Final

Record of Decision for Operable Units 21, 23, 35, 37, and 44

Langley Air Force Base, Virginia

SEPTEMBER 2008

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Acronyms and Abbreviations

AFB	Air Force Base
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	Contaminant of Concern
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERP	Environmental Restoration Program
ESD	Explanation of Significant Difference
FS	Feasibility Study
FTA	Fire Training Area
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IRP	Installation Restoration Program
LOAEL	Lowest-Observed-Adverse-Effect Level
lf	linear feet
LTM	Long-term Monitoring
LUC	Land Use Control
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MLB	Mile-Long Building
MSA	Munitions Storage Area
ng/kg	nanogram per kilogram
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No-Observed-Adverse-Effect Level
NPL	National Priorities List

O&M	Operations and Maintenance
OU	Operable Unit
pg/L	picograms per liter
PP	Proposed Plan
RA	Remedial Action
RACR	Remedial Action Completion Report
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RBC	Risk Based Concentration
RBSL	Risk-Based Screening Levels
RD	Remedial Design
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
SVOC	Semi-Volatile Organic Compound
TBC	To-Be-Considered
TCLP	Toxicity Characteristic Leaching Procedure
UTL	Upper Tolerance Limit
VDEQ	Virginia Department of Environmental Quality

SECTION 1

Declaration

1.1 Site Name and Location

Langley Air Force Base, (CERCLIS ID # VA2800005033)

- Operable Unit 21 (Site LF-01)
- Operable Unit 23 (Site LF-05)
- Operable Unit 35 (Site LF-18)
- Operable Unit 37 (Site LF-22)
- Operable Unit 44 (Site FT-41)

Hampton, Virginia

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) presents the Selected Remedy for contaminated soil and waste materials implemented at Operable Units (OUs) 21, 23, 35, and 37 and the Selected Remedy for contaminated soil, sediment, and surface water implemented at OU44 at Langley Air Force Base (AFB) in Hampton, Virginia. These OUs are otherwise known as Environmental Restoration Program (ERP) [formerly Installation Restoration Program (IRP)] Sites LF-01, LF-05, LF-18, and LF-22, and FT-41, respectively. The selected remedies for these Sites were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This determination is the final remedy for soil and waste materials at Sites LF-01, LF-05, LF-18, and LF-22 and for soil, sediment, and surface water at Site FT-41. This decision is based on the Administrative Record for the Sites.

The United States Air Force is the lead agency and provides funding for site cleanups at Langley AFB. This ROD for OUs 21, 23, 35, 37, and 44 supersedes only the portions of the *Final Record of Decision, Langley Air Force Base, Virginia, Operable Units 21, 23, 33, 35, 37, and 44* (Langley AFB, December 2001) signed by the Air Force relative to Sites LF-01, LF-05, LF-18, LF-22, and FT-41. The portions of the 2001 ROD relative to Site LF-15 (OU33) are addressed in a separate ROD. The United States Environmental Protection Agency (EPA) Region III did not sign and Virginia Department of Environmental Quality (VDEQ) did not concur with the multi-site ROD, stating it did not adequately address institutional controls for the sites at which hazardous substances would remain. Recently, the Air Force and EPA have come to agreement on the institutional controls and jointly select the remedy for waste and soil at Site LF-01, LF-05, LF-18, and LF-22, and for soil, surface water, and sediment at FT-41. VDEQ concurs with the Selected Remedy.

1.3 Assessment of the Site

Previous investigations identified waste and the presence of metals, semi-volatile organic compounds (SVOCs), and pesticides in soils at LF-01, LF-05, LF-18, LF-22, and FT-41, and dioxin in soil and metals, SVOCs, and pesticides in sediment and surface water associated with FT-41 at concentrations that pose a potential threat to human health and the environment. The response actions selected in this ROD and previously implemented were necessary to protect the public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment or of pollutants or contaminants from these Sites which may present an imminent and substantial endangerment to public health or welfare.

1.4 Description of the Selected Final Remedy

LF-01, LF-05, LF-18, LF-22, and FT-41 are part of a comprehensive environmental investigation and cleanup currently being performed at Langley AFB under the CERCLA program. This ROD addresses only these Sites; the other sites located at Langley AFB either have been or will be addressed in other RODs. This ROD identifies the final action for soil and waste materials at LF-01, LF-05, LF-18, and LF-22 and soil, sediment, and surface water at FT-41. Groundwater for these and other sites will be addressed on an installation-wide basis as part of OU52 (OT-64). Surface water and sediment associated with LF-01, LF-05, LF-18, and LF-22 will be addressed as part of the basewide surface water and sediment OU51 (SS-63). The Management Action Plan for Langley AFB, updated annually, includes the current CERCLA status and schedule of remedial actions (RAs) for each OU. The Management Action Plan and supplemental information can be found in the information repository for Langley AFB.

The remedial action objectives (RAOs) for LF-01, LF-05, LF-18, and LF-22 were to prevent exposure to waste and soil presenting unacceptable risks. The major shared components of the Selected Remedy for Sites LF-01, LF-05, LF-18, and LF-22 were:

- Containment, including application of clean soil cover over specific areas of the Sites that had insufficient soil cover over waste materials, followed by grading and re-vegetation; and
- Land use controls (LUCs) to ensure the integrity of the soil covers is maintained and to restrict use of the Sites inconsistent with risk assessment exposure assumptions.

The RAO for FT-41 was to prevent exposure to soil, surface water, and sediment presenting unacceptable risks. The major components of the Selected Remedy for FT-41 were:

- Erosion and sediment controls to reduce movement of contaminated sediments into adjacent wetlands area north of the Site;
- Cleaning/contouring one water drainage channel and flushing one catch basin and associated pipe culvert;
- Monitoring to assess the effectiveness of the remedy; and
- LUCs to restrict use of the Site inconsistent with risk assessment exposure assumptions.

The response actions that the Air Force selected in the 2001 ROD were subsequently implemented. However, because the 2001 ROD was not signed by EPA or concurred upon by VDEQ, this ROD documents the remedy selection process as summarized and presented in the Proposed Plan (PP) (URS, 2001) and the Revised PP (Langley AFB, 2008a). Based on the response actions conducted, unacceptable risk associated with exposure to waste and soil at Sites LF-01, LF-05, LF-18, and LF-22, and soil, surface water, and sediment at FT-41 was eliminated and no further action is necessary.

The Air Force is responsible for, has implemented, and will continue to operate, maintain, monitor, review, and enforce each Selected Remedy in accordance with CERCLA and the NCP, to ensure protection of human health and the environment for the duration of the Selected Remedy. LUCs will be maintained until the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure.

1.5 Statutory Determination

The final Selected Remedies for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 have shown to be protective of human health and the environment, complied with Federal and the Commonwealth of Virginia requirements that are legally applicable or relevant and appropriate to the RA, were cost effective, and used permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable. The remedies for LF-01, LF-05, LF-18, and LF-22 satisfied the requirements of the EPA directive for the application of the CERCLA municipal landfill presumptive remedy to military landfills. While the remedies did not promote the statutory preference for treatment as a principal element of the remedy, the Air Force and EPA have concluded that the LF-01, LF-05, LF-18, and LF-22 soil and FT-41 soil, sediment and surface water were not amenable to treatment.

The RA at LF-01 permanently impacted existing wetland areas. The taking of wetlands is an irreversible and irretrievable commitment of natural resources and wetlands restoration was conducted to mitigate the impact in accordance with Federal and State requirements and Langley AFB policies.

Because the Selected Remedies for Sites LF-01, LF-05, LF-18, LF-22 and FT-41 resulted in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of RA , and at 5-year intervals thereafter, to ensure that the remedies continue to be protective of human health and the environment.

1.6 Data Certification Checklist

The following information is included for each Site in the Decision Summary (Part 2) of this ROD. Additional information can also be found in the Administrative Record files for these Sites.

- Contaminants of concern (COCs) and their respective concentrations (Section 2.7 and associated tables)

- Baseline risk represented by the COCs (Section 2.7)
- Cleanup levels are not required as part of the presumptive remedy approach because the principal remedy component (i.e., cover) was completed in accordance with closure Applicable or Relevant and Appropriate Requirements (ARARs)
- How source materials constituting principal threats are addressed (Section 2.11)
- Current and reasonably anticipated future land use assumptions (Section 2.6)
- Potential land use that will be available at the Site as a result of the Selected Remedy (Section 12.2.4)
- Estimated capital, annual operations and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.12.3 and associated tables)
- Key factors that led to selecting the remedy and how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria (Section 2.12.1).

1.7 Authorizing Signatures

Richard J. Wheeler

RICHARD J. WHEELER
Colonel, USAF
Deputy Director of Installations and Mission Support (A7)

22 Sep 08
Date

James J. Burke

JAMES J. BURKE
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EPA (Region III)

9/29/08
Date

SECTION 2

Decision Summary

2.1 Site Name, Location, and Description

Langley Air Force Base (AFB) is located near Hampton, Virginia, between the Northwest Branch and Southwest Branch of the Back River, a tidal estuary of the Chesapeake Bay (Figure 1). The National Superfund electronic database identification number for Langley AFB is VA2800005033. The base, which covers 3,152 acres, was established in 1917 and has the distinction of being the oldest continuously active AFB in the United States. Langley AFB was listed jointly on the Superfund National Priorities List (NPL) with the National Aeronautics and Space Administration (NASA) Langley Research Center in 1994. The Department of the Air Force is the lead agency and EPA and VDEQ are support agencies for Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) activities at Langley AFB. Funds required for remediation originate from the United States Air Force Environmental Restoration Account. Operable Units (OUs) 21, 23, 35, 37, and 44 (Sites LF-01, LF-05, LF-18, LF-22 and FT-41, respectively) are five of the 24 Environmental Restoration Program (ERP) OUs investigated under CERCLA at Langley AFB.

2.1.1 ERP Site LF-01

Site LF-01 is a former waste disposal area, located at the northeast end of runway 08/26 in the eastern part of Langley AFB (Figure 2). Site LF-01 covers approximately 4.3 acres and is a flat, grassy, landscaped-area with some low areas that form gullies that drain toward the Back River. The Site is entirely within the graded area of the clear zone of the airfield, partially in the zone of frangibility, and within 60 feet of the runway overrun, a location that imposes restrictions on access, structures, grading, and ground slopes. There are no physical structures currently located within the former waste disposal boundary area.

2.1.2 ERP Site LF-05

Site LF-05 consists of an abandoned landfill, located in the southwestern part of Langley AFB known as the Shellbank Area (Figure 2). The Site is near the intersection of Nealy Avenue and Dogwood Avenue and is bisected by Nealy Avenue. The ground surface at this Site is a flat, grassy area with a drainage ditch on the northern boundary that flows to the Back River. The drainage ditch is tidally influenced, but contains water at both high and low tides. Vegetation is present along the drainage ditch.

2.1.3 ERP Site LF-18

Site LF-18 is a former disposal area located adjacent to NASA property in the northwestern part of Langley AFB, near the Munitions Storage Area (MSA) (Figure 2). The ground surface of Site LF-18 has irregular topography with a mixture of grass, shrubs, and trees. The northern half of Site LF-18 is densely overgrown and partially wooded. Some areas are also extremely marshy and are considered wetlands. Site LF-18 is most easily accessed at its southern end

via the parking lot associated with the MSA Administration Building. Site LF-18 is bounded on the eastern and western sides by fences.

2.1.4 ERP Site LF-22

Site LF-22 is a former waste disposal area located at Willoughby Point, between the former location of the Mile-Long Building (MLB) and the Back River (Figure 2). The Site is within the clear zone and zone of frangibility of the airfield, which imposes restrictions on access, structures, grading, and ground slopes. The ground surface of the Site is a flat, grassy landscaped area, with localized areas of shrubs and trees, and some low areas, which form gullies that drain toward the Back River.

2.1.5 ERP Site FT-41

Site FT-41 is a former fire training area (FTA) that is in the same location as the present FTA, between Weyland Road and Worley Avenue in the northern part of Langley AFB (Figure 2). Currently, the FTA is covered mostly with gravel. The Site is adjacent to a wetlands area and is prone to flooding.

2.2 Site History, CERCLA Activities, and Enforcement Actions

This section provides the history of Sites LF-01, LF-05, LF-18, LF-22, and FT-41, CERCLA activities, and enforcement actions taken at these Sites. The histories were developed based on a records search conducted in 1981 (CH2M HILL, 1981), along with review of available aerial photographs, site inspection (SI) data (Radian, 1996), remedial investigation (RI) data (Radian, 2000), site reconnaissance, and discussions with site personnel.

The SI and RI were performed to characterize the nature, magnitude and extent of contamination at LF-01, LF-05, LF-18, LF-22, and FT-41; to determine what risks to human health and the environment existed at these Sites; and to determine if further action was necessary. Site-specific results of the SI and RI are discussed in Section 2.5 of this ROD.

A feasibility study (FS) was completed by the Air Force to evaluate remedial action (RA) alternatives for LF-01, LF-05, LF-18, LF-22, and FT-41 (URS, 2001a). The presumptive remedy directives were applied in assessing remedial alternatives in the FS for LF-01, LF-05, LF-18, and LF-22. The FS evaluated the no action and management of waste in place alternatives for LF-01, LF-05, LF-18, and LF-22, as well as the excavation and off-site disposal alternative for LF-01. The management of waste in place was determined to be feasible for LF-01, LF-05, LF-18, and LF-22. Excavation and off-site disposal was also determined to be feasible for LF-01. The FS evaluated the no action and institutional controls alternatives for FT-41. The institutional controls alternative (including monitoring) was determined to be feasible for FT-41.

In accordance with the NCP, the Air Force issued a Proposed Plan (PP) for LF-01, LF-05, LF-18, LF-22, and FT-41 in July 2001 (URS, 2001b). The PP also included ERP Site LF-15, which is not included in this ROD. The PP identified the preferred alternatives for addressing the waste and associated soil at LF-01, LF-05, LF-18, and LF-22, and soil, surface water, and sediment associated with FT-41. The Air Force issued a public notice of availability, provided a public comment period, and held a public meeting as required by

the NCP. No significant changes were made to the preferred RA alternatives identified in the PP as a result of the public meeting and comment period.

After taking comments on the PP, the Air Force issued, on December 21, 2001, a document styled as a "Record of Decision (ROD)" for these Sites, four of which included institutional controls as a remedy component. EPA subsequently issued a letter on January 11, 2002, recording its objection to the December 21, 2001 document, noting the Agency's support for the engineered portions of the remedy (i.e., excavation and off-site disposal of buried waste and/or placement of soil covers over remaining waste and contamination), but stating that the document did not contain adequate provisions for the OUs requiring land use controls (LUCs) to ensure the long-term protectiveness of the remedy.

The Air Force began implementing the remedies selected in the December 2001 ROD based on an agreement reached with EPA to continue clean-up work at sites where there is an agreement on the physical work to be done while the LUC dispute was being resolved, as outlined in the letter from the DoD to EPA, (DoD, June 2002). Recently, the Air Force and EPA have come to agreement on LUCs and now issue this ROD.

2.2.1 ERP Site LF-01

2.2.1.1 Site History

Site LF-01 was reported to have been used from 1940 to 1950 as a possible waste disposal area where small quantities of wood, concrete rubble, glass, ash, and metal may have been disposed. Langley AFB identified this area as a "possible landfill site" in an area north of the runway. Available information indicated that the area in which the Site is located was developed by building up the elevation and filling-in along the coastline (primarily with construction debris) for the purpose of creating usable real estate. Test pit investigations revealed areas in which soil cover thickness was less than 24 inches.

2.2.1.2 CERCLA Activities

The preferred alternative for LF-01 to mitigate unacceptable human health risk from soil and waste documented in the July 2001 PP was excavation and off-site disposal of approximately 9,700 cubic yards of existing cover soil and debris in 1.4 acres. A Remedial Design (RD) detailing the remediation activities to be conducted at LF-01 was completed in April 2002 (URS, 2002). Following approval of the RD, a Remedial Action Work Plan (RAWP) was prepared in March 2003 (Shaw, 2003a) for excavation and off-site disposal of approximately 9,700 cubic yards of existing cover soil and waste in an area of 1.4 acres, the placement of clean backfill material and topsoil followed by site grading and re-vegetation with grasses and native wetland species.

Prior to initiating the RA, test pitting and waste characterization sampling was conducted in February and March 2004. Test pits completed around the perimeter of the planned excavation area identified buried waste outside the planned excavation area, resulting in an increase in the excavation area from 1.4 to 4.3 acres. The majority of the waste materials were identified as bricks, glass, wood, metal, and debris. Buried waste was shown to extend below the apparent groundwater depth [4 feet below ground surface (bgs)] in many locations. The waste characterization sampling indicated that approximately 3,000 cubic yards of waste would need to be disposed of as hazardous, based on Toxicity Characteristic

Leaching Procedure (TCLP) lead concentrations. Numerous buried utilities were identified in the waste area at LF-01.

Based on the increased scope of waste removal, a re-evaluation of the RA activities for LF-01 was conducted to determine whether excavation and off-site disposal would remain the preferred alternative. Based on the comparison of present worth costs of excavation and off-site disposal ($7,345,000) and management of waste in place ($1,252,000), management of waste in place was identified as the preferred alternative. The area requiring added soil cover increased only to 3.6 acres due to the existence of 24 inches of cover in some locations.

In accordance with the NCP, the Air Force issued a Revised PP for LF-01 in November 2005 (Langley AFB, 2005c). The Revised PP documented the fundamental change to the Selected Remedy and identified management of waste in place (soil cover and LUCs) as the preferred alternative. The Air Force issued a public notice of availability, provided a public comment period, and held a public meeting. No changes were made to the preferred RA alternative identified in the Revised PP as a result of the public meeting and comment period. The Air Force issued the ROD Amendment documenting the revised Selected Remedy for LF-01 (Langley AFB, 2006a) and issued a public notice of availability. No comments were received on the ROD Amendment.

An RD/RAWP addressing the soil cover to be constructed at LF-01 was drafted in May 2006, but did not include the wetland mitigation plan. In conformance with the multi-agency Memorandum of Agreement to address existing and future environmental conditions contributing to aircraft-wildlife strikes and following Federal Aviation Administration guidance, wetlands permanently impacted by construction of the selected remedy could not be mitigated on site or within 5 miles of the Langley AFB approach and departure air space and air operations area. However, it was necessary to move forward with installation of the selected remedy in the restricted airfield area that includes LF-01 while the airfield was closed and allow the wetland mitigation plan to be fully developed and implemented at a later date.

Following concurrence from EPA and VDEQ on the soil cover design, construction at LF-01 began in May 2006 and was completed in July 2006. Approximately 13,000 cubic yards of fill and topsoil were used to construct the soil cover at LF-01 that resulted in a minimum of 24 inches of soil over waste left in place. Following construction of the soil cover, the Site was graded for positive drainage and re-vegetated with approved grasses. Native wetland species were used to restore wetlands temporarily impacted by construction beyond the soil cover. LUCs were also implemented in 2006 and 2007, including plat recordation and deed notification to the City of Hampton, posting a sign near the landfill notifying the public of the location of the landfill and its restricted use, and revision of the Base General Plan to include the LUCs outlined in Section 2.12.2.1 of this ROD. Mitigation of wetlands was completed in October 2007 through in lieu payment to the Virginia Aquatic Resources Trust Fund. The RD/RAWP incorporating the wetland mitigation plan was finalized in 2008 (HGL, 2008).

Because EPA and VDEQ did not formally comment on the 2005 Revised PP issued by the Air Force to identify the new preferred RA alternative (Manage Waste in Place), the Air Force prepared a second Revised PP for LF-01 in 2008 (Langley AFB, 2008a), for which EPA and VDEQ provided formal comments. The preferred alternative, Manage Waste in Place,

remained the same in the second Revised PP as in the first Revised PP. The Air Force issued a public notice of availability, provided a public comment period, and held a public meeting on the second Revised PP. No changes were made to the preferred RA alternative identified in the second Revised PP as a result of the public meeting and comment period.

2.2.1.3 Enforcement Actions

No enforcement actions have been imposed on Site LF-01.

2.2.2 ERP Site LF-05

2.2.2.1 Site History

Site LF-05 was reported to have been used from the 1930s to the 1940s as a "general landfill" into which small quantities of waste solvents, old batteries, paint wastes, fly ash, and construction debris were placed. Langley AFB identified this Site as a former landfill, with available information indicating that the Site was used as a former waste disposal area during the late 1940s and early 1950s. Test pit investigations revealed that the extent of buried waste is limited to cleared areas identified on historical aerial photographs and to the same area where a geophysical anomaly is present in the eastern portion of the Site. Test pits also indicated areas of the Site where the cover over waste was less than 24 inches.

2.2.2.2 CERCLA Activities

The preferred alternative for LF-05 to mitigate potential risk associated with waste documented in the July 2001 PP was to manage waste in place. Components of the remedial alternative included construction of a soil cover and implementation of LUCs. The remedy also included removal and off-site disposal of waste from under Nealy Avenue to reduce subsidence that had been experienced in this area.

During the remedial design for LF-05, test pits in areas designated for wetland enhancement and creation revealed the presence of underground communication lines that would have been too costly to reroute, as well as large blocks of concrete that would have required specialized equipment for removal. Therefore, the design was altered to eliminate the discretionary wetland enhancement and creation activities initially included in the design to off-set future wetland impacts anticipated at other ERP sites. Elimination of these activities resulted in a significant cost decrease for the remedy as implemented at LF-05. Langley AFB subsequently issued an Explanation of Significant Difference (ESD) to inform the public of the decreased cost (Langley AFB, 2008b).

The RAWP and RD detailing the remediation activities to be conducted at LF-05 were completed in November and December 2002, respectively (IT, 2002c and 2002d). The RD and RAWP documented a minor change to the RA which was that only construction debris (roadway subbase and asphalt) related to repair of Nealy Avenue was disposed of off-site. The LF-05 RA construction included application of fill and topsoil on the area south of Nealy Avenue and topsoil on the area north of Nealy Avenue to achieve a minimum of 24 inches of soil cover over buried waste left in place at the Site. These construction areas were graded for positive drainage and revegetated with an approved grass mixture.

The RA activities also included repair of the section of Nealy Avenue that bisects LF-05. This section of the road had experienced subsidence which was attributed to waste buried under

the roadway. During road repair, Langley AFB, EPA, and VDEQ agreed to leave the waste in place under the roadway because a minimum of 24 inches of cover over the waste would be provided by the new subbase and asphalt materials and LUCs would be implemented for the site. Roadway repair was completed with placement of geotextile to minimize future subsidence, subbase, and asphalt, and replacement of concrete gutters and curbs.

The soil cover construction was completed in January 2003. Final inspection of the RA construction was completed on May 23, 2003. LUCs were implemented in 2003 and 2004, including plat recordation and deed notification to the City of Hampton, posting signs near the landfill notifying the public of the location of the landfill and its restricted use, and revision of the Base General Plan to include the LUCs outlined in Section 2.12.2.1 of this ROD.

