weight of the individual (in kilograms) each day.

When estimating exposure doses, health assessors evaluate chemical concentrations to which people could have been exposed, together with the length of time and the frequency of exposure. Collectively, these factors influence an individual's physiological response to chemical exposure and potential outcomes. Where possible, ATSDR used site-specific information regarding the frequency and duration of exposures. When site-specific information was not available, ATSDR employed several conservative assumptions to estimate exposures.

MRLs and RfDs are generally based on the most sensitive end point considered to be of relevance to humans. While estimated doses that are less than these values are not considered to be of health concern, exposure to levels above the MRL or RfD does not automatically mean that adverse health effects will occur. To maximize human health protection, they have built-in uncertainty or safety factors, making these values considerably lower than levels at which health effects have been observed. The result is that even if a dose is higher than the health guideline, it does not necessarily follow that harmful health effects will occur. Rather, it is an indication that ATSDR should further examine the harmful effect levels reported in the scientific literature and more fully review exposure potential.

In addition, to screen for cancer effects, estimated chronic-exposure doses were multiplied by EPA's cancer slope factors (CSFs) to measure the relative potency of carcinogens. This calculation estimates a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated cancer risk of 1×10^{-6} predicts the probability of one additional cancer over background levels in a population of 1 million. Because conservative models are used to derive CSFs, the doses associated with these estimated hypothetical risks may be orders of magnitude lower than doses reported in the toxicology literature to cause carcinogenic effects. As such, a low cancer risk estimate (risk estimates less than 1×10^{-5}) indicates that the toxicology literature would support a finding that no excess cancer risk is likely. A higher cancer risk estimate, however, indicates that

ATSDR should carefully review the toxicology literature before making conclusions about potential cancer risks.

Comparing Estimated Doses to Health Effects Levels

If the MRLs or RfDs are exceeded, ATSDR examines the health effects levels discussed in the scientific literature and more fully reviews exposure potential. ATSDR reviews available human studies as well as experimental animal studies. This information is used to describe the disease-causing potential of a particular chemical and to compare site-specific dose estimates with doses shown in applicable studies to result in illness (known as the margin of exposure). This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

Sources for Health-based Guidelines

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. These toxicological profiles were used to evaluate potential health effects at Camp Bonneville. ATSDR's toxicological profiles are available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html or by contacting the National Technical Information Service (NTIS) at 1-800-553-6847. EPA also develops health effects guidelines, and in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposure to various substances found in the environment. IRIS is available on the Internet at http://www.epa.gov/iris. For more information about IRIS, please call EPA's IRIS hotline at (202) 566-1676 or send an e-mail to hotline.iris@epa.gov.

Appendix C. ATSDR's Response to Public Comments

The Agency for Toxic Substances and Disease Registry (ATSDR) released the Camp Bonneville Public Health Assessment (PHA) for public comment on April 7, 2008. The public comment period ended May 16, 2008. ATSDR received comments from a former member of the Camp Bonneville Restoration Board (RAB). The comments received, as well as ATSDR's responses, are presented below.

General Comment

Comment #1:

The RAB applied to the DoD for funds it was entitled to for independent studies. In 2006 a RAB committee voted to apply for funds for an independent risk analysis by a firm renowned for its knowledge of UXO. The application was unfortunately incomplete and the RAB was intending to resubmit. However, the property was transferred and the RAB was dissolved before this could take place.

The risk analysis would have been weighted, and without a weighted risk analysis, the type of broad statements and conclusions about health hazards in ATSDR's report cannot be made with any degree of certainty or credibility.

ATSDR Response:

A quantitative risk analysis provides a numeric estimate of theoretical risk or hazard. It focuses on current and potential future exposures and considers all contaminated media regardless of whether exposures are occurring or are likely to occur. By design, it generally uses standard (default) protective exposure assumptions when evaluating site risk.

ATSDR's public health assessment differs from the more quantitative risk analysis in both its purpose and approach. The public health assessment is used by ATSDR to identify potential harmful exposures and to recommend actions needed to protect public health. ATSDR considers the same environmental data as a risk analysis, but focuses more closely on site-specific exposure conditions, specific community health concerns, and any available health outcome data to provide a more qualitative, less theoretical evaluation of possible public health hazards.

The general steps in the two processes are similar (e.g., data gathering, exposure assessment, toxicologic evaluation), but the public health assessment provides additional public health perspective by integrating site-specific exposure conditions with health effects data and specific community health concerns. Further, the public health assessment provides perspective on what the risk estimates mean in the context of the site community. The process identifies and explains whether exposures are truly likely to be harmful under site-specific conditions and recommends actions to reduce or prevent such exposures.