In 2004, Langley AFB decided to change land use at LF-05 from recreational to commercial, industrial, and recreational. At the request of EPA, Langley AFB re-evaluated human health risk to address the proposed land use change (URS, 2006). The re-evaluation showed there would be no unacceptable human health risks for the expanded land use. Langley AFB subsequently issued an ESD to inform the public of the change in land use and resulting potential human health risks associated with commercial use of the property (Langley AFB, 2005a).

Site LF-05 was included in the first five-year review conducted at Langley AFB in 2004. The report, finalized in 2006, stated that the RA completed at the Site remains protective of human health and the environment (Langley AFB, 2006b).

2.2.2.3 Enforcement Actions

No enforcement actions have been imposed on Site LF-05.

2.2.3 ERP Site LF-18

2.2.3.1 Site History

Site LF-18 was reported to have been used for disposal of batteries, fly ash, wood, stumps, and construction debris. Excavations are clearly visible on historical aerial photographs dating from the 1950s and 1960s, with available information supporting its use as a former waste disposal area during this time period. The ground surface of Site LF-18 has irregular topography with a mixture of grass, shrubs, and trees. Test pit investigations revealed that the soil cover thickness at Site LF-18 was a minimum of 24 inches except for a small area in the southern portion of the Site.

2.2.3.2 CERCLA Activities

The preferred alternative for LF-18 to mitigate potential risk associated with waste documented in the July 2001 PP was to manage waste in place. Components of the remedial alternative included construction of a soil cover, implementation of LUCs, and removal and off-site disposal of surface debris. The RAWP and RD detailing the remediation activities to be conducted at LF-18 were finalized in April 2002 (IT, 2002a and 2002b).

During site preparation activities, surface debris, noted as minimal, was left in place and subsequently covered with a minimum of 24 inches of soil. There was no debris or waste

excavated or disposed off site from Site LF-18. The Remedial Action Completion Report (RACR) for LF-18 will document this minor change to the remedy.

Approximately 6,000 cubic yards of fill and 3,000 cubic yards of top soil were used at LF-18 to construct a soil cover resulting in a minimum of 24 inches of soil cover over waste left in place. The construction areas were graded for positive drainage and re-vegetated with an approved grass mixture.

Final inspection of the RA construction was completed on January 22, 2003. LUCs were implemented in 2003 and 2004, including plat recordation and deed notification to the City of Hampton, posting a sign near the landfill notifying the public of the location of the landfill and its restricted use, and revision of the Base General Plan to include the LUCs outlined in Section 2.12.2.1 of this ROD.

Site LF-18 was included in the first five-year review conducted at Langley AFB in 2004. The report, finalized in 2006, stated that the RA completed at the Site remains protective of human health and the environment (Langley AFB, 2006b).

2.2.3.3 Enforcement Actions

No enforcement actions have been imposed on Site LF-18.

2.2.4 ERP Site LF-22

2.2.4.1 Site History

The records search and historical aerial photographs indicated that Site LF-22 was a former construction debris disposal area used from the 1930s through the 1970s. Buildings were constructed by 1959 on previously filled areas, and coastline backfilling (primarily using construction debris) continued through 1973 for the purpose of creating usable real estate. Test pit information revealed that the soil cover thickness at Site LF-22 ranged from 4 to 32 inches. Areas at the Site with less than 24 inches of cover were adjacent to the Back River coastline.

2.2.4.2 CERCLA Activities

The preferred alternative for LF-22 to mitigate unacceptable ecological risk associated with soil and waste documented in the July 2001 PP was to manage waste in place. Components of the remedial alternative included construction of a soil cover, implementation of LUCs, and removal and off-site disposal of surface debris.

Initially, this alternative involved the placement of additional soil cover in three areas of LF-22 within the airfield clear zone to provide a minimum of 24 inches of cover over buried waste. However, this approach resulted in an action that would not meet new airfield height restrictions and slope and grade requirements applicable to the clear zone and zone of frangibility. To meet the new airfield requirements, demolition of the northern 1,000 linear feet (lf) of the former MLB foundation to the west of LF-22 was required so the three covers could be merged into one and extended northward and eastward to the Back River and westward past the location of the former MLB foundation to attain required slopes and grades. The final soil cover area for LF-22 also included ERP Sites DP-66, DP-67, and DP-68 located at the southern end of LF-22, which contain construction debris and contaminated

surface and subsurface soils. The design revisions resulted in a significant increase in cost, which was documented in an ESD (Langley AFB, 2005b).

The RAWP and RD for the Site subsequently incorporated demolition and off-site disposal of the 1,000 lf of the former MLB foundation as discussed above and included an additional 1,000 lf to the south (HILL 2008a; HILL 2008b). Design and construction costs for demolition of the additional 1,000 lf of the foundation to the south were not related to the CERCLA remedy and were not included in the RA cost.

Site preparation activities began in April 2006. Soil from within and next to the MLB foundation walls was used at LF-22 for fill and grading, topped by an additional 13,000 cubic yards of top soil to result in a minimum of 24 inches of clean soil over waste left in place. Excess soils and concrete and scrap metal debris from the foundation and surface debris from LF-22 were disposed or recycled off site. Demolition of the foundation, construction of the soil cover, and site grading and hydroseeding were completed in August 2006. However, final inspection was delayed until spring 2007 once final vegetative growth was established.

LUCs were implemented in 2006 and 2007, including plat recordation and deed notification to the City of Hampton, posting signs near the landfill notifying the public of the location of the landfill and its restricted use, and revision of the Base General Plan to include the LUCs outlined in Section 2.12.2.1 of this ROD.

2.2.4.3 Enforcement Actions

No enforcement actions have been imposed on Site LF-22.

2.2.5 ERP Site FT-41

2.2.5.1 Site History

The former FTA was first used in the early 1960s. Fire training exercises were conducted at least quarterly, and occasionally up to five times per month. For each exercise, approximately 300 to 500 gallons of waste fuel, jet fuel grade JP-4, and hydraulic fluid were dumped onto the ground, ignited, and then extinguished. The former FTA had no facilities to retain or collect unburned fuel. The present FTA was constructed over the old FTA in 1985 with an impermeable liner and an oil-water collection system. Jet fuel grade JP-4 was last used at Site FT-41 in 1993. Propane gas has been used for exercises subsequent to 1993.

2.2.5.2 CERCLA Activities

The preferred alternative for FT-41 to mitigate unacceptable human health and ecological risk associated with soil, surface water, and sediment documented in the July 2001 PP was sediment monitoring and LUCs. Additionally, the December 2001 ROD included construction of a silt fence to the north of the Site to minimize contaminant migration to surrounding wetland and surface water bodies. The Revised Final RAWP for FT-41 (Shaw, 2003b) documents the following minor changes to replace construction of the silt fence:

- Installation of sediment logs in three of four Site drainage features;
- Cleaning sediment from the catch basin, culvert pipe, and grass-lined channel of the second drainage channel and off-site disposal of the cleared sediment;

- Reshaping the second drainage channel; and
- Installation of rock check dams in two drainage channels.

Construction of sediment controls was completed in April 2003. Final inspection of the RA was completed on June 18, 2003, and accepted by Langley AFB on February 18, 2004. LUCs were implemented in 2004, including plat recordation and deed notification to the City of Hampton, posting signs around the Site notifying the public of the location of the Site and its restricted use, and revision of the Base General Plan to include the LUCs outlined in Section 2.12.2.2 of this ROD. However, because the Site is not a landfill, Langley AFB, EPA, and VDEQ subsequently agreed that signs are not required at the Site and will be removed from the Site upon issuance of this ROD.

Site FT-41 was included in the first five-year review conducted at Langley AFB in 2004. The report, finalized in 2006, stated that the RA completed at the Site remains protective of human health and the environment (Langley AFB, 2006b).

2.2.5.3 Enforcement Actions

No enforcement actions have been imposed on Site FT-41.

2.3 Community Participation

In accordance with Sections 113 and 117 of CERCLA, 42 U.S.C. Sections 9613 and 9617, Langley AFB provided a public comment period on the PP identifying the preferred alternatives for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 from July 9, 2001 to August 7, 2001.

An announcement for a public meeting, the comment period, and the availability of the PP and supporting documentation for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 was published in the *Daily Press*, a newspaper of general circulation in Hampton, Virginia, on July 8, 2001. Additionally, this information was published in the *Langley Flyer*, a Langley AFB newspaper, on July 6, 2001.

No comments were received during the comment period. A public meeting was subsequently held at the Chamberlin Hotel, located at 2 Fenwick Road in Hampton, Virginia, on July 24, 2001, to discuss remedial alternatives and to seek public comment. At this meeting, EPA, VDEQ, and Air Force representatives were available to answer questions about site conditions and the preferred alternatives under consideration. No one appeared at the public meeting. The Air Force issued the ROD in December 2001 and a public notice of availability of the ROD was published in the *Daily Press* newspaper on January 25, 2002.

Due to a change in land use at LF-05 from recreational only to commercial, industrial and recreational, the Air Force issued an ESD. In accordance with the NCP, an announcement of the ESD and a summary of the modified remedy were published in the *Daily Press* on August 24, 2004, and in the *Langley Flyer* on September 3, 2004.

The cost of RA at LF-22 increased significantly to meet height, slope and grade requirements applicable to property within the clear zone of the airfield. In accordance with the NCP, an announcement of the ESD and a summary of the revised cost were published in the *Daily Press* on September 25, 2005, and in the *Langley Flyer* on October 14, 2005.

After preliminary RA activities for LF-01 revealed the need for a fundamental change to the preferred alternative identified in the July 2001 PP, the Air Force issued a Revised PP for LF-01 presenting the new information and the remedial alternatives. An announcement for a public meeting, the comment period, and the availability of the Revised PP and the supporting documentation for LF-01 were published in the *Daily Press* on November 20, 2005, and in the *Langley Flyer* on December 2, 2005.

The public comment period for the LF-01 Revised PP was open from December 1, 2005, to January 3, 2006. No comments were received. A public meeting was held at Machen Elementary School, located at 20 Sacramento Drive, Hampton, Virginia, on December 15, 2005, to discuss remedial alternatives and to seek public comment. At this meeting, Air Force representatives were available to answer questions about site conditions and the preferred remedy under consideration. One person attended at the public meeting, but no comments were received. The Air Force issued a public notice of availability of the ROD Amendment documenting selection of the revised remedy in the *Daily Press* newspaper on April 30, 2006, and in the *Langley Flyer* on May 12, 2006.

The 2005 Revised PP for LF-01 stated the selection of the revised remedy would be presented in a ROD Amendment for the Site. However, because the ROD Amendment related to the 2001 ROD signed by the Air Force, but not signed by EPA nor concurred with by VDEQ, EPA and VDEQ did not provide formal comments on the 2005 Revised PP or the ROD Amendment. Therefore, the Air Force prepared a second Revised PP for LF-01 in 2008, again presenting the new information and the remedial alternatives based on the fundamental change to the preferred alternative. The final 2008 Revised PP for Site LF-01 incorporated formal comments provided by EPA and VDEQ.

An announcement for a public meeting, the comment period, and the availability of the second Revised PP and the supporting documentation for LF-01 were published in the *Daily Press* on February 3, 2008. The public comment period for the second LF-01 Revised PP was open from February 3 to March 4, 2008. No comments were received. A public meeting was subsequently held at Machen Elementary School, located at 20 Sacramento Drive, Hampton, Virginia, on February 12, 2008, to discuss remedial alternatives and to seek public comment. At this meeting, Air Force representatives were available to answer questions about site conditions and the preferred remedy under consideration. One person attended the public meeting, but no comments were received.

The cost of RA activities at LF-05 decreased significantly due to the elimination of discretionary wetland enhancement and creation activities. In accordance with the NCP, an announcement of the ESD and a summary of the revised cost were published in the *Daily Press* on April 27, 2008.The above documents, along with other supporting project information, are available to the public in the Administrative Record files maintained at:

Langley AFB
37 Sweeney Boulevard
Langley AFB, Virginia 23665
By Appointment
Mr. John Tice
(757)764-1082

2.4 Scope and Role of Operable Units and Response Action

OUs 21, 23, 35, 37, and 44 (Sites LF-01, LF-05, LF-18, LF-22, and FT-41, respectively) are 5 of the 24 ERP OUs investigated under CERCLA at Langley AFB. The Management Action Plan for Langley AFB, updated annually, includes the current CERCLA status and schedule of RAs for each OU. The Management Action Plan and supplemental information can be found in the information repository for Langley AFB.

This ROD documents the final Selected Remedies for waste and soil at Sites LF-01, LF-05, LF-18, and LF-22; and for soil, sediment, and surface water at Site FT-41. Based on the RI results, the Air Force, EPA, and VDEQ agreed to separate the soil and waste and other media (groundwater, surface water and sediment) into distinct OUs for Sites LF-01, LF-05, LF-18, and LF-22. The Air Force, EPA, and VDEQ agreed to manage the groundwater underlying these Sites on an installation-wide basis as Site OT-64 (OU52); and the surface water and sediment along the Back River shoreline on an installation-wide basis as SS-63 (OU51). For Site FT-41, the Air Force, EPA, and VDEQ decided to keep soil, sediment and surface water within the OU designated for that Site; groundwater underlying Site FT-41 will also be addressed as part of OU52.

2.5 Summary of Site Characteristics

Sites LF-01, LF-05, LF-18, LF-22, and FT-41 were originally identified during the IRP records search for Langley AFB (CH2M HILL, 1981). In 1995, a SI was conducted to determine the presence or absence of contamination at these Sites resulting from past practices (Radian, 1996). The results were used in a screening risk assessment that was included as part of the SI report. Soil, groundwater, surface water and sediment were all sampled as part of the SI. The SI report recommended additional risk assessment and evaluation of potential off-site migration of contaminants to determine possible RAs for each of the five Sites. For purposes of this ROD, only soil information is presented in the following sections for Sites LF-01, LF-05, LF-18, and LF-22.

An RI was conducted in 1996 to further characterize potential contamination at Sites LF-01, LF-05, LF-18, LF-22, and FT-41, and to conduct a baseline human health and ecological risk assessment (ERA) (Radian, 2000). Soil, groundwater, surface water, and sediment were all sampled as part of the RI activities for each of these Sites. Groundwater underlying these Sites and surface water and sediment will be addressed on an installation-wide basis as Sites OT-64 and SS-63, respectively, for Sites LF-01, LF-05, LF-18, and LF-22. This ROD addresses only soil at these Sites. Soil, surface water and sediment associated with Site FT-41 are addressed as part of this ROD; however, groundwater underlying Site FT-41 will be addressed as part of OT-64.

As part of the human health risk assessment (HHRA), the maximum concentration of each detected constituent in each media was compared to EPA's Risk-Based Screening Levels (RBSLs) to select the chemicals of potential concern (COPCs) by media. If the maximum concentration of a constituent exceeded RBSLs, the constituent was selected as a COPC.

Once COPCs were identified, risk assessment procedures as outlined by EPA were performed resulting in a list of Contaminants of Concern (COCs). Resulting COCs may require RA to be taken at the Site.

Historical data for Sites LF-01, LF-05, LF-18, and LF-22 indicated that these landfill Sites were used primarily for municipal waste and/or construction debris disposal. Based on this use, available information was reviewed per EPA Directives, *Presumptive Remedy for CERCLA Municipal Landfill Sites* and A*pplication of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills*, to confirm that the EPA presumptive remedy for landfills would be applicable to Sites LF-01, LF-05, LF-18, and LF-22. These directives provide that a remedy of containment is appropriate for landfills where the volume and heterogeneity of the disposed waste generally make removal and/or treatment impractical. Accordingly, the RI performed for these Sites was conducted in a manner consistent with the presumptive remedy directives.

Historical aerial photograph interpretation and supplemental investigations were conducted in 1999 for Sites LF-01, LF-05, LF-18, and LF-22 to aid in defining the boundaries and nature of past waste disposal activities (Radian, 1999). The objectives of the activities were to determine the presence and specific location of buried waste materials, thickness of soil cover over waste, types of waste materials, and lateral extent of the waste. The information generated from these activities has been incorporated in the RI.

A FS was conducted to evaluate, screen, and develop remedial alternatives for the Sites (URS, 2001a). The FS also summarized the information presented in the RI. During the FS, remedial objectives were identified and alternatives developed to reduce risks to human health and the environment.

2.5.1 ERP Site LF-01

2.5.1.1 Investigation Results

The SI indicated that COPCs at Site LF-01 included metals in surface soil. The SI report contains a detailed description of these results and included a recommendation that additional investigation be conducted and that a RI/ FS be performed at this Site.

Surface soil and subsurface soil samples were collected at Site LF-01 from locations shown in Figure 3a. The RI findings for Site LF-01, presented in Tables 1a and 1b, included the following:

In surface soil samples, the following chemicals (maximum concentration) were detected at levels that exceeded the RBSL and the background upper tolerance limit (UTL):

- Aluminum [18,700 milligram per kilogram (mg/kg)];
- Arsenic (30.2 mg/kg);
- Chromium (57.6 mg/kg); and
- Dieldrin [(966 microgram per kilogram (µg/kg)].

No chemicals were detected at levels that exceeded either the RBSL or the UTL in subsurface soil samples.

Boreholes drilled indicated the top 2.5 feet of soil at Site LF-01 is composed of silty and clayey sand fill material that contains debris such as brick, wood, and concrete. Sandy clay was generally encountered below 2.5 feet bgs. Data from the test pits indicated that 24 inches of soil cover did not exist over buried waste in some areas of the Site.

2.5.1.2 Conceptual Site Model

The source of contamination at LF-01 is waste and soil. The conceptual site models (CSMs) for human health (Figure 4a) and ecological (Figure 4b) receptors show potential exposure pathways for LF-01. The HHRA, ERA, and the subsequent RAOs for LF-01 were based on these CSMs. Because groundwater, surface water, and sediment are addressed as separate OUs, the focus of the LF-01 CSM for this ROD is direct exposure to waste materials and impacted soil.

2.5.1.3 Site Overview

LF-01 covers approximately 4.3 acres. The surface topography is flat, grassy, and landscaped with some low areas which form gullies that drain toward the Back River. Portions of the Site are designated as wetlands. There are no physical structures currently located on the site. Numerous utilities are located below ground. The LF-01 area and adjacent land is used as an active airfield. Shallow groundwater at LF-01 is encountered between 0.0 and 4 feet bgs and flows toward and discharges to the Back River. No areas of archaeological or historical importance have been identified at the Site.

2.5.1.4 Sampling Strategy

Surface soil and subsurface soil samples were collected and analyzed to characterize the nature and extent of contamination and potential risks to human health and the environment at LF-01. While sediment is addressed as a separate OU, four sediment samples collected at LF-01 as part of the RI were later classified as surface soil and used in the risk assessment, which is summarized in Section 2.7 of this ROD. Sample locations are shown in Figure 3a. A total of 133 test pits were completed at LF-01 in 1999 and 2004 for visual determination of the extent of waste. Waste characterization sampling for off-site disposal evaluation was also conducted in 2004 for TCLP analysis.

2.5.1.5 Nature and Extent of Contamination

The source of contamination at LF-01 is the estimated 4.3 acres of waste and associated soil. The surface soil contained metals and organochlorine pesticides above the background UTLs and RBSLs (Figure 3a). No compounds were detected in subsurface soil at concentrations exceeding both the RBSLs and background UTLs.

The primary fate and contaminant migration pathways for soil at LF-01 include surface runoff and erosion of soil to the Back River, fugitive dust generation, and infiltration and leaching of precipitation through soil to the groundwater system discharging to the Back River. Although the potential for historical contaminant migration from LF-01 to underlying groundwater and adjacent sediment and surface water may exist, these media are addressed as separate OUs at Langley AFB and are not a part of this ROD.

2.5.2 ERP Site LF-05

2.5.2.1 Investigation Results

The SI identified metals in soil and recommended that additional investigation be conducted and that an RI/FS be performed at this Site.

Surface soil samples were collected at Site LF-05 from locations shown in Figure 3b. The RI findings for Site LF-05 presented in Table 2a included benzo(a)pyrene (231 mg/kg) and thallium (0.756 mg/kg) in surface soil, both of which exceeded their respective background UTL and RBSL.

Boreholes drilled indicated the top 2.5 feet of soil at Site LF-05 is composed of clayey sand to sandy clay. Clay was generally encountered below 2.5 feet bgs. Debris such as glass, wood, plastic, and concrete was encountered down to a depth of 14 feet bgs. Test pit investigations revealed that the extent of buried waste is limited to cleared areas identified on historical aerial photographs and to the same area where a geophysical anomaly is present in the eastern portion of the Site. Test pits also indicated the areas at the Site where the cover over the waste was less than 24 inches.

2.5.2.2 Conceptual Site Model

The source of contamination at LF-05 is waste and soil. The CSMs for human health (Figure 4c) and ecological (Figure 4d) receptors show potential exposure pathways for LF-05. The HHRA, ERA, and the subsequent RAOs for LF-05 were based on these CSMs. Because groundwater, surface water, and sediment are addressed as separate OUs, the focus of the CSM for this ROD is direct exposure to waste materials and impacted soil.

2.5.2.3 Site Overview

The total land area disturbed at LF-05 during historical waste disposal activities is approximately 3.8 acres. The surface of the Site is relatively flat and is comprised of developed and open, maintained grassy areas north and south of Nealy Avenue. The Site contains wetland areas along the eastern and northern borders, bounded by the Southwest Branch of the Back River and by a storm drainage channel, respectively. Nealy Avenue bisects the Site in a southwest to northwest direction. A portion of a convenience store parking/driveway exists on the far northwestern portion of the Site. Shallow groundwater at LF-05 is encountered between 0.0 and 3.5 feet bgs and flows toward the drainage channel that borders the Site to the north. No areas of archaeological or historical importance have been identified at the Site.

2.5.2.4 Sampling Strategy

Surface soil samples were collected and analyzed to characterize the nature and extent of contamination and potential risks to human health and the environment at LF-05. Subsurface soil samples collected by direct push technology were used to assist in groundwater modeling, but not to characterize the Site or to evaluate potential risk to receptors. The sample locations are shown in Figure 3b. A total of 34 test pits were completed in 1999 and 2002 at LF-05 for visual determination of the extent of waste. In 2005, 13 additional test pits were completed as part of the design of commercial structures subsequently built on this Site.

2.5.2.5 Nature and Extent of Contamination

The source of contamination at Site LF-05 is the estimated 3.8 acres of waste and associated soil. The surface soil contained thallium and benzo(a)pyrene above both the background UTLs and RBSLs (Figure 3b).

The primary fate and contaminant migration pathways for soil at Site LF-05 include surface runoff and erosion of soil to the bordering drainage channel and the Back River, fugitive dust generation, and infiltration and leaching of precipitation through the soil to the groundwater system discharging to the Back River. Although the potential for historical contaminant migration from Site LF-05 to underlying groundwater and adjacent sediment and surface water exist, these media are addressed as separate OUs at Langley AFB and are not a part of this ROD.

2.5.3 ERP Site LF-18

2.5.3.1 Investigation Results

The SI identified organochlorine pesticides and metals in soil and recommended that additional investigation be conducted and that an RI/FS be performed at this Site.

Surface soil samples were collected at Site LF-18 from the locations shown in Figure 3c. The RI findings for Site LF-18 presented in Table 3a included the following:

In surface soil samples, the following chemicals (maximum concentration) were detected at levels that exceeded the background UTL and RBSL:

- Benzo(a)anthracene (5,050 µg/kg);
- Benzo(a)pyrene (5,940 µg/kg);
- Benzo(b)fluoranthene (12,600 µg/kg);
- Benzo(k)fluoranthene (12,600 µg/kg);
- Indeno(1,2,3-cd)pyrene (3,550 µg/kg); and
- Manganese (340 mg/kg).

Boreholes drilled indicated the top 4.0 feet of soil at Site LF-18 is composed of silty sand to silty clay. Clay was generally encountered below 4.0 feet bgs. Debris such as bricks, metal, plastic, and concrete was encountered down to a depth of 10 feet in the vicinity of well 18W02. Test pit investigations revealed that the soil cover thickness at Site LF-18 was 24 inches or more except for an area in the southern portion of the Site.

2.5.3.2 Conceptual Site Model

The source of contamination at LF-18 is waste and soil. The CSMs for human health (Figure 4e) and ecological (Figure 4f) receptors show potential exposure pathways for LF-18. The HHRA, ERA, and the subsequent RAOs for LF-18 were based on these CSMs. Because groundwater, surface water, and sediment are addressed as separate OUs, the focus of the CSM for this ROD is direct exposure to waste materials and impacted soil.

2.5.3.3 Site Overview

Site LF-18 is a 5.5 acre former waste disposal area located in the northeastern portion of Langley AFB west of the MSA. The Site is south of the Northwest Branch of the Back River

and is heavily wooded and inhabited by deer. Some areas are extremely marshy and wetlands border the Site. There are no physical structures currently located on site. Shallow groundwater at LF-18 is encountered between 3 and 7 feet bgs and flows toward and discharges to the Northwest Branch of the Back River. No areas of archaeological or historical importance have been identified at the Site.

2.5.3.4 Sampling Strategy

Surface soil samples were collected and analyzed to characterize the nature and extent of contamination and potential risks to human health and the environment at LF-18. Subsurface soil samples collected by direct push technology were used to assist in groundwater modeling, but not to characterize the Site or to evaluate potential risk to receptors. The surface soil sample locations are shown in Figure 3c. A total of 21 test pits were completed at LF-18 in 1999 for visual determination of the extent of waste.

2.5.3.5 Nature and Extent of Contamination

The source of contamination at Site LF-18 is the estimated 5.5 acres of waste and associated soil. The surface soil contained manganese and semi-volatile organic compounds (SVOCs) above both the background UTLs and RBSLs (Figure 3c).

The primary fate and contaminant migration pathways for soil at Site LF-18 include surface runoff and erosion of soil to the marshy areas to the north of the Site and to the Back River, fugitive dust generation, plant and deer uptake, and infiltration and leaching of precipitation through the soil to the groundwater system discharging to the Back River. Although the potential for historical contaminant migration from Site LF-18 to underlying groundwater and adjacent sediment and surface water exist, these media are addressed as separate OUs at Langley AFB and are not a part of this ROD.

2.5.4 ERP Site LF-22

2.5.4.1 Investigation Results

The SI identified organochlorine pesticides, herbicides, and metals in soil and recommended that additional investigation be conducted and that an RI/FS be performed at this Site.

Surface soil samples were collected at Site LF-22 from the locations shown in Figure 3d. The RI findings for Site LF-22 presented in Table 4a included the following:

In surface soil samples, the following chemicals (maximum concentration) were detected at levels that exceeded the background UTL and the RBSL:

- Antimony (5.30 mg/kg)
- Benzo(a)anthracene (1,740 µg/kg);
- Benzo(a)pyrene (2,420 µg/kg);
- Benzo(b)fluoranthene (4,770 µg/kg);
- Cadmium (14.4 mg/kg)
- Copper (497 mg/kg)
- Dibenz(a,h)anthracene (591 µg/kg);
- Dieldrin (119 µg/kg);
- Indeno(1,2,3-cd)pyrene (1,550 µg/kg);

- Lead (998 mg/kg);
- Manganese (681 mg/kg); and
- Mercury (1.32 mg/kg).

Boreholes drilled indicated the top 5 feet of soil at Site LF-22 is composed of fill material that contains debris such as brick, concrete, glass, and gravel. Silty clay was generally encountered from approximately 5 to 15 feet bgs. Silty sand and sand was encountered from 15 to 41 feet bgs (the maximum drilling depth at this Site). Test pit information revealed that the soil cover thickness at Site LF-22 ranged from 4 to 32 inches. Areas at the Site with less than 24 inches of cover thickness were located adjacent to the Back River coastline.

2.5.4.2 Conceptual Site Model

The source of contamination at LF-22 is waste and soil. The CSMs for human health (Figure 4g) and ecological (Figure 4h) receptors show potential exposure pathways for LF-22. The HHRA, ERA, and the subsequent RAOs for LF-22 were based on these CSMs. Because groundwater, surface water, and sediment are addressed as separate OUs, the focus of the CSM for this ROD is direct exposure to waste materials and impacted soil.

2.5.4.3 Site Overview

LF-22 covers approximately 3.5 acres between the north end of the former MLB and the Back River in the northeastern portion of Langley AFB. The Site is located in the clear zone of the airfield, is relatively flat, with open, maintained grassy areas. Underground utilities and two concrete pads with two transformers each and two concrete pads with one light pole each are located within the boundaries of the waste. Other structures (a fire hydrant, one concrete pad with a light pole, and a concrete pad with two electrical boxes) are located outside of the boundary of the waste, but within the extent of the soil cover. Shallow groundwater at LF-22 is encountered between 3 and 6 feet bgs and flows toward and discharges to the Back River. No areas of archaeological or historical importance have been identified at the Site.

2.5.4.4 Sampling Strategy

Surface soil samples were collected and analyzed to characterize the nature and extent of contamination and potential risks to human health and the environment at LF-22. The sample locations are shown in Figure 3d. A total of 17 test pits were completed at LF-22 in 1999 for visual determination of the extent of waste.

2.5.4.5 Nature and Extent of Contamination

The source of contamination at Site LF-22 is the estimated 3.5 acres of waste and associated soil. The surface soil contained metals, SVOCs, and the organochlorine pesticide dieldrin above both the background UTLs and RBSLs (Figure 3d).

The primary fate and contaminant migration pathways for soil at Site LF-22 include surface runoff and erosion of soil to the Back River, fugitive dust generation, and infiltration and leaching of precipitation through the soil to the groundwater system discharging to the Back River. Although the potential for historical contaminant migration from Site LF-22 to underlying groundwater and adjacent sediment and surface water exist, these media are addressed as separate OUs at Langley AFB and are not a part of this ROD.

2.5.5 ERP Site FT-41

2.5.5.1 Investigation Results

The SI identified organochlorine pesticides and metals in soil and recommended that additional investigation be conducted and that an RI/FS be performed at this Site.

Surface soil, subsurface soil, sediment, and surface water were collected at Site FT-41 from the locations shown in Figure 3e. The RI findings for Site FT-41 presented in Tables 5a, 5b, 5c, and 5d included the following:

In surface soil samples, the following chemicals (maximum concentration) were detected at levels that exceeded the background UTL and the RBSL:

- Arsenic (40.5 mg/kg);
- Benzo(a)pyrene (406 µg/kg);
- Manganese (507 mg/kg); and
- 1,2,3,4,6,7,8,9-OCDD (a dioxin) (15,000 mg/kg).

In subsurface soil samples, the following chemicals (maximum concentration) were detected at levels that exceeded both the background UTL and the RBSL:

- Arsenic (91.4 mg/kg); and
- 1,2,3,4,6,7,8,9-OCDD [17,300 nanograms per kilogram (ng/kg)].

In sediment samples, the following chemicals (maximum concentration) were detected at levels that exceeded both the background UTL and the RBSL:

- Aluminum (40,800 mg/kg);
- Arsenic (33.7 mg/kg);
- Barium (1,010 mg/kg);
- Benzo(a)anthracene (5,350 µg/kg);
- Benzo(a)pyrene (7,080 µg/kg);
- Benzo(b)fluoranthene (14,300 µg/kg);
- Benzo(k)fluoranthene (14,300 µg/kg);
- Chromium (215 mg/kg);
- Dieldrin (12,100 µg/kg);
- 1,2,3,4,6,7,8-HpCDD (519 ng/kg);
- Indeno(1,2,3-cd)pyrene (3,350 mg/kg);
- Manganese (208 mg/kg);
- 1,2,3,4,6,7,8,9-OCDD (a dioxin)(16,400 ng/kg);and
- Vanadium (108 mg/kg).

In surface water samples, the following chemicals (maximum concentration) were detected at levels that exceeded both the background UTL and the RBSL:

- Aluminum [70.7 milligrams per liter (mg/L)];
- Arsenic (0.162 mg/L);
- alpha-BHC [0.172 micrograms per liter (µg/L)];
- beta-BHC (0.150 µg/L);
- delta-BHC (45.6 µg/L);

- Benzo(a)anthracene (1.82 µg/L);
- Benzo(a)pyrene (2.32 µg/L);
- Benzo(b)fluoranthene (5.41 µg/L);
- Benzo(k)fluoranthene (5.41 µg/L);
- Beryllium (0.00326 mg/L);
- Chromium (0.808 mg/L);
- Chrysene (3.08 µg/L);
- Dieldrin (0.830 µg/L);
- Heptachlor epoxide (0.0909 µg/L);
- 1,2,3,4,6,7,8-HpCDD [2,920 picograms per liter (pg/L)];
- 1,2,3,4,6,7,8-HpCDF (391 pg/L);
- 1,2,3,4,7,8,9-HpCDF (26.2 pg/L);
- 1,2,3,4,7,8-HxCDD (72.8 pg/L);
- 1,2,3,6,7,8-HxCDD (108 pg/L);
- 1,2,3,4,7,8-HxCDF (165 pg/L);
- 1,2,3,6,7,8-HxCDF (57.3 pg/L);
- Indeno(1,2,3-cd)pyrene (1.78 µg/L);
- Iron (204 mg/L);
- Lead (1.17 mg/L);
- Manganese (1.32 mg/L);
- Mercury (0.00122 mg/L);
- 1,2,3,4,6,7,8,9-OCDD (105,000 pg/L);
- 1,2,3,4,6,7,8,9-OCDF (2,250 pg/L);
- 1,2,3,7,8-PeCDD (47.7 pg/L);
- 1,2,3,7,8-PeCDF (38.9 pg/L);
- 2,3,7,8-TCDD (8.2 pg/L);
- 2,3,7,8-TCDF (44.2 pg/L);
- Vanadium (0.263 mg/L).

Boreholes drilled indicated the soil at Site FT-41 is composed of sand, clay, and gravel.

2.5.5.2 Conceptual Site Model

Soil is the primary source of contamination at FT-41. Stormwater runoff created secondary sources of contamination in surface water and sediment. The CSMs for human health (Figure 4i) and ecological (Figure 4j) receptors show potential exposure pathways for FT-41. The HHRA, ERA, and the subsequent RAOs for FT-41 were based on these CSMs. Because groundwater is addressed as a separate OU, the focus of the CSM for this ROD is exposure to surface and subsurface soil, sediment, and surface water.

2.5.5.3 Site Overview

Site FT-41 is a former FTA covering approximately 3.2 acres in the north-central portion of Langley AFB near the intersection of Weyland Road and Worley Road. The present FTA was constructed over the old FTA in 1985. The new FTA has an impermeable concrete liner and the pit is lined with gravel. Other structures at the Site include an observation tower and a firing-in abutment. The Site is gravel covered and the surrounding area is dirt mixed with gravel. The Site is adjacent to wetlands and is prone to flooding. Stormwater flows

radially away from the fire pit and is carried off-site via four drainage features, including sheet flow and piped and grassed channels. Shallow groundwater at FT-41 is encountered between 0.1 and 1 feet bgs and flows toward and discharges to the Back River. No areas of archaeological or historical importance have been identified at the Site.

2.5.5.4 Sampling Strategy

Surface soil and subsurface soil, sediment, and surface water samples were collected and analyzed to characterize the nature and extent of contamination and potential risks to human health and the environment at FT-41. Surface water and sediment samples were co-located in marshy areas to the north of the Site. The sample locations are shown in Figures 3e, 3f, 3g, and 3h.

2.5.5.5 Nature and Extent of Contamination

The source of contamination at Site FT-41 is the soil containing residual waste fuel, JP-4, and hydraulic fluid discharged during training exercises. Secondary releases of the soil contamination to surface water and sediment resulted from stormwater runoff. The surface soil contained arsenic, benzo(a)pyrene, manganese, and the dioxin 1,2,3,4,6,7,8,9-OCDD above both the background UTLs and RBSLs (Figure 3e). Subsurface soil contained arsenic and the dioxin 1,2,3,4,6,7,8,9-OCDD in concentrations that exceeded both the background UTLs and RBSLs (Figure 3f). Sediment contained metals, SVOCs, and the dioxins 1,2,3,4,6,7,8-HpCDD and 1,2,3,4,6,7,8,9-OCDD in concentrations that exceeded both the background UTLs and RBSLs (Figure 3g). Surface water contained metals, SVOCs, pesticides, dioxins, and furans in concentrations that exceeded both the background UTLs and RBSLs (Figure 3h).

The primary fate and contaminant migration pathways for soil at Site FT-41 include surface runoff and erosion of soil to sediments and surface water of the adjacent marshland, to Tabbs Creek, and to the Back River, fugitive dust generation, and infiltration and leaching of precipitation through the soil to the groundwater system discharging to the adjacent marshland, to Tabbs Creek, and to the Back River. Although the potential for historical contaminant migration from Site FT-41 to underlying groundwater exists, this medium is addressed as a separate OU at Langley AFB and is not a part of this ROD.

2.6 Current and Potential Future Site Land and Resource Uses

Groundwater underlying Sites LF-01, LF-05, LF-18, LF-22, and FT-41 is currently not a potable water or irrigation resource. Future residential land use of the Sites is unlikely; however, residential scenarios were evaluated in the HHRAs, to be conservative.

2.6.1 ERP Site LF-01

Site LF-01 has a current and future land use of airfield (open space), which imposes restrictions on access, aboveground structures, grading and slopes. The surrounding areas are also used as airfield (open space). The Site and adjacent land include wetlands.

2.6.2 ERP Site LF-05

Site LF-05 has a current and future land use of commercial and open space. Adjacent land use includes open space, recreational, and residential. The Site and adjacent land include wetlands.

2.6.3 ERP Site LF-18

Site LF-18 has a current and future land use of open space. Adjacent land use includes open space and industrial. The Site and adjacent land include wetlands.

2.6.4 ERP Site LF-22

Site LF-22 has a current and future land use of airfield (open space). Adjacent land use is airfield (open space).

2.6.5 ERP Site FT-41

Site FT-41 has a current and future land use land use of industrial. Adjacent land use includes open space and recreational, and includes wetlands.

2.7 Summary of Site Risks

Risk assessments were conducted during the RI for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 in accordance with current EPA policy on risk assessments. The risk assessments estimate what risks the Sites pose if no actions were taken. The assessments provide a basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the RA. The risk assessments consisted of both HHRA and ERA to address potential current and future risks to human health and the environment. Detailed discussions of the risk assessment approaches and results are provided in the RI report (Radian, 2000) for LF-01, LF-05, LF-18, LF-22, and FT-41 and in the Revised PP for LF-01 (for the utility worker scenario) (USAF, 2008). The general approaches for the HHRAs and the ERAs are summarized in Sections 2.7.1 and 2.7.2 of this ROD. For LF-01, LF-05, LF-18, and LF-22, risks related to site soil are presented in the site-specific summaries of risks in Sections 2.7.3 through 2.7.6 of this ROD. Risk evaluation for surface water and sediment at these Sites is not presented in this ROD because these media are being investigated as part of the Back River OU (OU51). For FT-41, risks related to site soil, surface water, and sediment are presented in the site-specific summary of risks in Section 2.7.7 of this ROD. This ROD does not evaluate groundwater risk for any of the five Sites because groundwater is being investigated as part of a separate basewide OU (OU52).

2.7.1 Human Health Risk Assessments

HHRA consists of four steps: identification of COPCs, exposure assessment, toxicity assessment, and risk characterization.

2.7.1.1 Contaminants of Potential Concern

For each Site, the maximum concentrations of all detected chemicals were compared to EPA Region III RBSLs in order to select COPCs to be carried through the exposure and toxicity assessment and the risk characterization. The RBSLs were equal to the EPA Region III Risk

Based Concentration (RBC) for carcinogens and one-tenth the EPA Region III RBC for non-carcinogens. The purpose of this initial screening is to allow chemicals that do not contribute significantly to the risk at a Site to be eliminated early in the risk assessment process.

2.7.1.2 Exposure Assessment

The human health exposure assessments identified and evaluated the contaminant sources, release mechanisms, exposure pathways, exposure routes, and receptors. The elements of the exposure assessments are identified in the respective Site CSMs provided in Figures 4a, 4c, 4e, 4g, and 4i. Detailed discussions of the exposure assessments for the receptor scenarios considered in each HHRA are provided in the RI Report (Radian, 2000). The receptors and exposure scenarios considered are summarized below. Not all receptors were evaluated for each Site.

- Groundskeeper (Other Worker) – The groundskeeper is a site worker who spends the majority of his time outdoors tending yards and gardens, trimming shrubs, and performing other general outdoor duties. Potential exposure pathways include incidental ingestion and dermal contact with surface soil, and inhalation of fugitive dust and volatile emissions. The groundskeeper exposure scenario was evaluated at each Site LF-01, LF-05, LF-22, and FT-41.

- Resident (adult and child) – The resident is a hypothetical receptor added to provide an evaluation of LF-01 under an unlimited use/unrestricted exposure scenario. Potential exposure pathways include incidental ingestion and dermal contact with soil, and inhalation of fugitive dust and volatile emissions. The residential receptor scenario was evaluated for LF-05, LF-18, LF-22, and FT-41 as well, but only for exposure to groundwater, which is excluded from this ROD.

- Construction worker – Potential exposure pathway includes direct exposure to surface soil and subsurface soil, and inhalation of fugitive dust and volatile emissions. The construction worker is involved in a short-term construction project that includes excavation and grading of soil. During certain operations (excavation, grading), this receptor is more intensely exposed to soil than during other activities (building construction). This exposure scenario was evaluated for Sites LF-05 and FT-41 due to the likelihood for future construction to occur at these Sites.

- Utility worker – This receptor exposure scenario was included in the Revised Proposed Plan to evaluate the potential for direct exposure to surface and subsurface soil, and inhalation of fugitive dust and volatile emissions during implementation of the remedial action. The utility worker is involved in short-term projects to install, remove, or repair underground utilities. This receptor exposure scenario was included for LF-01 due to the numerous underground utilities at the Site.

- Child trespasser – The trespassing child may walk, hike, and/or play on site and thereby become directly exposed to surface soil. The child trespasser may inhale fugitive dust and volatile emissions from the surface soil. He may also wade in surface waters and become exposed directly to surface water and sediment. The child trespasser exposure scenario was evaluated for Sites LF-05 and FT-41.

- Fish consumer (adult and child) – The fish consumer may eat fish from the Back River and become exposed indirectly to contaminants present in the surface water and sediment. The fish consumer exposure scenario was evaluated for each Site. However, this exposure scenario is only presented for Site FT-41 because sediment and surface water for the other sites is excluded from this ROD.
- Adult hunter/child venison consumer – The adult hunter makes regular and frequent visits to the grounds for the purpose of hunting. Potential exposure pathways include incidental ingestion and dermal contact with surface soil, and inhalation of fugitive dust and volatile emissions. For the adult hunter, consumption of venison and wild fruits and berries are a potential route of indirect exposure to surface soil due to the woods and wetlands that promote growth of wild fruits and berries and support deer habitat. The child may eat venison supplied by the adult hunter. Potential risk to the adult hunter and child venison consumer was evaluated at the only Site where hunting is permitted, Site LF-18.

2.7.1.3 Toxicity Assessment

Toxicity assessments provide numerical estimates of the relationship between the extent of exposure and possible severity of adverse effects, and consist of two steps: hazard identification and dose-response assessment. Most toxicity data used in the HHRA are EPA published toxicity values [reference doses (RfDs) for noncarcinogens, and cancer slope factors (CSFs) for carcinogens] in the Integrated Risk Information System and Health Effects Assessment Summary Tables databases, or in the Region III RBC Table.

2.7.1.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated using the following equation:

$$\text{Risk} = \text{CDI} \times \text{CSF}$$

where:

Risk = a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

CSF = cancer slope factor, expressed as $(\text{mg/kg-day})^{-1}$

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure (RME) estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. EPA's generally acceptable risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., 25 years for the groundskeeper) with an RfD derived for a similar exposure period. The RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An $HQ \leq 1$ indicates that a receptor's dose of a single contaminant

does not exceed the threshold value for adverse effects. The hazard index (HI) is generated by adding the HQs for all COPCs. Initially, HQs are summed across each exposure route for the Site (e.g., ingestion of soil), and then the HIs for the individual exposure routes are summed to provide the total HI for the Site. If the total HI is ≤ 1, then no adverse effect is expected. If the total HI exceeds 1, then a target organ analysis is performed. Noncarcinogenic chemicals typically cause adverse effects by disrupting the function of a specific body system or organ. For example, one chemical may cause kidney failure while others may impact the liver, skin or respiratory tract. The effects of these chemicals attacking various organs are independent, and their associated HI values are not additive unless the chemicals attack the same target organ. Therefore, if the HIs for the individual target organs are less than or equal to one, then adverse health effects are not expected. The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

In accordance with risk assessment guidance, the initial risk characterization is performed using all COPCs. CERCLA does not address hazards or risks associated with background conditions. Therefore, the contribution to hazard or risk posed by chemicals present at background levels is subtracted from the total hazard or risk to determine the hazard or risk associated with the site-related chemicals.

2.7.1.5 Uncertainty

The measures used in risk assessments are not fully probabilistic estimates of risk, but are conditional estimates given that a set of assumptions about exposure and toxicity are realized. A detailed discussion of the uncertainties associated with the risk assessment is included in the RI (Radian, 2000). Examples of potential HHRA uncertainties include sampling and analytical processes (e.g., distribution and location of samples; detection limits; sample contamination), appropriate selection of receptors, estimating exposure point concentrations, and the extrapolation of toxicity values derived from animal studies to humans.

2.7.2 Ecological Risk Assessments

The following steps were followed in the ERA: initial screening; exposure assessment; ecological effects assessment; and ecological risk characterization.

2.7.2.1 Initial Screening

For each medium (soil, sediment, surface water), the ERA initially compared the maximum concentration of all detected analytes to their respective EPA Region III Biological Technical Assistance Group (BTAG) screening levels. For the soil, this initial screening was performed on samples collected between 0 and 2 feet bgs. A chemical was retained for further evaluation if its maximum concentration in any medium exceeded the BTAG screening value, if no screening value was available, or if the chemical had a propensity to bioaccumulate.