Comments about Concern 1: UXO Hazards

Comment #2:

Broad statements such as the one on p. 18 ("It is unlikely that the public will encounter UXO") are premature because they are not fact-based. They are based on presumption, opinion and incomplete characterization.

ATSDR Response:

The majority of the unexploded ordnance (UXO) is contained within the Central Impact Target Area (CITA), which will remain restricted and fenced. Areas that are slated for reuse will be swept for UXO. If UXO is found, a 100 ×100 foot grid surrounding the point of discovery will be cleared. Further, the Bonneville Conservation, Restoration, and Renewal Team (BCRRT) is conducting brush and surface clearance along the property and CITA fence lines and is installing perimeter fences and signs warning people of the danger of UXO. Public access is prohibited on Camp Bonneville while cleanup is being conducted. Because of these precautions, it is unlikely that the public will encounter UXO after the characterization and cleanup is completed,. ATSDR adjusted the sentence to read "Therefore, after the characterization and cleanup, it is unlikely that the public will encounter UXO."

Comment #3:

The DoD made this statement in DoD 6055.09-STD, "DoD Ammunition and Explosives Safety Standards," February 29, 2008 (Chapter 15):

"UXO are considered the most dangerous category of military munitions."

The ATSDR should have had a weighted analysis available for this study that would enable it to address the risks of UXO.

ATSDR Response:

ATSDR's health assessments are driven by exposure. People can only be harmed by UXO if they come in contact with it. ATSDR evaluated site conditions to determine whether people are or could be exposed to UXO. Given the precautions being taken to prevent UXO exposure (restricted access, fencing, signs, UXO screening, and site clearance), it is unlikely that the public will encounter UXO once the characterization and cleanup is completed. However, since removal efforts are not 100 percent effective, it is very important for people who visit the future regional park be educated about what to do if they encounter any remaining UXO.

Comment #4:

The only certainty is that UXO will be found in unexpected places. Since ATSDR's study was conducted, cleanup crews have discovered another missile impact area that was not previously reported. As of April 2008, approximately 300 unexploded mortars, grenades and other ordnance had been found—considerably more than the WA DOE expected. The $15 million(?) earmarked for UXO cleanup has been expended and the County has had to ask the Army for the additional $10 million in reserve. UXO cleanup will no doubt stop once the funds are exhausted.

ATSDR Response:

The discovery of an unexpected missile impact area is yet another reason why it is very important that all areas that the public will be able to access in the future regional park are swept for UXO and that institutional controls are in place to limit the potential for exposure to UXO. In addition, access to the site is not permitted while cleanup is ongoing. To not take the appropriate precautions and complete the cleanup would endanger the public. The Army has allotted $25 million for UXO cleanup. Additionally, should the UXO cleanup exceed the budget, it is covered by a 100% insurance policy held by the BCRRT. Finally, DoD is ultimately responsible for the cleanup of UXO discovered even after the property has transferred.

Comment #5:

What statistics does ATSDR rely on to conclude that "Institutional Controls" (fences, warning signs and educational materials) will be an effective means of preventing contact with UXO? They will not prevent access, and many people (mostly kids) will find UXO alluring, despite education about its dangers. (The local School Districts used to conduct Outdoor School at Camp Bonneville, and teachers have reported that—despite caution—students would come back to camp with buckets of debris, much of which would be carried off-site.)

ATSDR Response:

ATSDR recognizes that children may be attracted to hazards and some children may be especially attracted by the possibility of finding ordinance. ATSDR also recognizes the procedures associated with the clearance process and the associated risk reductions for the various strategies. ATSDR's recommendations are based on the weight of the evidence.

Wilcox (1997) discussed the use of institutional controls at sites with UXO. In his paper, he advocates considering institutional controls at sites and states that institutional controls are "potentially as effective as any removal action" (Wilcox 1997). Fences are one of the most direct ways of preventing inadvertent access to an area. Under local trespass laws, violators can be prosecuted (USACE 2000). For the areas that are not fenced off, the most important precaution is to identify and remove the UXO. Additional institutional controls, such as signs and educational materials, need to be in place to further prevent contact since current technologies cannot detect and remove all UXO. Warning signs are an "effective means" to warn the public about the potential hazards associated with entering a restricted area (USACE 2000). Warning signs will be placed along fences every 50 feet at Camp Bonneville. Educational programs "can be an

effective method" for spreading the word about the nature and extent of the hazards associated with an area and the precautions that should be taken (USACE 2000). Together, these safety measures should limit the risk of unintentional contact with UXO.

Comment #6:

The "fewer than 10" UXO accidents referenced on p. 18 were reported in a study that is more than a decade old. It seems to have included only those that occurred on FUDS sites, and the incidents were probably only the fatal ones. Presumably accidents occur that are not recorded, either because they aren't fatal or because UXO has been carried off-site so accidents are not counted when they occur.