2.7.2.2 Exposure Assessment

The objective of the ecological exposure assessment is to determine the pathways and media through which ecological receptors may be exposed to site contaminants. Potential exposure pathways depend on habitats and receptors present on site, extent and magnitude of

contamination, and chemical fate and transport. The elements of the exposure assessments are identified in the respective Site CSMs provided in Figures 4b, 4d, 4f, 4h, and 4j. For all five Sites, effects from exposure to soil were evaluated for the earthworm (terrestrial invertebrate), deer mouse (small insect-eating mammal), red fox (large omnivorous mammal), American robin (insect-eating bird), and red-tailed hawk (carnivorous bird). For Site FT-41, effects from exposure to sediment were evaluated for the benthic invertebrate, belted kingfisher, and mink. Effects from exposure to surface water were evaluated for fish (Atlantic croaker), belted kingfisher, and mink.

Ecological assessment and measurement endpoints for each of the five Sites were selected using previously collected data, site reconnaissance, and general agreement on the habitat types present at each of the Sites. Assessment endpoints focused on the viability of terrestrial and avian populations as well as organism survivability. Measurement endpoints were selected based on the presence of receptors at each Site, and the potential for exposure to chemicals.

2.7.2.3 Risk Characterization

Ecological risk characterization quantitatively defines the magnitude of potential risks to ecological receptors under a specific set of circumstances. HQs for mammals and birds were calculated using literature-based no-observed-adverse-effect level (NOAEL) and lowest-observed-adverse-effect level (LOAEL) toxicity endpoint values. HQs for terrestrial invertebrates and benthic invertebrates were calculated using no observed effects concentrations and lowest observed effects concentrations obtained from a toxicity study conducted at Langley AFB. For each receptor, the ERA calculated a maximum NOAEL HQ, a mean NOAEL HQ, a maximum LOAEL HQ, and a mean LOAEL HQ for each chemical of potential ecological concern. If one of these four HQ values was less than 1.0, then the risk assessment concluded that the chemical did not pose a risk to that particular receptor. Because LOAEL HQs are less than NOAEL HQs, the LOAEL HQs dictated whether a chemical was identified as having the potential to pose a risk to a given receptor. If a chemical was identified as posing a potential risk, then the risk assessment considered additional lines of evidence in order to characterize the potential risk. These lines of evidence included, but were not limited to, detection frequency, chemical bioavailability, comparison to background conditions, and the conservatism of the toxicity values.

2.7.2.4 Uncertainty

The results of the ERA are influenced to some degree by variability and uncertainty, which need to be considered when interpreting results. Major sources of uncertainty include natural variability, and incomplete knowledge of site-specific biological processes and fate and transport mechanisms.

2.7.3 ERP Site LF-01 Risk Assessment Summary

2.7.3.1 Human Health Risk Assessment

The risk assessment included estimates of the risk to human health posed by exposure to soil assuming Site LF-01 has a current land use of airfield (open space) and a proposed future land use of recreational.

COPCs were identified by comparing the maximum concentration of each analyte detected in the surface soil samples to the RBSL. The chemicals identified as COPCs and their associated exposure point concentrations (EPCs) are presented in Table 1a. COPCs and EPCs were also determined for a subset of the surface soil data (assuming "hot spot" soil removals); results are provided in Table 1b.

The CSM for LF-01 is shown in Figure 4a. The original HHRA evaluated risk for the other worker only. A supplemental risk assessment evaluated risk for a potential future resident (adult and child) to support evaluation of unrestricted exposure to soil at LF-01. For this supplemental assessment, data for soil sample locations SS09 and SS10 were excluded from the data set because it was assumed that limited soil removal would be performed within the former disposal area boundary to support unrestricted closure. The supplemental risk assessment was incorporated into the Final RI report for LF-01. Based on new information gathered during the RD, a utility worker scenario was also evaluated for LF-01. It was assumed that the utility worker would be exposed to surface and subsurface soil, fugitive dust emissions, and volatile emissions.

The CSFs and RfDs used in the HHRA for Site LF-01 are provided in Tables 1c, 1d, 1e, and 1f.

The risks to the receptors included in the Final RI Report for LF-01, the groundskeeper, adult resident, and child resident, are summarized in Table 1g. The site-related cancer risks were calculated to be 4×10^{-6} for the groundskeeper (other worker) and 8×10^{-5} for the age-adjusted resident (accounts for both childhood and adult exposure). These cancer risks are within the EPA target risk range of 1×10^{-6} to 1×10^{-4}. The site-related HIs were estimated to be 0.06 for the groundskeeper, 0.3 for the adult resident, and 2 for the child resident. Because the HIs for the groundskeeper and adult resident are less than 1, no adverse health effect is expected for these receptors. A target organ analysis demonstrated that all target organ HIs for the child resident were less than the target HI of 1 (Table 1h), indicating that an adverse health effect is not expected for this receptor.

The risks to the utility worker are presented in Table 1i. For the utility worker, the site-related cancer risk is estimated to be 6×10^{-8}, and the site-related HI is calculated to be 0.3. Both results are less than EPA target values, indicating no potential health threat to the utility worker.

With the full surface soil data set from the RI, the site-related chemicals do not pose a health threat to the groundskeeper or the utility worker. With a limited soil removal in the vicinity of soil sample locations SS09 and SS10, there is no health threat under the unrestricted land use scenario. However, no soil removal actions were conducted; therefore, the potential residential risk for soil exposure was underestimated.

2.7.3.2 Ecological Risk Assessment

The maximum concentration of each chemical detected in the surface soil samples was compared to the EPA Region III BTAG screening values to select chemicals requiring further evaluation. Chemicals that required further evaluation are identified in Table 1j.

Site LF-01 is an abandoned landfill encompassing approximately 4.3 acres at the northeast end of runway 08/26. The area is covered with mowed grass, but has depressions in which rain water accumulates periodically, attracting waterfowl, gulls, and wading birds. These

birds use the ponded areas mainly for resting and bathing. Insect-eating birds and small mammals may forage for soil invertebrates and seeds at the Site. Raptors and larger mammals may not use the Site because of insufficient prey population, lack of perches, lack of cover, and/or presence of the adjacent aircraft runway. The ecological exposure pathways of concern and assessment and measurement endpoints for LF-01 are presented in Table 1k.

For each receptor, chemicals with at least one LOAEL HQ greater than 1.0 are summarized on Table 1l. For the American robin (insect-eating bird), red fox (large omnivorous mammal), and red-tailed hawk (carnivorous bird), no LOAEL HQ exceeded 1.0, indicating no potential threats to these receptors. For the deer mouse, the mean aluminum concentration resulted in an HQ of 16.8. Aluminum was determined to be at concentrations consistent with background levels at Langley AFB. For the earthworm, the mean heptachlor epoxide concentration resulted in an HQ of 3.98. Heptachlor epoxide was detected in only one of 13 samples collected from the Site, and the detected concentration was less than the BTAG soil screening level. Based on the isolated occurrence and comparison to the BTAG screening value, it was concluded that this chemical posed minimal risk to the soil invertebrate. Following the weight of evidence analysis, the ERA for Site LF-01 identified minimal risk to the terrestrial ecosystem.

2.7.4 ERP Site LF-05 Risk Assessment Summary

The baseline risk assessment included in the Final RI Report estimated the risk to human health and the environment posed by exposure to soil assuming LF-05 has a current land use of open space with a proposed future land use of recreational. Since completion of the RI, land use at LF-05 changed from open space to commercial. To ensure that this altered land use remained protective of human health, risk was re-evaluated. The purpose of the re-evaluation was to determine whether constituents in media at the Site would pose an unacceptable risk to workers or patrons of a commercial establishment considered for construction at the Site. The *Summary of Risk Assessment Results and Land Use Restrictions, Environmental Restoration Program Site LF-05* (URS, 2006) contains the details of the risk re-evaluation. The baseline risk assessment and risk re-evaluation are summarized below.

2.7.4.1 Human Health Risk Assessment

The receptors for soil contact evaluated in the RI were the other worker (groundskeeper), construction worker, and child trespasser. When land use at LF-05 expanded to include commercial and industrial uses, potential risk to a resident was also evaluated. Langley AFB, EPA, and VDEQ agreed the residential scenario would be more protective than any conceivable commercial scenario. If risk estimates calculated using a residential scenario were within EPA target risk levels, a commercial facility could be constructed at the Site without additional RA. The construction worker exposure assumptions were also changed to address potential facility construction. Detailed exposure assumptions can be found in the *Summary of Risk Assessment Results and Land Use Restrictions* report (URS, 2006).

The chemicals identified as COPCs and their associated EPCs are presented in Table 2a. The CSFs and RfDs used in the HHRA for LF-05 are presented on Tables 2b, 2c, 2d, and 2e.

The cancer risks and non-cancer HIs calculated as part of the baseline risk assessment in the RI are summarized on Tables 2f, 2g, and 2h. The estimated site-related cancer risks under

the open space and recreational land use scenarios were 1×10^{-6} for the groundskeeper and 2×10^{-6} for the construction worker, which are at the low end of the EPA target risk range. The site-related cancer risk for the child trespasser was 6×10^{-7}, which shows no significant exposure. The site-related HIs were 0.01 for the groundskeeper, 0.1 for the construction worker, and 0.02 for the child trespasser. All HIs were less than the target value of 1. Under the open space and recreational land use scenarios, no threat is posed to human health by chemicals in the surface soil at LF-05.

The results of the risk re-evaluation are presented in Tables 2i, 2j, and 2k.The calculated cancer risks were 8×10^{-8} for the construction worker, 1×10^{-6} for the adult resident, and 3×10^{-6} for the child resident. These risks are less than or within the EPA target risk range. The non-cancer HI was estimated to be 0.05 for the construction worker, 0.04 for the adult resident and 0.3 for the child resident, indicating no potential for adverse, non-cancer health effects to these receptors. The risk re-evaluation demonstrated that use of the Site for commercial or industrial purposes will not pose a threat to human health. In summary, no unacceptable risks for the receptors evaluated were attributable to soil at Site LF-05.

2.7.4.2 Ecological Risk Assessment

The maximum concentration of each chemical detected in the surface soil samples was compared to the EPA Region III BTAG screening values to select chemicals requiring further evaluation. Chemicals that required further evaluation are identified in Table 2l.

Site LF-05 is an abandoned landfill that encompasses 7 acres at the intersection of Nealy Avenue and Dogwood Avenue. The Site is adjacent to the Back River. The landfill is covered by a maintained grass lawn which does not appear to provide permanent shelter for wildlife. Birds may forage for invertebrates or seeds at the Site. Waterfowl and gulls are attracted to the depressions where water accumulates periodically after rain events. These birds appear to use the depressions for resting and bathing. Use of the Site by raptors is expected to be rare due to the lack of perches, insufficient prey population, and/or presence of humans. The ecological exposure pathways of concern and assessment and measurement endpoints for LF-05 are presented in Table 2m.

For each receptor, chemicals with at least one LOAEL HQ greater than 1.0 are summarized on Table 2n. For the earthworm, red fox, and red-tailed hawk, all mean LOAEL HQs were less than 1.0. These results demonstrate that chemicals in the LF-05 surface soil do not pose a threat to terrestrial invertebrates or higher trophic level receptors. For the American robin (insect-eating bird), magnesium resulted in the only mean LOAEL HQ greater than 1.0. Magnesium, however, is an essential nutrient and is present at background levels. For the deer mouse, mean concentrations of six metals resulted in LOAEL HQs greater than 1.0. Five of the metals, aluminum, arsenic, barium, magnesium, and vanadium, were present at concentrations statistically similar to background levels. The sixth metal, calcium, is an essential nutrient. In summary, no site-related chemicals in the surface soil at LF-05 posed a threat to ecological receptors.

2.7.5 ERP Site LF-18 Risk Assessment Summary

2.7.5.1 Human Health Risk Assessment

The risk assessment included estimates of the risk posed to human health by exposure to soil assuming LF-18 has a current land use of open space with a proposed future land use of recreational. The only receptor expected to contact the surface soil at LF-18 under the assumed current and future land use scenarios was the recreational hunter. This receptor may be exposed directly to chemicals in the surface soil through incidental ingestion and dermal contact. Although the recreational hunter may inhale fugitive dust and volatile emissions, this exposure route was determined to be negligible and was not quantified. The recreational hunter may be exposed indirectly to chemicals in the soil through ingestion of berries grown at the Site and ingestion of venison from deer hunted at the Site. It was assumed that children of the recreational hunter would also eat venison obtained from LF-18. This indirect exposure pathway was quantified, and the receptor is referred to as the child venison consumer.

There is a pond on LF-18, but exposure to surface water and sediment in this pond was determined to be an incomplete pathway due to the dense vegetation surrounding the pond.

Table 3a identifies the COPCs and their EPCs for surface soil at Site LF-18. The CSFs and RfDs used in the HHRA for LF-18 are provided in Tables 3b, 3c, 3d, and 3e.

The cancer risks and non-cancer hazards for the recreational hunter and the child hunter are presented in Tables 3f and 3g. The site-related HIs for the adult hunter and child hunter were less than 0.1, indicating no potential for adverse, non-cancer health effect. Cancer risk to the child hunter was not assessed. Cancer risk to the adult hunter was estimated to be 3×10^{-5}, due primarily to ingestion of indeno(1,2,3-c,d)pyrene in venison. This cancer risk estimate is within EPA's target risk range of 1×10^{-6} to 1×10^{-4}. Chemicals in the surface soil at LF-18 presented no unacceptable human health risks.

2.7.5.2 Ecological Risk Assessment

The maximum concentration of each chemical detected in the surface soil samples was compared to the EPA Region III BTAG screening values to select chemicals requiring further evaluation. Chemicals that required further evaluation are identified in Table 3h.

Site LF-18 is an abandoned landfill that encompasses 13 acres near the Northwest Branch of the Back River. The Site is heavily vegetated. Approximately two-thirds of the Site is bottomland hardwood forest adjacent to the tidal marsh along the Northwest Branch of the Back River. The upland third of the Site is dominated by grasses and other herbs, *Phragmites communis*, and patches of shrubs and small trees. Site LF-18 provides good shelter and foraging habitats for terrestrial receptors. The aquatic habitat along the shores adjacent to LF-18 is part of Site SS-63 and is not included in this ROD. The ecological exposure pathways of concern and assessment and measurement endpoints for LF-18 are presented in Table 3i.

For each receptor, chemicals with at least one LOAEL HQ greater than 1.0 are summarized on Table 3j. These chemicals include 10 metals, benzo(b)fluoranthene, benzo(k)fluoranthene, dioxin, endosulfan sulfate, and cyanide. Except for calcium, the metals shown on Table 3j were present at background levels. Calcium is an essential nutrient. The organic compounds

were characterized by low detection frequencies. In addition, the PAH concentrations were consistent with those observed in the background data set. The only chemical identified as an ecological COC was cyanide. This inorganic compound resulted in a potential risk for only the earthworm. Overall, the risk to terrestrial ecological receptors posed by chemicals in soil at Site LF-18 was minimal.

2.7.6 ERP Site LF-22 Risk Assessment Summary

2.7.6.1 Human Health Risk Assessment

The risk assessment included estimates of the risk posed to human health and the environment by exposure to soil assuming LF-22 has a current land use of airfield (open space) with a proposed future land use of recreational. Under the current and future land use scenarios, it was assumed that only the other worker (groundskeeper) would be exposed to the surface soil at LF-22. This receptor could be exposed to chemicals in the surface soil via ingestion, dermal contact, and inhalation of fugitive dust and volatile emissions.

The chemicals identified as COPCs and their associated EPCs are presented in Table 4a. The CSFs and RfDs used in the HHRA for LF-22 are provided in Tables 4b, 4c, 4d, and 4e.

Exposure of the groundskeeper to the LF-22 surface soil resulted in a site-related cancer risk of 9×10^{-7} and a site-related HI of 0.1 (primarily due to manganese). These values, presented in Table 4f, are less than the EPA target levels, indicating no threat to human health.

The HHRA identified lead as a COPC. The potential effects due to lead exposure are not evaluated in the same manner as cancer risk or non-cancer hazards. For adult receptors, exposure to lead in soil is assessed through use of the Adult Lead Model. This model calculates the lead soil concentration that is protective of a given adult receptor. For the groundskeeper at LF-22, the protective concentration of lead in soil was calculated to be 5,809 mg/kg. Both the mean lead concentration (175 mg/kg) and the maximum lead concentration (998 mg/kg) were less than this protective level, indicating no potential for health effects due to exposure of the groundskeeper to lead in the surface soil at LF-22.

2.7.6.2 Ecological Risk Assessment

The maximum concentration of each chemical detected in the surface soil samples was compared to the EPA Region III BTAG screening values to identify chemicals requiring further evaluation. Chemicals which exceeded the screening values and chemicals with the potential to bioaccumulate are listed in Table 4g.

Site LF-22 is an abandoned landfill located between the former MLB and the Back River at Willoughby Point. The upland portion of the Site is a flat, well-maintained, grass-covered area. Small mammals, such as voles and mice, potentially could forage for seeds and invertebrates in this upland area. Larger mammals are unlikely to forage in the upland portion of the Site due to its location within the clear zone of the airfield. The ecological exposure pathways of concern and assessment and measurement endpoints for LF-22 are presented in Table 4h.

For each receptor, chemicals with at least one LOAEL HQ greater than 1.0 are summarized on Table 4i. No LOAEL HQ exceeded 1.0 for either the red fox or red-tailed hawk, indicating

no risk to these upper trophic level receptors. Mean concentrations of barium, cadmium, lead, sodium, benzo(b)fluoranthene, benzo(k)fluoranthene, and heptachlor epoxide resulted in LOAEL HQs greater than 1.0 for the earthworm, deer mouse, and/or American robin. Although identified as a COC in the RI and FS reports, sodium is an essential nutrient. The three other metals were determined to be present at concentrations greater than background values. The two PAHs and the pesticide were characterized by high detection frequencies in the surface soil samples. Accordingly, barium, cadmium, lead, benzo(b)fluoranthene, benzo(k)fluoranthene, and heptachlor epoxide were identified as ecological COCs in surface soil.

The ERA demonstrated that chemicals in the LF-22 surface soil posed no threat to higher trophic level receptors (e.g., red fox, red-tailed hawk), but have the potential to affect terrestrial invertebrates, insect-eating birds (e.g., American robin), and small, insect-eating mammals (e.g., deer mouse).

2.7.7 ERP Site FT-41 Risk Assessment Summary

The risk assessment included estimates of the risk posed to human health and the environment by exposure to soil, surface water, and sediment assuming FT-41 has a current and future land use of industrial.

2.7.7.1 Human Health Risk Assessment

Three receptors were identified for this Site: groundskeeper/fire crew; construction worker; and child trespasser. Only the child trespasser was expected to be exposed to the surface water and sediment. While all three receptors would be exposed to surface soil, only the construction worker would be exposed to subsurface soil.

The chemicals identified as COPCs and their associated EPCs are presented in Tables 5a, 5b, 5c, and 5d. The CSFs and RfDs used in the HHRA for Site FT-41 are provided in Tables 5e, 5f, 5g, and 5h.

Tables 5i, 5j, and 5k summarize the potential cancer risks and non-cancer hazards associated with exposure to the site-related chemicals at Site FT-41. Estimates of cancer risk resulting from contact with soil, surface water and sediment for each of the receptors are as follows: groundskeeper/fire crew, 3×10^{-6}; construction worker, 6×10^{-6}; and child trespasser, 2×10^{-4}. The site-related cancer risk estimate for the child trespasser exceeded the upper bound of EPA's target risk range (i.e., 1×10^{-4}) while risk estimates for the other two receptors were within EPA's target risk range. The risk to the child trespasser resulted primarily from dermal contact with surface water (wetlands) adjacent to Site FT-41. The primary contributors to this risk were dioxins/furans and delta-BHC. The combined risk from the individual dioxins/furan congeners was $\times10^{-5}$, and delta-BHC contributed a risk of 1×10^{-4}.

The site-related HIs for Site FT-41 were: groundskeeper/fire crew, 0.1; construction worker, 4; and child trespasser, 2. Exposure of the child trespasser to chromium in the sediment and surface water resulted in an HI of 2 for bone marrow, the fetus, the gastrointestinal tract, and the liver. Exposure of the construction worker to manganese in the surface soil resulted in an HI of 3 for the central nervous system. No other target organ HIs exceeded 1.

In summary, manganese in the surface soil posed an unacceptable health threat to the future construction worker. Chromium in the surface water and sediment posed an unacceptable health threat to the child trespasser. Delta-BHC and dioxins/furans in surface water resulted in an unacceptable cancer risk to the child trespasser.

2.7.7.2 Ecological Risk Assessment

The maximum concentration of each chemical detected in the soil (0 to2 feet bgs), sediment, and surface water was compared to the EPA Region III BTAG screening values to identify chemicals requiring further evaluation. Chemicals that required further evaluation are identified in Tables 5l, 5m, and 5n.

Site FT-41 encompasses 0.5 acres bordered by the base golf course to the west, a horse pasture to the east, and wetlands to the north. The wetlands are associated with Tabbs Creek. The majority of the Site is covered with gravel and sand, and is still used as a FTA. There is limited habitat in the soil along the periphery of the Site. The wetlands are dominated by *Phragmites communis* in drier areas, and rushes, sedges, and *Spartina* in tidal areas. Wildlife observed at the Site included crabs, mollusks, and amphibians. The wetland area may be used by wading birds and aquatic mammals for foraging. The ecological exposure pathways of concern and assessment and measurement endpoints for FT-41 are presented in Table 5o.

For each receptor, chemicals with at least one LOAEL HQ greater than 1.0 are summarized on Table 5p. For the soil, one PAH (benzo(k)fluoranthene), and ten metals (aluminum, arsenic, barium, beryllium, lead, magnesium, manganese, thallium, vanadium, and zinc) were characterized by mean LOAEL HQs greater than 1.0. To assess whether these chemicals posed a threat to terrestrial receptors, additional lines of evidence were evaluated. Aluminum, arsenic, lead, and vanadium were present in soil samples at concentrations consistent with background conditions. In addition, the single thallium detection was consistent with background values. Magnesium is an essential nutrient. The HQs for benzo(k)fluoranthene only slightly exceeded the screening value of 1.0. Finally, because of the sand and gravel across the Site and continued use of the Site for fire training, the Site has limited, poor quality terrestrial habitat. Based on these lines of evidence, the ERA concluded that chemicals in the Site soil do not pose a threat to terrestrial receptors.

For benthic invertebrates, mean LOAEL HQs for lead, chrysene, DDD, DDE, and dieldrin exceeded 1.0. As part of the RI, two sediment samples were collected for toxicity testing. These samples showed no toxic effect. For this reason, it is likely that the calculated HQs overstated the potential risk from chemicals in the sediment.

For the belted kingfisher (aquatic birds), the mean LOAEL HQ for aluminum, antimony, beryllium, lead, and magnesium exceeded 1.0. Magnesium is an essential nutrient. The sediment concentrations of aluminum, antimony, and beryllium were consistent with background conditions. The exposure assessment overestimated the bioavailability of aluminum. Antimony was not positively detected in the surface water samples. Based on these lines of evidence, the ERA concluded that aluminum, antimony, beryllium, and magnesium did not pose a threat to aquatic birds. Lead was identified as a COC for the belted kingfisher because it was detected in the sediment samples at concentrations greater than background values.

For the mink (aquatic mammal), the mean LOAEL HQs for aluminum, arsenic, lead, and delta-BHC were greater than 1.0. As described for the belted kingfisher, aluminum was present in the sediment at background concentrations and the bioavailability of aluminum was overestimated in the exposure assessment. Aluminum was not identified as a COC for the mink. Arsenic and lead concentrations in the sediment samples exceeded background values. Delta-BHC was detected in all surface water samples. Accordingly, arsenic, lead, and delta-BHC were identified as COCs for the mink.

For the Atlantic croaker, the mean LOAEL HQs for eleven metals, three PAHs (benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene), and four pesticides (dieldrin, heptachlor epoxide, alpha-BHC, and delta-BHC) were greater than 1.0. The bioavailability of aluminum was overestimated in the exposure assessment. The three PAHs had isolated detections (1 of5) and HQs that only slightly exceeded 1.0. Alpha-BHC was detected in only one surface water sample and was not found in the sediment samples. The selenium concentrations in the surface water samples were consistent with background values. Therefore, aluminum, alpha-BHC, selenium, benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were not identified as COCs. The Atlantic croaker, due to its size, is not likely to inhabit the wetland area adjacent to FT-41. In addition, fish toxicity testing of surface water samples collected during the RI showed similar survival rates (> 95%) as compared to reference samples. For these reasons, no COCs were identified for the Atlantic croaker.

In summary, lead was identified as a COC for the belted kingfisher (sediment and surface water), and arsenic, lead, and delta-BHC were identified as COCs for the mink (sediment and surface water). While calculated HQs indicated the potential for risk to benthic invertebrates from lead, chrysene, DDD, DDE, and dieldrin, sediment toxicity testing showed no toxic effect.

2.7.8 Assessment Conclusions

The overall conclusion of the RI risk assessments was that risk to human health at Site LF-01 was underestimated; unacceptable human health risk existed at Site FT-41; and unacceptable risks to the environment existed at Sites LF-22 and FT-41. These risks, as well as the potential risks due to the remaining source material at Sites LF-01, LF-05, LF-18, and LF-22, presented unacceptable risks to human health and the environment for unlimited use and unrestricted exposure at the five Sites.

2.8 Remedial Action Objectives

It is the current judgment of the Air Force and EPA, in consultation with VDEQ, that the response actions selected in this ROD and implemented were necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment at Sites LF-01, LF-05, LF-18, LF-22, and FT-41. The RAOs for Sites LF-01, LF-05, LF-18, and LF-22 were to prevent exposure to waste and soil presenting unacceptable risks. The RAO for FT-41 was to prevent exposure to soil, surface water, and sediment posing unacceptable risks.

2.9 Description of the Remedial Alternatives

A detailed analysis of possible remedial alternatives for these Sites is presented in the Final FS for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 (URS, 2001a). Additional details for LF-01 are presented in the Revised PP (Langley AFB, 2008). Summaries of the alternatives considered for each Site are presented in this section.

2.9.1 ERP Site LF-01

Remedial alternatives considered for Site LF-01 were No Action, Manage Waste in Place, and Excavation and Off-Site Disposal.

2.9.1.1 Alternative S1: No Action

Estimated Capital Cost: $0
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: None

The No Action alternative was included in accordance with the NCP to serve as a baseline for comparison with other alternatives. Under the No Action alternative, Site LF-01 would have been left as is.

2.9.1.2 Alternative S2: Manage Waste in Place (Soil Cover and Land Use Controls)

Capital Cost: $1,054,000
Estimated Institutional Controls Cost: $198,000
Estimated Present Worth Cost: $1,252,000
Construction Timeframe: 3 months

This alternative had two basic components: addition of soil cover and implementation of LUCs. The alternative included adding up to 18 inches of fill and 6 inches of topsoil in areas with less than 24 inches of cover over buried waste to conform to the Virginia solid waste management regulations related to closure of landfills. The alternative also included grading to promote positive drainage off the constructed cover and to minimize erosion, and revegetation of the soil cover areas.

Portions of Site LF-01 are low quality wetland areas. The alternative included restoration of temporarily impacted wetlands and compensation for 2.1 acres of permanently impacted wetlands through an approved compensation mechanism for establishing or enhancing off-base wetlands.

The LUC component of the alternative for LF-01 included updating the Base General Plan to include information on restricted activities at LF-01; providing a survey plat to the local government property records office identifying the LUC boundary and restricted uses at LF-01; installation of signage notifying the public of the location of the landfill; and implementing LUC Operations and Maintenance (O&M) activities.

2.9.1.3 Alternative S3: Excavation and Off-Site Disposal

Estimated Capital Cost: $7,294,000
Estimated Present Worth Cost: $7,294,000
Estimated Construction Timeframe: 10 months

Components of this alternative would have included waste excavation to a depth corresponding to the water table elevation; characterization of excavated waste and associated soil for proper disposal; off-site disposal of waste and associated soil; backfilling excavated areas; and re-vegetation of the excavation areas.

Portions of Site LF-01 are low quality wetland areas. The alternative also would have included restoration of approximately 1.7 acres of permanently impacted wetlands through an approved compensation mechanism for establishing or enhancing off-base wetlands.

2.9.1.4 Common Elements and Distinguishing Features

Because the two action alternatives evaluated are significantly different from one another (S2 consisting of a presumptive remedy of containment and S3 consisting of excavation and off-site disposal), key distinguishing features are as follows:

- Alternative S2 resulted in buried waste and impacted soil remaining on-site under a protective soil cover (presumptive remedy), whereas Alternative S3 would have resulted in off-site disposal of the estimated 41,900 cubic yards of waste and soil, including potentially hazardous waste;
- The estimated time for design and construction for Alternative S2 was 3 months, but would have been substantially longer (10 months) for Alternative S3;
- The estimated capital costs associated with Alternative S2 were $1,054,000, but would have been substantially more ($7,294,000) for Alternative S3;
- Although both Alternatives S2 (Soil Cover and LUCs) and S3 (Excavation and Off-Site Disposal) provide long-term reliability, the useful life of a soil cover with sufficient O&M can surpass 30 years; whereas complete excavation would have provided for complete mitigation of risk; and
- Because Alternative S2 resulted in management of waste in place, statutory 5-year remedy reviews are required, but would not have been required for Alternative S3.

The need for wetland mitigation was a common feature of both action alternatives.

2.9.1.5 Expected Outcomes of Each Alternative

Current land uses are expected to continue at LF-01. Alternative S1 (No Action) would not have eliminated nor controlled the risk of exposure to contaminated soil and buried waste at LF-01. Alternative S2 (Manage Waste in Place) controls the risk of exposure to contaminated soil and buried waste through containment and implementation of LUCs to restrict future land use in the absence of additional action. If Alternative S3 had been implemented, exposure would have been controlled through off-site disposal of impacted soil and waste and would have resulted in unlimited use and unrestricted exposure.

2.9.2 ERP Site LF-05

Remedial alternatives considered for Site LF-05 were No Action and Manage Waste in Place.

2.9.2.1 Alternative S1: No Action

Estimated Capital Cost: $0
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: None

The No Action alternative was included in accordance with the NCP to serve as a baseline for comparison with other alternatives. Under the No Action alternative, Site LF-05 would have been left as is.

2.9.2.2 Alternative S2: Manage Waste in Place (Soil Cover and LUCs)

Capital Cost: $558,800
Estimated Institutional Controls Cost: $122,100
Estimated Present Worth Cost: $672,900
Construction Timeframe: 8 months

This alternative had two basic components: addition of soil cover and implementation of LUCs.

The soil cover south of Nealy Avenue included the addition of an 18-inch thick layer of fill and 6-inch topsoil layer to attain the required 24 inches of soil cover to prevent exposure to buried waste materials and to conform to the Virginia solid waste management regulations related to closure of landfills. North of Nealy Avenue only 6 inches of topsoil was required to achieve the minimum 24 inches of soil over buried waste. The construction areas required re-vegetation with native grasses.

The LUC component of the alternative for LF-05 included updating the Base General Plan to include information on restricted activities at LF-05; providing a survey plat to the local government property records office identifying the LUC boundary and restricted uses at LF-05; installation of signage notifying the public of the location of the landfill; and implementing LUC O&M activities.

2.9.2.3 Common Elements and Distinguishing Features

There were no common elements of remedial alternatives S1 and S2.

2.9.2.4 Expected Outcomes of Each Alternative

Current land uses are expected to continue at LF-05. Alternative S1 (No Action) would not have eliminated nor controlled the risk of exposure to contaminated soil and buried waste at LF-05. Alternative S2 (Manage Waste in Place) controls the risk of exposure to contaminated soil and buried waste at LF-05 through containment and implementation of LUCs to restrict future land use in the absence of additional action.

2.9.3 ERP Site LF-18

Remedial alternatives considered for Site LF-18 were No Action and Manage Waste in Place.

2.9.3.1 Alternative S1: No Action

Estimated Capital Cost: $0
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: None

The No Action alternative was included in accordance with the NCP to serve as a baseline for comparison with other alternatives. Under the No Action alternative, Site LF-18 would have been left as is.

2.9.3.2 Alternative S2: Manage Waste in Place (Soil Cover and LUCs)

Capital Cost: $345,700
Estimated Institutional Controls Cost: $122,100
Estimated Present Worth Cost: $467,800
Construction Timeframe: 9 months

This alternative had two basic components: addition of a soil cover and implementation of LUCs.

This alternative involved the placement of additional soil cover in the half-acre area to attain a minimum of 24 inches of cover over buried waste and to conform to the Virginia solid waste management regulations related to closure of landfills. The construction area required re-vegetation with native plants and grasses.

The LUC component of the alternative for LF-18 included updating the Base General Plan to include information on restricted activities at LF-18; providing a survey plat to the local government property records office identifying the LUC boundary and restricted uses at LF-18; installation of signage notifying the public of the location of the landfill; and implementing LUC O&M activities.

2.9.3.3 Common Elements and Distinguishing Features

There were no common elements of remedial alternatives S1 and S2.

2.9.3.4 Expected Outcomes of Each Alternative

Current land uses are expected to continue at LF-18. Alternative S1 (No Action) would not have eliminated nor controlled the risk of exposure to contaminated soil and buried waste at LF-18.

Alternative S2 (Manage Waste in Place) controls the risk of exposure to contaminated soil and buried waste at LF-18 through containment and implementation of LUCs to restrict future land use in the absence of additional action.

2.9.4 ERP Site LF-22

Remedial alternatives considered for Site LF-22 were No Action and Manage Waste in Place.

2.9.4.1 Alternative S1: No Action

Estimated Capital Cost: $0
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: None

The No Action alternative was included in accordance with the NCP to serve as a baseline for comparison with other alternatives. Under the No Action alternative, Site LF-22 would have been left as is.

2.9.4.2 Alternative S2: Manage Waste in Place (Soil Cover and LUCs)

Capital Cost: $1,807,719
Estimated Institutional Controls Cost: $122,100
Estimated Present Worth Cost: $2,029,819
Construction Timeframe: 3 months

This alternative for LF-22, had two basic components: addition of soil cover and implementation of LUCs. Site preparation activities also included demolition of 1,000 LF of the former MLB foundation and off-site disposal of surface debris and demolition debris. Demolition of the former MLB foundation was required to meet airfield height restrictions. The placement of additional soil cover attained a minimum of 24 inches of cover over buried waste in conformance to the Virginia solid waste management regulations related to closure of landfills. The soil cover was also extended to cover three other ERP sites to the south of LF-22, DP-66, DP-67, and DP-68, which also contain buried waste and soil contaminants.

The LUC component of the alternative for LF-22 included updating the Base General Plan to include information on restricted activities at LF-22; providing a survey plat to the local government property records office identifying the LUC boundary and restricted uses at LF-22; installation of signage notifying the public of the location of the landfill; and implementing LUC O&M activities.

2.9.4.3 Common Elements and Distinguishing Features

There were no common elements of remedial alternatives S1 and S2.

2.9.4.4 Expected Outcomes of Each Alternative

Current land uses are expected to continue at LF-22. Alternative S1 (No Action) would not have eliminated nor controlled the risk of exposure to contaminated soil and buried waste at LF-22. Alternative S2 (Manage Waste in Place) controls the risk of exposure to contaminated soil and buried waste at LF-22 through containment and implementation of LUCs to restrict future land use in the absence of additional action.

2.9.5 ERP Site FT-41

Remedial alternatives considered for Site FT-41 were No Action and Sediment Controls, LUCs, and Monitoring.

2.9.5.1 Alternative S1: No Action

Estimated Capital Cost: $0
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: None

The No Action alternative was included in accordance with the NCP to serve as a baseline for comparison with other alternatives. Under the No Action alternative, Site FT-41 would have been left as is.

2.9.5.2 Alternative S2: Sediment Controls, LUCs, and Monitoring

Capital Cost: $112,800
Estimated Institutional Controls Cost: $122,100
Estimated Present Worth Cost: $234,900
Construction Timeframe: 3 months

Implementation of sediment controls and LUCs and monitoring were the primary components of this alternative. Sediment controls to minimize contaminant migration to surrounding wetland and surface water bodies included:

- Cleaning sediment from the catch basin, culvert pipe, and grass-lined channel of the drainage channel and off-site disposal of the cleared sediment;
- Installation of sediment logs in three of four site drainage features; and
- Installation of a rock check dam in the third and fourth drainage channels.

LUCs for Site FT-41 included updating the Base General Plan to include information on restricted activities at FT-41; providing a survey plat to the local government property records office identifying the LUC boundary and restricted uses at FT-41; and implementing LUC O&M activities. Monitoring includes fish and wildlife tissue sampling to evaluate effectiveness of sediment removal and controls by measuring sediment toxicity to benthic invertebrates, aquatic birds, and aquatic mammals.

2.9.5.3 Common Elements and Distinguishing Features

There were no common elements of remedial alternatives S1 and S2 for FT-41.

2.9.5.4 Expected Outcomes of Each Alternative

Current land uses are expected to continue at FT-41. Alternative S1 (No Action) would not have eliminated nor controlled the risk of exposure to contaminated soil and buried waste at FT-41. Alternative S2 (Sediment Controls, LUCs, and Monitoring) controls the risk of exposure to contaminated soil, surface water, and sediment through off-site disposal of impacted sediment, reduction of off-site migration of contaminants, sediment monitoring, and implementation of LUCs. LUCs eliminate or minimize exposure pathways associated with unacceptable risk at FT-41.

2.10 Comparative Analysis of Alternatives

Nine criteria were used to evaluate the different remediation alternatives individually and against each other to select a remedy. This section of the ROD profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed below. The detailed analysis of alternatives can be found in the FS Report.

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, and/or LUCs.

Section 121(d) of CERCLA, requires that RAs attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as Applicable or Relevant and Appropriate Requirements (ARARs), unless waivers are obtained.

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

2.10.1 ERP Sites LF-01, LF-05, LF-18, and LF-22

The following sections summarize comparison of three RA alternatives for LF-01 and two RA alternatives each for LF-05, LF-18, and LF-22 under nine evaluation criteria.

2.10.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment

Alternative S1 (No Action) would have provided no long-term protection of human health or the environment because it would not reduce or prevent migration of contamination or exposure to site wastes and is not considered further in this ROD.

Alternative S2 (Manage Waste in Place) provided adequate protection of human health and the environment at LF-01, LF-05, LF-18, and LF-22 because exposure to COCs and buried waste was eliminated through additional soil cover to achieve a minimum thickness of 24 inches across the Site and through LUCs. O&M activities are required to ensure protectiveness is maintained. Alternative S2 also restricts future use and development of these four Sites.

Selecting Alternative S3 (Excavation and Off-site Disposal) for Site LF-01 would have provided a higher level of protection of human health and the environment because this action would have removed the waste from the former disposal area, allowing for unlimited use and unrestricted exposure.

Compliance with ARARs

Alternative S2 (Manage Waste in Place) complied with ARARs for LF-01, LF-05, LF-18, and LF-22. For Site LF-01, Alternative S3 (Excavation and Off-site Disposal) would also have complied with ARARs.

2.10.1.2 Primary Balancing Criteria

Long-term Effectiveness and Permanence

Implementation of Alternative S2 (Manage Waste in Place) provided an effective RA to eliminate the soil exposure pathways at LF-01, LF-05, LF-18, and LF-22 through implementation of LUCs. Long-term maintenance and monitoring is required and reassessment of the effectiveness of Alternative S2 is necessary at 5-year intervals for all four Sites. This alternative deters exposure to buried waste materials from intrusive activities associated with construction and land development.

For LF-01, selecting Alternative S3 (Excavation and Off-Site Disposal) would have provided the greatest degree of long-term effectiveness and a more permanent solution than Alternative S2 because the source area would have been removed, allowing for unlimited use and unrestricted exposure.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Alternative S2 (Manage Waste in Place) did not reduce the toxicity or volume of contaminants through treatment; however, the addition of soil covers reduced the mobility of COCs in the environment.

Selecting Alternative S3 (Excavation and Off-Site Disposal) for LF-01 would have resulted in COCs from the excavation areas being placed within an approved landfill. No reduction in contaminant toxicity, mobility, or volume would have occurred through treatment unless stabilization had been required prior to disposal.

Short-term Effectiveness

Alternative S2 (Manage Waste in Place) took 2 months to complete at LF-01, 5 months at LF-05, 9 months at LF-18, and 4 months at LF-22. The short-term impacts from clearing and grubbing and placement of additional soil cover materials (e.g., fugitive dust emissions, erosion, and disturbance of existing habitat) were controlled through dust-suppression and erosion and sediment control measures.

Potential short-term impacts due to off-site transportation of former MLB foundation debris from LF-22 were minimized by using recycling facilities close to Langley AFB. Wetlands temporarily impacted at the edges of the soil cover at Site LF-01 were restored. Permanently impacted wetlands at LF-01were offset through payment into the Virginia Aquatic Resources Trust Fund to establish or enhance off-base wetlands.

Alternative S3 (Excavation and Off-Site Disposal) at LF-01 would have required approximately 10 months for completion. This alternative also included potential impacts from waste excavation, hauling, and off-site disposal.

Implementability

Alternatives S2 (Manage Waste in Place) were easily implemented at LF-01, LF-05, LF-18, and LF-22 based on commonly accepted construction methods and availability of equipment and materials.

Alternative S3 (Excavation and Off-Site Disposal) would not have been easily implemented at LF-01 due to the presence of numerous underground utilities and due to the location of the landfill within the zone of frangibility and graded area of the clear zone of the airfield.

Cost

The present worth costs for Alternative S2 (Manage Waste in Place) at LF-01, LF-05, LF-18, and LF-22 and Alternative S3 (Excavation and Off-Site Disposal) for LF-01 were:

	Alternative S2	Alternative S3
LF-01	$1,252,000	$7,294,000
LF-05	$672,900	not applicable
LF-18	$467,800	not applicable
LF-22	$2,029,819	not applicable

2.10.1.3 Modifying Criteria

State Acceptance

State involvement was solicited throughout the CERCLA process and proposed remedy selection. The VDEQ as the designated state support agency in Virginia has reviewed this ROD and previous documentation and concurs with the Selected Remedies for LF-01, LF-05, LF-18, and LF-22.

Community Acceptance

A public meeting on the PP for LF-01, LF-05, LF-18, and LF-22 was held on July 24, 2001 in Hampton, Virginia. Public meetings were held for the two subsequent Revised PPs for LF-01 on December 5, 2005, and February 12, 2008, also in Hampton, Virginia. No public comments were received at the public meetings or during the public comment periods.

2.10.2 ERP Site FT-41

The following sections summarize comparison of two remediation alternatives for FT-41 under the nine evaluation criteria.

2.10.2.1 Threshold Criteria

Overall Protection of Human Health and the Environment

Alternative S1 (No Action) would not have provided long-term protection of human health and the environment because it did not prevent migration of contamination or exposure of site contaminants and is not considered further in this ROD.

Alternative S2 (Sediment Controls, LUCs, and Monitoring) provided adequate protection of human health and the environment by controlling the risk of exposure to contaminated soil, surface water, and sediment through off-site disposal of impacted sediment, thereby reducing off-site migration of contaminants; implementation of LUCs; and sediment monitoring. LUCs restrict future property use, development, and site access and eliminate or minimize exposure pathways associated with unacceptable risk at FT-41. Fish and wildlife tissue sampling are used to confirm effectiveness of sediment removal and controls by assessing toxicity to benthic invertebrates, aquatic birds, and aquatic mammals.

Compliance with ARARs

Alternative S2 (Sediment Controls, LUCs, and Monitoring) complied with ARARs.

2.10.2.2 Primary Balancing Criteria

Long-term Effectiveness and Permanence

Alternative S2 (Sediment Controls, LUCs, and Monitoring) achieved long-term effectiveness through removal of contaminated sediment as part of the sediment controls, implementation of LUCs to restrict access and site use, and monitoring. LUCs deter exposure to contamination from unauthorized intrusive activities associated with construction and land development. Long-term monitoring (LTM) is required; and reassessment of the effectiveness of Alternative S2 is necessary at 5-year intervals for FT-41.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Alternative S2 (Sediment Controls, LUCs, and Monitoring) did not reduce the toxicity or volume of contaminants through treatment. However, the removal of contaminated sediments and installation of rock check dams in site drainage channels reduced the mobility of COCs in the environment.

Short-term Effectiveness

Alternative S2 (Sediment Controls, LUCs, and Monitoring) took approximately 3 months for completion. The short-term impacts from clearing and grubbing and removal of contaminated sediment (e.g., fugitive dust emissions, erosion, and disturbance of existing habitat) were controlled through dust-suppression and erosion and sediment control measures.

Implementability

Alternative S2 (Sediment Controls, LUCs, and Monitoring) was easy to implement based on commonly accepted construction methods and availability of equipment and materials.

Cost

The present-worth cost estimate for S2 (Sediment Controls, LUCs, and Monitoring) was $234,900.

2.10.2.3 Modifying Criteria

State Acceptance

State involvement was solicited throughout the CERCLA process and proposed remedy selection. The VDEQ as the designated state support agency in Virginia has reviewed this ROD and previous documentation and concurs with the Selected Remedy for FT-41.

Community Acceptance

A public meeting on the PP, which described Alternative S2 as the preferred alternative, was held on July 24, 2001, in Hampton, Virginia. No public comments were received at the public meeting or during the public comment period.

2.11 Principal Threat Waste

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The landfill Sites consist primarily of construction debris and no principal threat wastes were identified in the RI for any of the Sites.