ATSDR Response:

ATSDR revised the sentence to read: "While it is essential to note these cautions, it is also important to recognize that few ordnance-related deaths occur in the United States (Wilcox 1997)."

Comments About Concern 3: Groundwater Contamination

Comment #7:

No water modeling has been done. All ATSDR statements regarding contamination are based on assumptions concerning groundwater flow, soil density, proximity to the aquifer, etc.

ATSDR Response:

ATSDR's conclusions about exposure to groundwater are based on an exhaustive groundwater sampling effort that was completed by the U.S. Army Corps of Engineers in 2000. The Multi-Site Investigation sampled groundwater for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), metals, explosives, pesticides, herbicides, and other contaminants from 18 sites at Camp Bonneville. The overwhelming majority of compounds were not detected. Of those that were detected, most were naturally-occurring metals detected below comparison values (CVs) for drinking water. The only known groundwater contamination at Camp Bonneville is at a former landfill (LF4). No one is drinking water from this area, and the closest drinking water well to the landfill is three miles away. Therefore, exposure to groundwater contamination is an incomplete pathway.

Comment #8:

EPA stated in comments to DOE on the Final Remedial Investigation Report, Demolition Areas 2 and 3, Camp Bonneville, Vancouver, Washington:

> "There is inadequate data to measure ground water quality and flow conditions at the site, ground water should be considered to be uncharacterized at this site." (Comment 17)

> "Water quality information from the sampled wells is not necessarily representative of ground water at the subject site." (Comment 29)
>
> "There are not enough data points to empirically determine the direction of ground water flow in the Lacamas Creek valley." (Comment 12)

Please note and address the remainder of EPA's comments on groundwater (attached).

ATSDR Response:

The referenced Environmental Protection Agency (EPA) comments are specific to a remedial investigation conducted for Demolition Areas 2 and 3. These comments do not appear to be applicable to groundwater conditions at the entire Camp Bonneville site. As noted in the response to Comment #7, ATSDR based its conclusions about groundwater exposure on an exhaustive groundwater sampling effort that was completed by the U.S. Army Corps of Engineers in 2000 (a different report than the one that EPA commented on).

Because ATSDR's health assessments are exposure driven, the main conclusion that groundwater is an incomplete pathway does not change, regardless of whether the groundwater contamination at Demolition Areas 2 and 3 is fully characterized. Sentinel wells have been, and will continue to be, monitored to insure that contamination is not traveling off-site to drinking water wells where people could come into contact with it. If no one is drinking contaminated water, no exposures are occurring, and no health effects can occur.

Since ATSDR did not help generate the *Final Remedial Investigation Report for Demolition Areas 2 and 3*, it is not feasible for ATSDR to address EPA's comments on the report. The author of the report, BCRRT, is the appropriate party to address these comments.

Comments About Concern 10: Fire Response

Comment #9:

DNR officials stated to me personally in 2006 that they would follow the Dept of Defense guidelines for fire suppression. Some of the munitions used at Camp Bonneville have a kill radius of 600 ft. DoD 6055.09-STD, "DoD Ammunition and Explosives Safety Standards," February 29, 2008 (Chapter 8) lists an Emergency Withdrawal Distance of at least the radius of the munitions used on the site—in this case 600 ft.

The Camp Bonneville site is densely forested and has a history of forest fires. The County's Park Plan has more than 40 miles of roads and trails available to the public. These will have only 10-ft of UXO clearance to each side. If a forest fire breaks out in the vicinity of the trails, fire suppression will not be provided if the DoD guidelines are followed. This could leave hundreds of people stranded.

If the County Fire Districts also follow the DoD guidelines, fire suppression will not be provided to adjacent homes that are within 600 ft of the Camp Bonneville the clearance area inside the property line.

ATSDR Response:

In March 2007, the Washington State Department of Natural Resources (WDNR) developed a *Pacific Cascade Region Fire Operations Guide*, part of which specifically deals with wildfire suppression on Camp Bonneville (WDNR 2007). There is no mention of following Department of Defense (DOD) guidelines for Camp Bonneville in this document. The plan does state that in the event of a fire, WDNR will contact and coordinate closely with a BCRRT representative to determine the best and safest fire fighting strategy, specific to each fire situation. Fire fighters can and will fight fires on Camp Bonneville property, as long as a BCRRT representative has been consulted.

The wildfire suppression plan for Camp Bonneville includes special considerations for the many rural developments that border the site. The plan states that "Careful planning and consideration of these developments should drive the operations plan in extended attack. Preplanning and coordination with local rural Fire districts should be implemented should evacuation of these developments need to take place." (WDNR 2007).