2.12 Selected Remedy

Following review and consideration of the information in the Administrative Record file, requirements of CERCLA and the NCP, and the review of public comments on the PP, the Air Force and EPA, in consultation with VDEQ, selected the following remedies which were previously implemented:

- Sites LF-01, LF-05, LF-18 and LF-22: Manage Waste in Place (Soil Cover and LUCs);
- Site FT-41: Sediment Controls, LUCs, and Monitoring.

The following sections present the rationale for the Selected Remedy, descriptions of the Selected Remedy, estimated costs, and expected outcomes.

2.12.1 Summary of the Rationale for the Selected Remedy

Alternative S2, Manage Waste in Place, was selected for Sites LF-01, LF-05, LF-18, and LF-22 because it achieved the following:

- Substantial risk reduction preventing direct exposure to impacted soil and waste
- Compliance with Federal and Commonwealth of Virginia ARARs
- A useful life that can easily surpass 30 years
- Reduction in the mobility of contaminants
- Ease of implementation with conventional equipment in a relatively short time using standard construction methods
- Cost effectiveness

Alternative S2, Sediment Controls, LUCs, and Monitoring, was selected for Site FT-41 because it achieved the following:

- Increased protection of human health by reducing exposure to COCs through excavation and off-site disposal of contaminated sediment and implementation of LUCs to eliminate or minimize exposure pathways
- Measurement of sediment toxicity to benthic invertebrates, aquatic birds, and aquatic mammals to ensure no unacceptable ecological risks remain
- Compliance with Federal and Commonwealth of Virginia ARARs

- Reduction in volume and mobility of contaminants through sediment removal and sediment controls to prevent off-site migration of contaminants
- Ease of implementation
- Cost effectiveness

2.12.2 Description of the Selected Remedy

The Air Force is responsible for, has implemented, and will continue to operate, maintain, monitor, review, and enforce the Selected Remedy in accordance with CERCLA and the NCP to ensure protection of human health and the environment for the duration of the Selected Remedy.

Because the Selected Remedy for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 resulted in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of RA to ensure that the remedies continue to be protective of human health and the environment. The statutory review conducted in 2004 for Langley AFB CERCLA sites included Sites LF-05, LF-18, and FT-41 because the RAs at these Sites were complete. RAs at Sites LF-01 and LF-22 had not been initiated in 2004; therefore, the first statutory review of these Sites will be included in the next statutory review of Langley AFB CERCLA sites scheduled for 2009.

2.12.2.1 Sites LF-01, LF-05, LF-18, and LF-22

The Selected Remedy is divided into two parts, addition of soil cover and LUCs.

Soil Cover Objectives

Objectives of the soil cover were to prevent contact with waste and soil and minimize infiltration of precipitation and control surface water runoff and erosion.

Soil Cover Implementation

Constructing the soil cover included applying soil cover (minimum 24 inches thick) over the buried waste where less than 2 feet of soil cover existed; grading the soil cover into the existing contours to promote positive drainage and to minimize erosion; and vegetating the cover.

The addition of the soil cover permanently impacted approximately 2.1 acres of jurisdictional wetlands at LF-01. Impacts to the jurisdictional wetlands were mitigated through approved payment into the Virginia Aquatic Resources Trust Fund to establish or enhance off-base wetlands.

The addition of soil cover at LF-22 also required demolition of the former MLB foundation to meet height restrictions and slope and grade requirements in this area of the airfield and was extended to include ERP Sites DP-66, DP-67, and DP-68. Surface and demolition debris were taken off base for recycling or disposal.

LUC Objectives

The LUC objectives for LF-01, LF-05, LF-18, and LF-22 included preventing contact with waste and soil by restricting land use, preventing unauthorized ground-disturbing activities, and maintaining the integrity of the soil cover.

LUC Implementation

The Air Force has implemented and is committed to effectively maintaining, monitoring, reviewing, and enforcing LUCs and ensuring protection of human health and the environment. The Base General Plan, both in text and graphical forms, provides pertinent information used in planning and decision-making regarding permissible current and future land uses and activities. Upon RA completion, the Langley AFB Base Community Planner revised the Base General Plan to include all LUCs identified by this ROD. Overall implementation and maintenance of LUCs will be the responsibility of the Base ERP Chief, designee, or equivalent. In addition:

- The Air Force posted signs at or near LF-01, LF-05, LF-18, and LF-22 clearly indicating the presence of buried waste and restricted activities.
- The Air Force submitted a survey plat for each Site to the City of Hampton recording authority for the purpose of providing public notice of the environmental conditions of and limitations on the use of the properties. The plats were prepared by a certified Professional Land Surveyor with a prominently displayed note stating Langley AFB's obligations to restrict uses (i.e., to non-residential) and activities (i.e., no digging without a permit) at LF-01, LF-05, LF-18, and LF-22. The filing of this plat is for notice purposes only and is not intended to create a property right or interest.
- The Base Civil Engineer Work Clearance Request or equivalent process will be used to prevent unauthorized disturbance of the soil covers at LF-01, LF-05, LF-18, and LF-22.

LUCs apply to the areas within the boundaries of the waste area and soil cover. The approximate LUC boundaries are shown on Figures 5a through 5d. All of the LUCs set forth in this ROD will remain in place until concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure.

Soil Cover and LUCs Monitoring/Inspection

Monitoring the integrity of the soil cover will be conducted semi-annually at a minimum through visual inspection. The inspection will also evaluate the status of the LUCs and how any LUCs deficiencies or inconsistent uses have been addressed. The inspection will address whether the use restrictions and controls referenced above were documented and maintained in the Base General Plan, and whether use of the property has conformed to such restrictions and controls. The first inspection will confirm that a plat with use restrictions was filed with the local recording office.

LUC Reporting

Any activity that is inconsistent with the LUCs objectives, or any other action that may interfere with the effectiveness of the LUCs, will be documented with the cover inspection results and provided to EPA and VDEQ for informational use. In addition:

1. The inconsistent activities will be addressed by Langley AFB as soon as practicable, but in no case will the process be initiated later than 15 calendar days after Langley AFB confirms the breach has occurred.

2. Langley AFB will inform EPA and VDEQ regarding how Langley AFB has addressed or will address the LUC breach within 15 calendar days of confirming a LUC breach has occurred. The information will include a summary description and discussion of any problems or deficiencies in the LUCs or other controls and measures that may have caused or allowed the inconsistent activity, and any corrective measures taken or planned.

3. Langley AFB will notify EPA and VDEQ 60 days in advance of any proposed land use changes that are inconsistent with LUC objectives and the Selected Remedy.

4. Langley AFB will provide notice to EPA and VDEQ at least six (6) months prior to any transfer or sale of LF-01, LF-05, LF-18, or LF-22 so that EPA and VDEQ can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective LUCs. If it is not possible for the facility to notify EPA and VDEQ at least 6 months prior to any transfer or sale, then the facility will notify EPA and VDEQ as soon as possible, but no later than 60 days prior to the transfer or sale of any property subject to LUCs. In addition to the land transfer notice and discussion provisions above, Langley AFB further agrees to provide EPA and VDEQ with similar notice, within the same time frames, as to federal-to-federal transfer of property. Langley AFB will provide a copy of executed deed or transfer assembly to EPA and VDEQ.

5. Langley AFB will not modify or terminate LUCs, implementation actions identified in this ROD, or modify land use without first seeking concurrence from EPA and VDEQ on any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs. Within 60 days of approved changes Langley AFB will update the Base General Plan and notify EPA and VDEQ.

2.12.2.2 Site FT-41

The Selected Remedy is divided into three parts, construction of sediment controls, implementation of LUCs, and contaminant monitoring.

Sediment Control Objectives

The objective of the sediment controls was to prevent migration off-site of elevated levels of sediment COCs from the site surface soil.

Sediment Controls Implementation

Constructing sediment controls at FT-41 included the following components:

- Removal and off-site disposal of sediment from a catch basin and underground piping.
- Reshaping the drainage channel where underground piping daylights down to the tributary to Tabbs Creek.
- Placement of approximately 31 cubic yards of gravel in a low spot southwest of the training pit.

- Installation of sediment logs in three of four site drainage features.
- Installation of a rock check dam in two drainage channels, just upstream of the point at which the channels enter the tributary to Tabbs Creek.

Sediment Controls Monitoring/Inspection

Initially, the sediment controls will be inspected semi-annually to ensure they are maintained and functioning properly to reduce the amount of sediment leaving the Site. After sufficient eroded soil ("sediment") has accumulated at the sediment controls, samples will be collected and analyzed for pesticides, SVOCs, and metals. Concentrations of detected chemicals will be compared to surface soil background levels. If the chemical concentrations exceed background values, the results will be compared to toxicity values protective of benthic invertebrates. If the detections exceed the toxicity values, then the data will be evaluated to determine whether the chemical is attributable to historic releases or to ongoing site activities. If the presence of chemicals with concentrations above background levels and toxicity values is determined to not be related to historical releases (i.e., chemicals detected are different from site-related COCs), then inspection and maintenance of the sediment controls under the ERP will be discontinued. The sediment controls monitoring and inspection results will be documented and provided to EPA and VDEQ for informational use.

LUC Objectives

The LUC objectives for FT-41 included restricting land use and access to eliminate potentially complete exposure pathways; preventing unauthorized ground-disturbing activities; and maintaining the integrity of the sediment controls.

LUC Implementation

The Air Force has implemented and is committed to effectively maintaining, monitoring, reviewing, and enforcing LUCs and ensuring protection of human health and the environment. The Base General Plan, both in text and graphical forms, provides pertinent information used in planning and decision-making regarding permissible current and future land uses and activities. Upon RA completion, the Langley AFB Base Community Planner revised the Base General Plan to include all LUCs identified by this ROD. Overall implementation and maintenance of LUCs will be the responsibility of the Base ERP Chief, designee, or equivalent. In addition:

- The Air Force submitted a survey plat for FT-41 to the City of Hampton recording authority for the purpose of providing public notice of the environmental condition of and limitations on the use of the property. The plat was prepared by a certified Professional Land Surveyor with a prominently displayed note stating Langley AFB's obligations to restrict uses (i.e., to non-residential) and activities (i.e., no digging without a permit) at FT-41. The filing of this plat is for notice purposes only and is not intended to create a property right or interest.
- The Base Civil Engineer Work Clearance Request or equivalent process will be used to prevent unauthorized intrusive activity at FT-41.

LUCs apply to the area shown on Figure 5e. All of the LUCs set forth in this ROD will remain in place until concentrations of hazardous substances at FT-41 are at levels allowing for unlimited use and unrestricted exposure.

LUC Monitoring/Inspection

Monitoring of LUCs will be conducted semi-annually at a minimum through visual inspection. The inspection will evaluate the status of the LUCs and how any LUCs deficiencies or inconsistent uses have been addressed. The inspection will address whether the use restrictions and controls referenced above were documented and maintained in the Base General Plan, and whether use of the property has conformed to such restrictions and controls. The first inspection will confirm that a plat with use restrictions has been filed with the local recording office.

Contaminant Monitoring Objectives

As described in Section 2.7.7.2, arsenic, lead, and delta-BHC in surface water and sediment were identified as COCs for the belted kingfisher (lead only) and the mink. For benthic invertebrates, no COCs were identified conclusively because although the LOAEL HQs for lead, chrysene, DDD, DDE, and dieldrin exceeded 1.0, toxicity testing showed no toxic effect. The objective of the contaminant monitoring is to resolve the discrepancy between the modeled risk to benthic invertebrates from sediment and the results of the toxicity study and to confirm no unacceptable risk to aquatic birds and mammals remain after sediment removal.

Contaminant Monitoring Implementation

To monitor the wildlife COCs, samples of sediment, surface water, and fish tissue (indirect surface water exposure pathway) will be collected and analyzed for arsenic, lead, and delta-BHC on an annual basis. NOAEL and LOAEL HQs will be calculated from the resulting analytical data. If data collected during two consecutive annual sampling events demonstrate that concentrations of the COCs in sediment, surface water, and fish tissue do not pose a threat to the wildlife receptors, wildlife monitoring will be discontinued. To monitor sediment toxicity to benthic invertebrates, sediment samples will be collected for toxicity testing and for analysis of metals, SVOCs, organochlorine pesticides, PCBs, and chlorinated herbicides. If the toxicity data collected during two consecutive annual sampling events show no toxic effect to the test organisms, sediment monitoring will be discontinued. If a toxic effect is observed, the analytical data will be evaluated to determine if a threshold HI can be developed for the Site sediment. Depending on the results (e.g., whether the toxic results appear to be related to a particular chemical or set of chemicals or whether the results appear to be anomalous), additional monitoring or evaluation of remedial options may be recommended and agreed upon by the Air Force and EPA. Contaminant monitoring results, conclusions, and recommendations will be provided to EPA and VDEQ for informational purposes.

Sediment Controls, Contaminant Monitoring, and LUC Reporting

Any activity that is inconsistent with the LUCs objectives, or any other action that may interfere with the effectiveness of the LUCs, will be documented with the sediment controls inspection and contaminant monitoring results and provided to EPA and VDEQ for informational use. In addition,

1. The inconsistent activities will be addressed by Langley AFB as soon as practicable, but in no case will the process be initiated later than 15 calendar days after Langley AFB confirms the breach.

2. Langley AFB will inform EPA and VDEQ regarding how Langley AFB has addressed or will address the LUC breach within 15 calendar days of confirming a LUC breach has occurred. The information will include a summary description and discussion of any problems or deficiencies in the LUCs or other controls and measures that may have caused or allowed the inconsistent activity, and any corrective measures taken or planned. Langley AFB will notify EPA and VDEQ 60 days in advance of any proposed land use changes that are inconsistent with LUC objectives and the Selected Remedy.

3. Langley AFB will provide notice to EPA and VDEQ at least six (6) months prior to any transfer or sale of FT-41 so that EPA and VDEQ can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective LUCs. If it is not possible for the facility to notify EPA and VDEQ at least 6 months prior to any transfer or sale, then the facility will notify EPA and VDEQ as soon as possible, but no later than 60 days prior to the transfer or sale of any property subject to LUCs. In addition to the land transfer notice and discussion provisions above, Langley AFB further agrees to provide EPA and VDEQ with similar notice, within the same time frames, as to federal-to-federal transfer of property. Langley AFB will provide a copy of executed deed or transfer assembly to EPA and VDEQ.

4. Langley AFB will not modify or terminate LUCs, implementation actions identified in this ROD, or modify land use without first seeking concurrence from EPA and VDEQ on any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs. Within 60 days of approved changes Langley AFB will update the Base General Plan and notify EPA and VDEQ.

2.12.3 Summary of the Estimated Costs for the Selected Remedy

The estimated costs for the selected remedies for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 are detailed in Tables 6 through 10, respectively. The information in these tables is based on the best available information regarding the scope of the selected remedies as implemented.

As was discussed in Section 2.2, CERCLA Activities, Alternative S2 was implemented at each of the five Sites with minor, significant or fundamental changes to the remedies. The revised costs incorporating these changes are presented in the tables.

2.12.4 Expected Outcomes of the Selected Remedy

Current land uses are expected to continue at LF-01, LF-05, LF-18, LF-22, and FT-41. Alternative S2 (Manage Waste in Place) controls exposure at LF-01, LF-05, LF-18, and LF-22 through the addition of a soil cover and implementation of LUCs. LUCs will ensure the integrity of soil covers is maintained and will restrict uses incompatible with the risk assumptions for each Site.

Alternative S2 (Sediment controls, LUCs, and Monitoring) controls exposure at FT-41 through sediment removal, improved surface water flow across the Site, minimized off-site

contaminant migration, and implementation of LUCs. LUCs eliminate or minimize the exposure pathways associated with unacceptable risk at FT-41.

2.13 Statutory Determinations

RAs must meet the statutory requirements of Section 121 of CERCLA, 42 U.S.C. § 9621 discussed below. RAs undertaken at NPL sites must protect human health and the environment, comply with ARARs of both Federal and state laws and regulations, be cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste as their principle element. The following sections discuss the selected remedies in light of these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The Selected Remedy for each of the Sites protects human health and the environment through containment. This was achieved by preventing direct contact with buried waste, reducing infiltration and resultant contaminant leaching to groundwater, and controlling surface water runoff and erosion (Sites LF-01, LF-05, LF-18, and LF-22) and controlling surface water runoff and erosion (Site FT-41). Sediment monitoring and fish and wildlife tissue sampling at Site FT-41 will confirm residual ecological risk to benthic invertebrates, aquatic birds, and aquatic mammals is acceptable.

In addition, LUCs included notice to the public as to the presence of the Sites and prevent future use of the properties for residential purposes. Additional protection was provided by posted warning signs (LF-01, LF-05, LF-18, and LF-22). The anticipated continued active use of Langley AFB for flight operations prevents uncontrolled general public access to the Sites.

The placement of additional cover materials at Sites LF-01, LF-05, LF-18, and LF-22 provided reduced exposure potentials for future onsite workers performing long-term mowing/ maintenance activities and for those using the Sites for recreational activities. The additional cover material also resulted in reduced potential for exposure of ecological receptors to waste materials. Proper grading of the newly placed cover materials also helps to reduce future infiltration to groundwater and surface water

There were no short-term risks that were not readily controlled.

2.13.2 Compliance with Applicable or Relevant and Appropriate Requirements and To-Be-Considered Criteria

The Selected Remedy met all identified ARARs. Federal and state ARARs, summarized by classification, are presented in Table 11. In addition, other TBC criteria are included as appropriate for each classification. The classifications of federal and state ARARs identified include chemical-specific, location-specific, and action-specific.

Implementation of the Selected Remedy at LF-01 permanently impacted 2.1 acres of wetlands. The taking of wetlands is an irreversible and irretrievable commitment of natural

resources and wetlands restoration was conducted to mitigate the impact in accordance with Federal and State requirements and Langley AFB policies.

2.13.3 Cost Effectiveness

In the judgment of the Air Force and EPA, the selected remedies were cost effective and represented a reasonable value for the money spent. In making this determination, the following definition was used: "A remedy shall be cost effective if its costs are proportional to its overall effectiveness." This was accomplished by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (protective of human health and the environment and ARAR-compliant).

The Air Force and EPA made this determination by evaluating the overall protectiveness of the presumptive containment remedy for Sites LF-01, LF-05, LF-18, and LF-22 and the sediment controls, LUCs, and monitoring remedy for Site FT-41, which satisfied the threshold criteria (i.e., protectiveness of human health and the environment and compliance with ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of the selected remedial alternative was determined to be proportional to its costs; therefore, the Selected Remedy for each of the five Sites has been determined to represent a reasonable value for the money to be spent.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The Air Force and EPA, with VDEQ concurrence, have determined that the Selected Remedies represent the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Sites. No principal threat wastes were identified at the Sites. Additionally, treatment of the landfill contents was not practicable in a cost-effective manner because of the large volume of waste. Since long-term effectiveness and permanence were achieved in the shortest timeframe and no off-site disposal was necessary, the Air Force and EPA have determined that the Selected Remedies provided the best balance of trade-offs in terms of the five balancing criteria. The Air Force and EPA also considered the statutory preference for treatment as a principal element, the bias against off-site treatment and disposal, and state and community acceptance.

2.13.5 Preference for Treatment as a Principal Element

Although the Selected Remedies did not satisfy the statutory preference for treatment as a principal element, this was appropriate because of the absence of principal threat wastes, and the impracticability of treating the waste and/or contamination.

2.13.6 Five-Year Review Requirements

Because the selected remedies for Sites LF-01, LF-05, LF-18, LF-22, and FT-41 resulted in hazardous substances, pollutants, or contaminants remaining on the Sites above levels that allow for unlimited use and unrestricted exposure, and in accordance with CERCLA §121(c) and NCP §300.430(f)(5)(iii)(C), a statutory review will be conducted no less often than every

5 years after initiation of RA to ensure that the remedy is, or will be, protective of human health and the environment. Langley AFB will provide a draft five-year review report to EPA and VDEQ, for review and comment only, and will consider EPA and VDEQ comments prior to issuing a final five-year review report. Langley AFB will provide a copy of the five-year review report to EPA and VDEQ and place a copy in the facility file.

2.14 Documentation of Significant Changes

This section documents significant changes to the PPs and to the ROD for sites LF-01, LF-05, LF-18, LF-22, and FT-41 only. Changes related to the 2001 PP and to the 2001 ROD relative to site LF-15 are addressed in a separate ROD.

The PP for LF-01, LF-05, LF-18, LF-22, and FT-41 was released for public comment in July 2001. The plan identified excavation and off-site disposal of waste and surface and subsurface soil as the preferred alternative for LF-01; containment (manage waste in place) as the preferred alternatives for Sites LF-05, LF-18 and LF-22; and institutional controls and sediment monitoring for Site FT-41. No comments were received during the public comment period and no significant changes were made to the preferred alternatives for LF-18 and FT-41 presented in the PP.

Following submittal to and acceptance of the PP by EPA, VDEQ, and the general public, Langley AFB issued a ROD for the preferred alternatives at LF-01, LF-05, LF-18, LF-22, and FT-41 as part of a multi-site ROD. The ROD clarified that the remedy for FT-41 included action to control sediment. EPA did not sign and VDEQ did not concur with the multi-site ROD, stating it did not adequately address LUCs for the sites at which hazardous substances would remain. While the LUC dispute was being resolved, the Air Force, EPA, and VDEQ reached an agreement to continue clean-up work at sites where there is agreement on the physical work to be done which justified implementation of the remedy at Sites LF-01, LF-05, LF-18, LF-22, and FT-41 absent a ROD containing EPA's signature or VDEQ concurrence.

During the RD for LF-01, a test pitting program showed the extent of the landfill was greater than originally anticipated; the area requiring excavation was underlain by multiple utilities; and lead concentrations in soil would require disposal as hazardous waste. Based on a new comparison of the excavation and off-site disposal alternative to the other alternatives, it was determined that containment represents the best balance of tradeoffs of all the options. The nine criteria analysis indicated the containment alternative was the least cost alternative with fewer short-term risks. The information supporting this determination is available in the Administrative Record file.

As a result of this new information, Langley AFB and EPA decided to propose containment as the new preferred alternative for waste and soil remediation at LF-01. VDEQ concurred with this decision. In compliance with statutory requirements for ensuring the public had the opportunity to comment on major remedy selection decisions, a Revised PP was prepared presenting containment as the preferred alternative for LF-01. The Revised PP was made available to the public in December 2005. No questions or comments were received in the public meeting for the Revised PP held on December 15, 2005. No written comments were received during the public comment period from December 1, 2005, through January 3,

2006. No comments were received during the second public comment period, and no significant changes were made to the proposed remedy. The Air Force issued the ROD Amendment for LF-01 in 2006.

The PP for LF-01 was revised a second time because EPA and VDEQ did not formally comment on the first Revised PP (2005) due to the ongoing 2001 ROD dispute. The second Revised PP, incorporating EPA and VDEQ formal comments, was made available to the public in February 2008. No questions or comments were received in the public meeting for the Revised PP held on February 12, 2008. No written comments were received during the public comment period from February 3 to March 4, 2008. No comments were received during the second public comment period, and no changes were made to the proposed remedy.

During the remedial design for LF-05, test pits revealed the presence of underground communication lines that would have been too costly to reroute, as well as large blocks of concrete which would have required specialized equipment for removal. The design was altered to eliminate the discretionary wetland enhancement and creation activities initially included in the design to off-set future wetland impacts anticipated at other ERP sites. Elimination of these activities resulted in a significant cost decrease for the remedy as implement. Langley AFB subsequently issued an ESD to inform the public of the decreased cost.

After completion of the containment remedy at LF-05 in May 2003, Langley AFB decided to change land use of the Site from recreational to commercial, industrial, and recreational. At the request of EPA, Langley AFB re-evaluated human health risk to address the proposed land use change. The re-evaluation showed there would be no unacceptable human health risks. Langley AFB subsequently issued an ESD to inform the public of the change in land use and resulting potential human health risks associated with commercial use of the property.

In 2005, the RD for LF-22 changed to incorporate new airfield requirements relating to ground surface elevations, slopes, and grades. The design change required demolition of the former MLB foundation to the west of LF-22 and extension of the soil cover to meet slope requirements and to attain positive drainage. These changes resulted in a significant RA cost increase. Langley AFB issued an ESD to inform the public of the increased cost.

This ROD for LF-01, LF-05, LF-18, LF-22, and FT-41 (OUs 21, 23, 35, 37, and 44, respectively) supersedes the *Final Record of Decision, Langley Air Force Base, Virginia, Operable Units 21, 23, 33, 35, 37, and 44* (Langley AFB, 2001) signed by the Air Force on December 21, 2001.

SECTION 3

Responsiveness Summary

In a PP released for public comment on July 9, 2001, Langley AFB, with the support of EPA and VDEQ, identified excavation and off-site disposal as the preferred alternative for Site LF-01; containment as the preferred alternative for Sites LF-05, LF-18, and LF-22; and institutional controls and sediment monitoring for Site FT-41. No questions or comments were received in the public meeting for the PP held on July 24, 2001. No written comments were received during the public comment period from July 9, 2001 through August 7, 2001.

Additionally, no comments were received on either of the two Revised PPs for LF-01, which were made available to the public in December 2005 to inform them of the new preferred alternative (containment) and in February 2008 to incorporate formal comments from EPA and VDEQ on the fundamental change in the remedy. No comments were received based on the announcement of the availability of the ESDs and summaries of remedy and cost modifications for Site LF-05 (Langley AFB, 2005a; Langley AFB, 2008) and LF-22 (Langley AFB, 2005b).

SECTION 4

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Tables

TABLE 1a
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
LF-01, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil at LF-01

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum	mg/kg	8.12E+03	9.95E+03	1.87E+04	K	mg/kg	9.95E+03	95% UCL-T	W-Test (1)	8.05E+03	Mean-T	W-Test (1)
Arsenic	mg/kg	1.15E+01	1.51E+01	3.02E+01		mg/kg	1.51E+01	95% UCL-T	W-Test (1)	1.13E+01	Mean-T	W-Test (1)
Chromium	mg/kg	2.32E+01	2.91E+01	5.76E+01		mg/kg	2.91E+01	95% UCL-N	W-Test (4)	2.32E+01	Mean-N	W-Test (4)
Iron [T]	mg/kg	1.68E+04	2.11E+04	4.12E+04		mg/kg	2.11E+04	95% UCL-N	W-Test (4)	1.68E+04	Mean-N	W-Test (4)
Vanadium [T]	mg/kg	3.35E+01	4.02E+01	6.94E+01		mg/kg	4.02E+01	95% UCL-T	W-Test (1)	3.33E+01	Mean-T	W-Test (1)
Organics												
Benzo(a)pyrene [T]	mg/kg	5.38E-02	7.38E-02	1.15E-01		mg/kg	7.38E-02	95% UCL-N	W-Test (4)	5.38E-02	Mean-N	W-Test (4)
Dieldrin	mg/kg	8.21E-02	3.33E+00	9.66E-01		mg/kg	9.66E-01	Max	W-Test (2)	3.26E-02	Mean-T	W-Test (1)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 1b
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
LF-01, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil at LF-01 for Supplemental RA*

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum	mg/kg	8.57E+03	1.07E+04	1.87E+04	K	mg/kg	1.07E+04	95% UCL-T	W-Test (1)	8.50E+03	Mean-T	W-Test (1)
Arsenic	mg/kg	1.17E+01	1.65E+01	3.02E+01		mg/kg	1.65E+01	95% UCL-T	W-Test (1)	1.15E+01	Mean-T	W-Test (1)
Chromium	mg/kg	2.41E+01	3.14E+01	5.76E+01		mg/kg	3.14E+01	95% UCL-T	W-Test (1)	2.38E+01	Mean-T	W-Test (1)
Iron [T]	mg/kg	1.73E+04	2.23E+04	4.12E+04		mg/kg	2.23E+04	95% UCL-N	W-Test (4)	1.73E+04	Mean-N	W-Test (4)
Vanadium [T]	mg/kg	3.45E+01	4.30E+01	6.94E+01		mg/kg	4.30E+01	95% UCL-T	W-Test (1)	3.43E+01	Mean-T	W-Test (1)
Organics												
Benzo(a)pyrene [T]	mg/kg	5.12E-02	7.21E-02	9.78E-02		mg/kg	7.21E-02	95% UCL-N	W-Test (4)	5.12E-02	Mean-N	W-Test (4)
Dieldrin	mg/kg	9.68E-02	2.58E+01	9.66E-01		mg/kg	9.66E-01	Max	W-Test (2)	4.94E-02	Mean-T	W-Test (1)

* Sample locations SS09 and SS10 have been removed from surface soil data set for Supplemental RA.

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 1c
CANCER TOXICITY DATA -- ORAL/DERMAL
LF-01, Langley Air Force Base

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	1.7E+01	90%	1.9E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	1.5E+00	95%	1.6E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benzo(a)pyrene	7.3E+00	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
bis(2-ethylhexyl)phthalate	1.4E-02	55%	2.6E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Dieldrin	1.6E+01	90%	1.8E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	9.1E+00	90%	1.0E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
(1) Adjusted $SF_d = Sf_o$ / GI Absorption Factor
(2) The date IRIS was searched.
The date of HEAST.
The date of article provided by NCEA.

NCEA - National Center for Environmental Assessment

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 1d
CANCER TOXICITY DATA -- INHALATION
LF-01, Langley Air Force Base

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	4.9E-03	$(ug/m^3)^{-1}$	3,500	1.7E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3,500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benzo(a)pyrene	8.8E-04	$(ug/m^3)^{-1}$	3,500	3.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	11/18/94, 10/01/00
bis(2-ethylhexyl)phthalate	4.0E-06	$(ug/m^3)^{-1}$	3,500	1.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	09/20/95, 10/01/00
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	1.2E-02	$(ug/m^3)^{-1}$	3,500	4.2E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Dieldrin	4.6E-03	$(ug/m^3)^{-1}$	3,500	1.6E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	2.6E-03	$(ug/m^3)^{-1}$	3,500	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
NCEA - National Center for Environmental Assessment

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor=
70kg x 1/20m3/day x 1000ug/mg
(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 1e
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
LF-01, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Aldrin	Chronic	3.0E-05	mg/kg-day	90%	2.7E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Aluminum	Chronic	1.0E+00	mg/kg-day	27%	2.7E-01	mg/kg-day	Dev. NS	100	NCEA	08/26/96
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	skin/vascular	3	IRIS	10/01/00
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bis(2-ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	55%	1.1E-02	mg/kg-day	liver	1000	IRIS	10/01/00
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	Chronic	1.5E+00	mg/kg-day	1%	1.5E-02	mg/kg-day	spleen/liver	1000	IRIS, NCEA	10/01/00, 12/10/98
Chromium VI	Chronic	3.0E-03	mg/kg-day	1%	3.0E-05	mg/kg-day	fetus/bone marrow/GI tract/liver	900	IRIS	10/01/00
Dieldrin	Chronic	5.0E-05	mg/kg-day	90%	4.5E-05	mg/kg-day	liver	100	IRIS	10/01/00
Heptachlor Epoxide	Chronic	1.3E-05	mg/kg-day	90%	1.2E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Iron	Chronic	3.0E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	blood/liver/GI tract	1	NCEA	01/05/99
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	Chronic	1.4E-01	mg/kg-day	5%	7.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Manganese (non-food)	Chronic	2.0E-02	mg/kg-day	5%	1.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	Chronic	7.0E-05	mg/kg-day	100%	7.0E-05	mg/kg-day	blood/liver	3000	OTHER	10/01/98
Vanadium	Chronic	7.0E-03	mg/kg-day	2%	1.4E-04	mg/kg-day	GI tract/nervous system/kidney/bone marrow/liver	100	HEAST	07/31/97

N/A = Not Available

(1) Refer to RAGS, Part A

(2) Adjusted Dermal $RfD_{chemical}$ = Oral Chronic RfDchemical x GI Absorption $Factor_{chemical}$

(3) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
N/A = Not Available
NCEA - National Center for Environmental Assessment
OTHER - EPA Region III RBC Table, Oct. 1998.

TABLE 1f

NON-CANCER TOXICITY DATA -- INHALATION

LF-01, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
Aldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	5.0E-03	mg/m^3	1.0E-03	mg/kg-day	Dev. NS	300	NCEA	06/20/97
Arsenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bis(2-ethylhexyl)phthalate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium VI	Chronic	1.0E-04	mg/m^3	2.9E-05	mg/kg-day	respiratory tract	300	IRIS	10/01/00
Dieldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor Epoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (non-food)	Chronic	5.0E-05	mg/m^3	1.4E-05	mg/kg-day	CNS	1000	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Available

(1) Doses were derived from inhalation reference concentrations (mg/m^3) from IRIS and HEAST by multiplying a conversion factor of 20 m^3/day per 70 kg by the reference concentraions.

(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

CNS - Central Nervous System

Dev. NS - Developmental nervous system

GI tract - Gastrointestinal tract

IRIS - Integrated Risk Information System

HEAST - Health Effects Assessment Summary Tables

N/A = Not Available

NCEA - National Center for Environmental Assessment

TABLE 1g
RISK ASSESSMENT SUMMARY (SOIL)
REASONABLE MAXIMUM EXPOSURE
LF-01, Langley Air Force Base

Chemical Risk Driver	Cancer Risk				Hazard Quotient (HQ)			
	Inhalation	Ingestion	Dermal	Total	Inhalation	Ingestion	Dermal	Total
Groundskeeper								
Chromium	1.70E-06	NC	NC	2.E-06	<0.1	<0.1	<0.1	<0.1
Subtotal	2.E-06	NC	NC	2.E-06	<0.1	<0.1	<0.1	<0.1
Cumulative Total[a]	2.E-06	1.E-06	7.E-06	4.E-06	0.04	0.009	0.01	0.06
Child Resident [b]								
Aluminum	NA	NA	NA	NA	NA	0.1	<0.1	0.1
Arsenic	NA	NA	NA	NA	NA	0.7	<0.1	0.7
Chromium	NA	NA	NA	NA	NA	0.1	0.2	0.3
Dieldrin	NA	NA	NA	NA	NA	0.2	<0.1	0.2
Subtotal	NA	NA	NA	NA	NA	1.1	0.2	1
Cumulative Total[a]	NA	NA	NA	NA	NA	1.2	0.4	2
Adult Resident [b,c]								
Arsenic	NA	3.8E-05	5.6E-06	4E-05	NA	<0.1	<0.1	<0.1
Dieldrin	NA	2E-05	2.4E-05	4E-05	NA	<0.1	<0.1	<0.1
Chromium	NA	NC	NC	NC	NA	<0.1	0.1	0.1
Subtotal	NA	6.E-05	2.E-05	8E-05	NA	<0.1	0.1	0.1
Cumulative Total[a]	NA	6.E-05	2.E-05	8E-05	NA	0.1	0.2	0.3

[a] Cumulative total includes risk and hazard values from all analytes for a receptor in this medium

[b] The surface soil results for the child and adult resident were derived using a modified surface soil data set (see Section 6.6 of the RI report)

[c] Cancer risk results for the resident are for age-adjusted exposure. Separate cancer risk calculations for the child and adult resident are in the RI report, Appendix G5A.

NA = Not applicable; pathway not evaluated

NC = Not calculated; chemical-specific factor(s) not available

TABLE 1h
RISK ASSESSMENT SUMMARY
TARGET ORGAN ANALYSIS
LF-01, Langley Air Force Base

Scenario Timeframe: Future
Receptor Population: Residen
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Non-Carcinogenic Hazard Quotient				
				Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at LF-01	Aluminum	Developmental Nervous system	0.14	--	0.0093	0.15
			Arsenic	Skin/Vascular System	0.70	--	0.043	0.75
			Chromium	Fetus, Bone Marrow, GI Tract, Liver	0.13	--	0.24	0.38
			Dieldrin	Liver	0.25	--	0.050	0.30
			(Total)		1.2	--	0.35	1.6
							Total Hazard Index Across Surface Soil	2

Total Hazard Index Across All Media and All Exposure Routes	2

Total liver HI =	0.7
Total nervous system HI =	0.1
Total skin HI =	0.7
Total Vascular System HI =	0.7
Total Fetus HI =	0.4
Total Bone Marrow HI =	0.4
Total GI tract HI =	0.4

TABLE 1i
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-01, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Utility Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil[b]	Surface Soil	Surface Soil at LF-01	Aluminum	NA	NA	NA	NA	Aluminum	Nervous system	4.74E-03	1.89E-01	1.40E-03	1.95E-01
			Arsenic	1.27E-08	5.10E-09	3.41E-09	2.12E-08	Arsenic	Skin	2.40E-02	NA	6.48E-03	3.05E-02
			Chromium	NA	2.67E-08	NA	2.67E-08	Chromium VI	GI tract	4.62E-03	1.95E-02	3.70E-02	6.11E-02
			Dieldrin	8.64E-09	3.46E-10	7.68E-09	1.67E-08	Dieldrin	Liver	9.20E-03	NA	8.18E-03	1.74E-02
			(Total)	2.13E-08	3.21E-08	1.11E-08	6.46E-08	(Total)		4.26E-02	2.09E-01	5.31E-02	3.04E-01
						Total Risk Across Surface Soil	6.E-08					Total Hazard Index Across Surface Soil	3.E-01

Total liver HI =	2.E-02
Total nervous system HI =	2.E-02
Total skin HI =	3.E-02
Total GI tract HI =	6.E-02

[a] Cancer risk and noncancer hazard estimates adapted from data for the groundskeeper compiled on pages G3-50 and -51, and pages G3-58 and -59 in Appendix G3 of the RI report for LF-01.

[b] Cancer risk and noncancer hazard estimates adapted from data for the groundskeeper compiled on pages G3-84 through -89 in Appendix G3 of the RI report for LF-01.

Table 1j
Occurrence, Distribution, and Selection
of Chemicals of Ecological Concern
LF-01, Langley Air Force Base

Exposure Medium: Surface Soil								
Chemical of Concern	**Minimum Concentration [1] (ppm)**	**Maximum Concentration [1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean [2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source [3]**	**COPEC[4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	4.32E+03	1.87E+04	8.12E+03	-	8.82E+03	1.00E+00	Region III BTAG	Y
Arsenic	4.91E+00	3.02E+01	1.15E+01	-	8.99E+00	3.28E+02	Region III BTAG	N
Barium	1.07E+01	1.62E+02	3.57E+01	-	3.42E+01	4.40E+02	Region III BTAG	N
Beryllium	3.74E-01	1.10E+00	5.50E-01	-	6.15E-01	2.00E-02	Region III BTAG	Y
Cadmium	8.05E-02	2.69E-01	1.35E-01	-	2.00E-01	2.50E+00	Region III BTAG	N
Calcium	4.76E+02	7.90E+03	2.20E+03	-	2.52E+03	-	Region III BTAG	Y
Chromium	1.41E+01	5.76E+01	2.32E+01	-	1.63E+01	7.50E-03	Region III BTAG	Y
Cobalt	1.72E+00	7.30E+00	3.28E+00	-	3.08E+00	2.00E+02	Region III BTAG	N
Copper	2.46E+00	8.80E+00	4.71E+00	-	3.97E+00	1.50E+01	Region III BTAG	N
Iron	9.87E+03	4.12E+04	1.68E+04	-	1.91E+04	1.20E+01	Region III BTAG	Y
Lead	8.42E+00	7.12E+01	2.52E+01	-	3.77E+01	1.00E-02	Region III BTAG	Y
Magnesium	8.71E+02	3.52E+03	1.60E+03	-	7.60E+02	4.40E+03	Region III BTAG	N
Manganese	2.63E+01	1.05E+02	6.28E+01	-	1.16E+02	3.30E+02	Region III BTAG	N
Nickel	4.20E+00	1.38E+01	6.80E+00	-	4.61E+00	2.00E+00	Region III BTAG	Y
Potassium	7.92E+02	3.42E+03	1.61E+03	-	4.68E+02	-	Region III BTAG	Y
Sodium	5.33E+01	1.81E+03	5.93E+02	-	9.20E+01	-	Region III BTAG	Y
Vanadium	1.73E+01	6.94E+01	3.35E+01	-	3.43E+01	5.80E+01	Region III BTAG	Y
Zinc	2.04E+01	9.10E+01	3.76E+01	-	2.72E+01	1.00E+01	Region III BTAG	Y
Volatile Organic Compounds								
Methylene chloride	1.98E-03	1.98E-03	7.79E-04	-	-	3.00E-01	Region III BTAG	N
Semivolatile Organic Compounds								
Benzo(a)anthracene	3.08E-02	1.24E-01	4.13E-02	-	5.37E-02	1.00E-01	Region III BTAG	Y
Benzo(a)pyrene	5.19E-02	1.15E-01	5.38E-02	-	9.18E-02	1.00E-01	Region III BTAG	Y
Benzo(b)fluoranthene	4.34E-02	1.90E-01	8.59E-02	-	1.03E-01	1.00E-01	Region III BTAG	Y
Benzo(g,h,i)perylene	2.91E-02	6.22E-02	3.58E-02	-	6.31E-02	1.00E-01	Region III BTAG	N
Benzo(k)fluoranthene	4.34E-02	1.90E-01	8.32E-02	-	9.66E-02	1.00E-01	Region III BTAG	Y
Chrysene	3.39E-02	1.30E-01	5.51E-02	-	7.21E-02	1.00E-01	Region III BTAG	Y
Fluoranthene	2.51E-02	2.51E-01	7.34E-02	-	8.81E-02	1.00E-01	Region III BTAG	Y
Indeno(1,2,3-cd)pyrene	2.73E-02	5.50E-02	3.06E-02	-	5.50E-02	1.00E-01	Region III BTAG	N
Phenanthrene	2.81E-02	1.65E-01	4.90E-02	-	7.27E-02	1.00E-01	Region III BTAG	Y
Pyrene	4.41E-02	2.29E-01	6.93E-02	-	8.73E-02	1.00E-01	Region III BTAG	Y
bis(2-Ethylhexyl)phthalate	9.67E-02	1.42E-01	5.81E-02	-	-	-	Region III BTAG	Y
Pesticides & PCBs								
4,4'-DDD	2.20E-03	6.13E-03	4.12E-03	-	1.59E-03	1.00E-01	Region III BTAG	N
4,4'-DDE	1.88E-03	4.55E-02	1.26E-02	-	1.05E-02	1.00E-01	Region III BTAG	N
4,4'-DDT	2.05E-03	1.13E-02	5.87E-03	-	8.08E-03	1.00E-01	Region III BTAG	N
Dieldrin	4.45E-04	9.66E-01	8.21E-02	-	7.86E-03	-	Region III BTAG	Y
Endrin Ketone	3.84E-03	1.50E-02	3.96E-03	-	2.67E-03	-	Region III BTAG	Y
Heptachlor epoxide	1.81E-02	1.81E-02	2.39E-03	-	-	1.00E-01	Region III BTAG	N

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels, *U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 1k
Ecological Exposure
Pathways of Concern
Operable Unit 21 (LF-01)
Langley Air Force Base, Virginia

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/Threatened Special Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Soil Invertebrate Communities	N	Ingestion, respiration, and direct contact with chemcials in soil	Maintain species diversity and nutrient cycling.	A 14-day and 28-day toxicity/bioaccumulation study was conducted with earthworm *Eisenia foetida*. The endpoint of the test was mortality and COPEC tissue concentration.
	N	Small Insectivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Large Omnivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Insectivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to worm-eating birds that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
		Carnivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to carnivorous birds that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.

Table 1l
Mean LOAEL Hazard Quotients >1
for Ecological Receptors
Operable Unit 21 (LF-01)
Langley Air Force Base

Receptor Name	Exposure Medium	Analyte	Hazard Quotient[1]	COC?	Rationale
Earthworm	Surface Soil	Heptachlor epoxide	3.98E+00	No	Low detection frequency (1/13); detected concentration less than BTAG screening value
Deer Mouse	Surface Soil [2]	Aluminum	1.68E+01	No	Concentrations consistent with background conditions; overestimated bioavailability

Notes:
1 - Hazard Quotients presented are based on mean COC concentrations values, using Langley site-specific toxicological data
2 - The deer mouse has been exposed to surface water as well as soil.

TABLE 2a
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
LF-05, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil at LF-05

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum [T]	mg/kg	6.69E+03	8.87E+03	1.47E+04		mg/kg	8.87E+03	95% UCL-N	W-Test (4)	6.69E+03	Mean-N	W-Test (4)
Arsenic [T]	mg/kg	7.15E+00	9.81E+00	1.28E+01		mg/kg	9.81E+00	95% UCL-T	W-Test (1)	7.11E+00	Mean-T	W-Test (1)
Chromium	mg/kg	1.96E+01	2.18E+01	2.60E+01		mg/kg	2.18E+01	95% UCL-N	W-Test (3)	1.96E+01	Mean-N	W-Test (3)
Iron [T]	mg/kg	1.53E+04	1.75E+04	2.19E+04		mg/kg	1.75E+04	95% UCL-T	W-Test (1)	1.52E+04	Mean-T	W-Test (1)
Thallium	mg/kg	3.34E-01	5.06E-01	7.56E-01		mg/kg	5.06E-01	95% UCL-N	W-Test (3)	3.34E-01	Mean-N	W-Test (3)
Vanadium [T]	mg/kg	3.02E+01	4.51E+01	5.60E+01		mg/kg	4.51E+01	95% UCL-T	W-Test (1)	3.00E+01	Mean-T	W-Test (1)
Organics												
Benzo(a)pyrene	mg/kg	6.62E-02	1.17E-01	2.31E-01		mg/kg	1.17E-01	95% UCL-N	W-Test (4)	6.62E-02	Mean-N	W-Test (4)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 2b

CANCER TOXICITY DATA -- ORAL/DERMAL

LF-05, Langley Air Force Base

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	1.7E+01	90%	1.9E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	1.5E+00	95%	1.6E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Barium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Benz(a)anthracene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/00
Benz(a)pyrene	7.3E+00	N/A	N/A	N/A	B2	IRIS	10/01/00
Benzo(b)flouranthene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/00
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Dibenz(a,h)anthracene	7.3E+00	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/00
1,2-Dicholoroethane	9.1E-02	90%	1.0E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Dieldrin	1.6E+01	90%	1.8E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor	4.5E+00	90%	5.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	9.1E+00	90%	1.0E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	D	IRIS	N/A
alpha-BHC	6.3E+00	90%	7.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
alpha-Chlordane (3)	3.5E-01	90%	3.9E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

N/A= Not Available

NCEA - National Center for Environmental Assessment

(1) Adjusted $SF_d = Sf_o$ / GI Absorption Factor

(2) The date IRIS was searched.

The date of HEAST.

The date of article provided by NCEA.

(3) Values listed for chlordane, not specific to isomer.

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known/Likely

Cannot be Determined

Not Likely

TABLE 2c
CANCER TOXICITY DATA -- INHALATION
LF-05, Langley Air Force Base

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	4.9E-03	$(ug/m^3)^{-1}$	3500	1.7E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Barium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Benz(a)pyrene	8.8E-04	$(ug/m^3)^{-1}$	3500	3.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	11/18/94, 12/01/98
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	1.2E-02	$(ug/m^3)^{-1}$	3500	4.1E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
1,2-Dichloroethane	2.6E-05	$(ug/m^3)^{-1}$	3500	9.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Dieldrin	4.6E-03	$(ug/m^3)^{-1}$	3500	1.6E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor	1.3E-03	$(ug/m^3)^{-1}$	3500	4.5E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	2.6E-03	$(ug/m^3)^{-1}$	3500	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
alpha-BHC	1.8E-03	$(ug/m^3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
alpha-Chlordane (3)	1.0E-04	$(ug/m^3)^{-1}$	3500	3.5E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
NCEA - National Center for Environmental Assessment

(1) Adjusted $SF_d = Sf_o$ / GI Absorption Factor
(2) The date IRIS was searched.
The date of HEAST.
The date of article provided by NCEA.
(3) Values listed for chlordane, not specific to isomer.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 2d

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

LF-05, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Aldrin	Chronic	3.0E-05	mg/kg-day	90%	2.7E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Aluminum	Chronic	1.0E+00	mg/kg-day	27%	2.7E-01	mg/kg-day	Dev. NS	100	NCEA	08/26/96
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	skin/vascular	3	IRIS	10/01/00
Barium	Chronic	7.0E-02	mg/kg-day	100%	7.0E-02	mg/kg-day	kidney	3	IRIS	10/01/00
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benz(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calcium	N/A	N/A	N/A	NA	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	Chronic	1.5E+00	mg/kg-day	1%	1.5E-02	mg/kg-day	spleen/liver	1000	IRIS, NCEA	10/01/00, 12/10/98
Chromium VI	Chronic	3.0E-03	mg/kg-day	1%	3.0E-05	mg/kg-day	GI tract/fetus/bone marrow/liver	900	IRIS	10/01/00
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dicholoroethane	Chronic	3.0E-02	mg/kg-day	90%	2.7E-02	mg/kg-day	Nervous system/GI tract/thymus	1000	NCEA	04/28/97
Dieldrin	Chronic	5.0E-05	mg/kg-day	90%	4.5E-05	mg/kg-day	liver	100	IRIS	10/01/00
Heptachlor	Chronic	5.0E-04	mg/kg-day	90%	4.5E-04	mg/kg-day	liver	300	IRIS	10/01/00
Heptachlor Epoxide	Chronic	1.3E-05	mg/kg-day	90%	1.2E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	Chronic	3.0E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	blood/liver/GI tract	1	NCEA	01/05/99
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	Chronic	1.4E-01	mg/kg-day	5%	7.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Manganese (non-food)	Chronic	2.0E-02	mg/kg-day	5%	1.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	Chronic	7.0E-05	mg/kg-day	100%	7.0E-05	mg/kg-day	blood/liver	3000	OTHER	10/01/98
Vanadium	Chronic	7.0E-03	mg/kg-day	2%	1.4E-04	mg/kg-day	GI tract/nervous system/kidney/bone marrow/liver	100	HEAST	07/31/97
alpha-BHC	N/A	N/A	N/A	NA	N/A	N/A	N/A	N/A	N/A	N/A
alpha-Chlordane (4)	Chronic	5.0E-04	mg/kg-day	90%	4.5E-04	mg/kg-day	liver	300	IRIS	10/01/00

(1) Refer to RAGS, Part A

(2) Adjusted Dermal $RfD_{chemical}$ = Oral Chronic RfDchemical x GI Absorption $Factor_{chemical}$

(3) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(4) Values listed for chlordane, not specific to isomer.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
N/A = Not Available
NCEA - National Center for Environmental Assessment
OTHER - EPA Region III RBC Table, Oct. 1998

TABLE 2e
NON-CANCER TOXICITY DATA -- INHALATION
LF-05, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
Aldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	5.0E-03	mg/m^3	1.0E-03	mg/kg-day	Dev. NS	300	NCEA	06/20/97
Arsenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barium	Chronic	5.0E-04	mg/m^3	1.4E-04	mg/kg-day	fetus	1000	HEAST	07/31/97
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benz(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calcium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium VI	Chronic	1.0E-04	mg/m^3	2.9E-05	mg/kg-day	respiratory tract	300	IRIS	10/01/00
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dichloroethane	Chronic	5.0E-03	mg/m^3	1.4E-03	mg/kg-day	GI tract/liver/gallbladder	3000	NCEA	04/05/93
Dieldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor Epoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (non-food)	Chronic	5.0E-05	mg/m^3	1.4E-05	mg/kg-day	CNS	1000	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
alpha-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
alpha-Chlordane (3)	Chronic	7.0E-04	mg/m^3	2.0E-04	mg/kg-day	liver	1000	IRIS	10/01/00

N/A = Not Available

(1) Doses were derived from inhalation reference concentrations (mg/m^3) from IRIS and HEAST by multiplying a conversion factor of 20 m^3/day per 70 kg by the reference concentraions.

(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(3) Values listed for chlordane, not specific to isomer.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
NCEA - National Center for Environmental Assessment
OTHER - EPA Region III RBC Table, Oct. 1998

TABLE 2f
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-05, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Other Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at LF-05	Chromium	--	--	--	--	Chromium	GI tract/fetus/bone marrow/liver	0.0004	--	0.008	0.008
			(Total)	--	--	--	--	(Total)		0.0004	--	0.008	0.008
	Air	Ambient air above LF-05 (vapors and particulates)	Chromium	--	1.3E-06	--	1E-06	Chromium	respiratory tract	--	0.003	--	0.003
			(Total)	--	1E-06	--	1E-06	(Total)		--	0.003	--	0.003
						Total Risk Across Surface Soil	1E-06					Total Hazard Index Across Surface Soil	0.01

Other Worker = Groundskeeper

Total Risk Across All Media and All Exposure Routes: 1E-06

Total Hazard Index Across All Media and All Exposure Routes: 0.01

Note: The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.

Total bone marrow HI =	0.008
Total fetus HI =	0.008
Total GI tract HI =	0.008
Total liver HI =	0.008
Total respiratory tract HI =	0.003

TABLE 2g
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-05, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at LF-05	Chromium	--	--	--	--	Chromium	liver/fetus/bone marrow/GI tract	0.01	--	0.03	0.04
			(Total)	--	--	--	--	(Total)		0.01	--	0.03	0.04
	Air	Ambient air above LF-05 (vapors and particulates)	Chromium	--	1.5E-06	--	2E-06	Chromium	respiratory tract	--	0.09	--	0.09
			(Total)	--	2E-06	--	2E-06	(Total)		--	0.09	--	0.09
						Total Risk Across Surface Soil	2E-06					Total Hazard Index Across Surface Soil	0.1

Total Risk Across All Media and All Exposure Routes: 2E-06

Total Hazard Index Across All Media and All Exposure Routes: 0.1

Total bone marrow HI = 0.04
Total fetus HI = 0.04
Total GI tract HI = 0.04
Total liver HI = 0.04
Total respiratory tract HI = 0.09

Note: The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.

TABLE 2h
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-05, Langley Air Force Base

Scenario Timeframe: Future
Receptor Population: Trespasser
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	**Inorganics**					**Inorganics**					
			Chromium (Total)	--	--	--	--	Chromium (Total)	GI tract/fetus/bone marrow/liver	0.093	--	0.1696	0.26
			Thallium	--	--	--	--	Thallium	blood/liver	0.092	--	0.002	0.09
			Organics					**Organics**					
			Benzo(a)pyrene	9.4E-07	--	1.7E-07	1.E-06	Benzo(a)pyrene	--	--	--	--	--
			(Total)	9.4E-07	--	1.7E-07	1.E-06	(Total)		0.185	--	0.17	0.4
	Air	Ambient Air	**Inorganics**					**Inorganics**					
			Chromioum (Total)	--	2.1E-08	--	2.1E-08	Chromioum (Total)	respiratory tract	--	0.0002	--	0.0002
			Thallium	--	--	--	--	Thallium	--	--	--	--	--
			Organics					**Organics**					
			Benzo(a)pyrene	--	8.6E-12	--	8.6E-12	Benzo(a)pyrene	--	--	--	--	--
			(Total)	--	2.1E-08	--	2.E-08	(Total)		--	0.0002	--	0.0002

Total Risk Across Surface Soil: 1.E-06

Total Hazard Index Across Surface Soil: 0.4

Total Risk Across All Media and All Exposure Routes: 1.E-06

Total Hazard Index Across All Media and All Exposure Routes: 0.4

Total blood HI= 0.09
Total bone marrow HI = 0.26
Total fetus HI = 0.26
Total GI tract HI = 0.26
Total liver HI = 0.36
Total respiratory tract HI = 0.0002

TABLE 2i
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-05, Langley Air Force Base

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil[b]	Surface Soil	Surface Soil at LF-05	Chromium	NA	2.5E-09	NA	2.5E-09	Chromium	Fetus, Bone Marrow, GI Tract, Liver	0.017	0.00014	0.016	0.033
			Thallium	NA	NA	NA	N/A	Thallium	blood, liver	0.017	--	0.0004	0.017
			Benzo(a)pyrene	5.7E-08	1.5E-10	1.8E-08	7.5E-08	Benzo(a)pyrene		N/A	N/A	N/A	N/A
			(Total)	5.7E-08	2.7E-09	1.8E-08	7.8E-08	(Total)		0.034	0.00014	0.016	0.051
						Total Risk Across Surface Soil	8.E-08					Total Hazard Index Across Surface Soil	0.05

Total Risk Across All Media and All Exposure Routes: 8E-08

Total Hazard Index Across All Media and All Exposure Routes: 0.05

TABLE 2j
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-05, Langley Air Force Base

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil[b]	Surface Soil	Surface Soil at LF-05	Chromium	NA	5.0E-08	NA	5.0E-08	Chromium	Fetus, Bone Marrow, GI Tract, Liver	0.01	0.0001	0.016	0.026
			Thallium	NA	NA	NA	N/A	Thallium	blood, liver	0.01	--	0.0004	0.010
			Benzo(a)pyrene	8.0E-07	3.0E-09	4.0E-07	1.2E-06	Benzo(a)pyrene		N/A	N/A	N/A	N/A
			(Total)	8.0E-07	5.3E-08	4.0E-07	1.3E-06	(Total)		0.02	0.0001	0.016	0.037
							Total Risk Across Surface Soil	1.E-06					Total Hazard Index Across Surface Soil	0.04

Total Risk Across All Media and All Exposure Routes 1E-06

Total Hazard Index Across All Media and All Exposure Routes 0.04

TABLE 2k
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-05, Langley Air Force Base

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil[b]	Surface Soil	Surface Soil at LF-05	Chromium	NA	3.0E-08	NA	3.0E-08	Chromium	Fetus, Bone Marrow, GI Tract, Liver	0.093	0.0003	0.1	0.19
			Thallium	NA	NA	NA	N/A	Thallium	blood, liver	0.092	--	0.002	0.094
			Benzo(a)pyrene	1.8E-06	2.0E-09	6.7E-07	2.5E-06	Benzo(a)pyrene		N/A	N/A	N/A	N/A
			(Total)	1.8E-06	3.2E-08	6.7E-07	2.5E-06	(Total)		0.19	0.0003	0.1	0.29
						Total Risk Across Surface Soil	3.E-06					Total Hazard Index Across Surface Soil	0.3

Total Risk Across All Media and All Exposure Routes: 3E-06

Total Hazard Index Across All Media and All Exposure Routes: 0.3

Table 2I
Occurrence, Distribution, and Selection of
Chemicals of Ecological Concern
LF-05, Langley Air Force Base

Exposure Medium: Surface Soil								
Chemical of Concern	**Minimum Concentration [1] (ppm)**	**Maximum Concentration [1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean [2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source [3]**	**COPEC[4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	4.85E+03	1.47E+04	6.69E+03	-	8.82E+03	1.00E+00	Region III BTAG	Y
Arsenic	4.62E+00	1.28E+01	7.15E+00	-	8.99E+00	3.28E+02	Region III BTAG	N
Barium	1.50E+01	4.37E+01	1.97E+01	-	3.42E+01	4.40E+02	Region III BTAG	N
Beryllium	5.46E-01	7.97E-01	6.08E-01	-	6.15E-01	2.00E-02	Region III BTAG	Y
Cadmium	6.78E-02	6.78E-02	1.69E-02	-	2.00E-01	2.50E+00	Region III BTAG	N
Calcium	4.03E+03	4.81E+04	3.39E+04	-	2.52E+03	-	Region III BTAG	Y
Chromium	1.52E+01	2.60E+01	1.96E+01	-	1.63E+01	7.50E-03	Region III BTAG	Y
Cobalt	3.05E+00	4.07E+00	3.56E+00	-	3.08E+00	2.00E+02	Region III BTAG	N
Copper	2.55E+00	6.11E+00	3.62E+00	-	3.97E+00	1.50E+01	Region III BTAG	N
Iron	1.24E+04	2.19E+04	1.53E+04	-	1.91E+04	1.20E+01	Region III BTAG	Y
Lead	5.66E+00	3.08E+01	1.48E+01	-	3.77E+01	1.00E-02	Region III BTAG	Y
Magnesium	1.31E+03	2.15E+03	1.74E+03	-	7.60E+02	4.40E+03	Region III BTAG	N
Manganese	9.28E+01	1.14E+02	1.02E+02	-	1.16E+02	3.30E+02	Region III BTAG	N
Mercury	8.40E-03	2.88E-02	1.46E-02	-	3.20E-02	5.80E-02	Region III BTAG	N
Nickel	6.47E+00	1.08E+01	7.27E+00	-	4.61E+00	2.00E+00	Region III BTAG	Y
Potassium	1.10E+03	1.74E+03	1.53E+03	-	4.68E+02	-	Region III BTAG	Y
Selenium	2.37E-01	2.37E-01	1.18E-01	-	-	1.80E+00	Region III BTAG	N
Sodium	1.93E+02	9.11E+02	4.36E+02	-	9.20E+01	-	Region III BTAG	Y
Thallium	2.73E-01	7.56E-01	3.34E-01	-	1.64E-01	1.00E-03	Region III BTAG	Y
Vanadium	1.63E+01	5.60E+01	3.02E+01	-	3.43E+01	5.80E+01	Region III BTAG	N
Zinc	2.80E+01	5.11E+01	3.31E+01	-	2.72E+01	1.00E+01	Region III BTAG	Y
Semivolatile Organic Compounds								
Anthracene	7.97E-02	7.97E-02	2.28E-02	-	4.53E-02	1.00E-01	Region III BTAG	N
Benzo(a)anthracene	8.23E-02	2.46E-01	5.93E-02	-	5.37E-02	1.00E-01	Region III BTAG	Y
Benzo(a)pyrene	9.68E-02	2.31E-01	6.62E-02	-	9.18E-02	1.00E-01	Region III BTAG	Y
Benzo(b)fluoranthene	1.51E-01	3.99E-01	1.02E-01	-	1.03E-01	1.00E-01	Region III BTAG	Y
Benzo(g,h,i)perylene	4.90E-02	1.11E-01	3.78E-02	-	6.31E-02	1.00E-01	Region III BTAG	Y
Benzo(k)fluoranthene	1.51E-01	3.99E-01	1.04E-01	-	9.66E-02	1.00E-01	Region III BTAG	Y
Carbazole	4.00E-02	4.00E-02	5.00E-03	-	7.00E-03	-	Region III BTAG	Y
Chrysene	9.76E-02	2.77E-01	7.03E-02	-	7.21E-02	1.00E-01	Region III BTAG	Y
Dibenz(a,h)anthracene	2.92E-02	2.92E-02	1.60E-02	-	4.30E-02	1.00E-01	Region III BTAG	N
Fluoranthene	2.18E-02	5.95E-01	1.41E-01	-	8.81E-02	1.00E-01	Region III BTAG	Y
Fluorene	4.10E-02	4.10E-02	2.32E-02	-	-	1.00E-01	Region III BTAG	N
Indeno(1,2,3-cd)pyrene	4.55E-02	1.11E-01	3.43E-02	-	5.50E-02	1.00E-01	Region III BTAG	Y
Phenanthrene	9.95E-02	3.89E-01	8.75E-02	-	7.27E-02	1.00E-01	Region III BTAG	Y
Pyrene	3.35E-02	5.02E-01	1.22E-01	-	8.73E-02	1.00E-01	Region III BTAG	Y
Pesticides & PCBs								
4,4'-DDE	6.62E-04	6.32E-03	1.65E-03	-	1.05E-02	1.00E-01	Region III BTAG	N
4,4'-DDT	1.15E-02	1.15E-02	1.94E-03	-	8.08E-03	1.00E-01	Region III BTAG	N
Aldrin	8.98E-04	1.35E-03	5.66E-04	-	8.44E-04	1.00E-01	Region III BTAG	N
Dieldrin	1.08E-03	9.12E-03	2.68E-03	-	7.86E-03	-	Region III BTAG	Y
Endosulfan II	2.04E-03	2.04E-03	6.95E-04	-	-	-	Region III BTAG	Y
Endosulfan Sulfate	2.89E-03	2.89E-03	8.49E-04	-	-	-	Region III BTAG	Y
Endrin	1.35E-03	1.35E-03	1.08E-03	-	-	1.00E-01	Region III BTAG	N
Heptachlor epoxide	3.16E-04	3.16E-04	2.84E-04	-	-	1.00E-01	Region III BTAG	N
PCB-1254	5.63E-02	5.63E-02	9.26E-03	-	-	-	Region III BTAG	Y
gamma-BHC(Lindane)	6.57E-04	4.09E-03	6.83E-04	-	-	1.00E-01	Region III BTAG	N
gamma-Chlordane	9.41E-04	9.41E-04	3.69E-04	-	-	1.00E-01	Region III BTAG	N

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels,*U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 2m
Ecological Exposure
Pathways of Concern
Operable Unit 23 (LF-05)
Langley Air Force Base, Virginia

Exposure Medium	Environment Flag (Y or N)	Receptor	Endangered/Threatened Special Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Soil Invertebrate Communities	N	Ingestion, respiration, and direct contact with chemcials in soil	Maintain species diversity and nutrient cycling.	A 14-day and 28-day toxicity/bioaccumulation study was conducted with earthworm *Eisenia foetida* . The endpoint of the test was mortality and COPEC tissue concentration.
	N	Small Insectivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Large Omnivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Insectivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to worm-eating birds that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
		Carnivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to carnivorous birds that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.

Table 2n
Mean LOAEL Hazard Quotients >1
for Ecological Receptors
Operable Unit 23 (LF-05)
Langley Air Force Base

Receptor Name	Exposure Medium	Analyte	Hazard Quotient[1]	COC?	Rationale
Deer Mouse	Surface Soil	Aluminum	4.00E+01	No	Concentrations consistent with background conditions; overestimated bioavailability
		Arsenic	8.91E+00	No	Concentrations consistent with background conditions
		Barium	2.11E+01	No	Concentrations consistent with background conditions
		Calcium	1.59E+00	No	Essential nutrient
		Magnesium	1.24E+01	No	Concentrations consistent with background conditions; essential nutrient
		Vanadium	5.16E+00	No	Concentrations consistent with background conditions
American Robin	Surface Soil [2]	Magnesium	9.62E+00	No	Concentrations consistent with background conditions; essential nutrient

Notes:
1 - Hazard Quotients presented are based on mean COC concentrations and LOAEL values, using Langley site-specific
2 - American robin has been exposed to surface water as well as soil.

TABLE 3a
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
LF-18, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil at LF-18

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum [T]	mg/kg	4.60E+03	6.02E+03	8.63E+03		mg/kg	6.02E+03	95% UCL-N	W-Test (3)	4.60E+03	Mean-N	W-Test (3)
Arsenic [T]	mg/kg	6.71E+00	1.05E+01	1.77E+01		mg/kg	1.05E+01	95% UCL-N	W-Test (3)	6.71E+00	Mean-N	W-Test (3)
Chromium [T]	mg/kg	1.10E+01	2.60E+01	3.17E+01		mg/kg	2.60E+01	95% UCL-T	W-Test (1)	1.09E+01	Mean-T	W-Test (1)
Iron [T]	mg/kg	1.15E+04	1.63E+04	2.65E+04		mg/kg	1.63E+04	95% UCL-N	W-Test (3)	1.15E+04	Mean-N	W-Test (3)
Manganese	mg/kg	1.04E+02	2.55E+02	3.40E+02		mg/kg	2.55E+02	95% UCL-T	W-Test (1)	1.00E+02	Mean-T	W-Test (1)
Organics												
Benzo(a)anthracene	mg/kg	6.88E-01	1.87E+00	5.05E+00		mg/kg	1.87E+00	95% UCL-N	W-Test (4)	6.88E-01	Mean-N	W-Test (4)
Benzo(a)pyrene	mg/kg	8.27E-01	2.21E+00	5.94E+00		mg/kg	2.21E+00	95% UCL-N	W-Test (4)	8.27E-01	Mean-N	W-Test (4)
Benzo(b)fluoranthene	mg/kg	1.68E+00	4.63E+00	1.26E+01	J	mg/kg	4.63E+00	95% UCL-N	W-Test (4)	1.68E+00	Mean-N	W-Test (4)
Benzo(k)fluoranthene	mg/kg	1.65E+00	4.62E+00	1.26E+01	J	mg/kg	4.62E+00	95% UCL-N	W-Test (4)	1.65E+00	Mean-N	W-Test (4)
Indeno(1,2,3-cd)pyrene	mg/kg	4.99E-01	1.32E+00	3.55E+00		mg/kg	1.32E+00	95% UCL-N	W-Test (4)	4.99E-01	Mean-N	W-Test (4)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 3b
CANCER TOXICITY DATA -- ORAL/DERMAL
LF-18, Langley Air Force Base

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	1.7E+01	90%	1.89E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
alpha-BHC	6.3E+00	90%	7.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	1.5E+00	95%	1.58E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benzo(a)anthracene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/0(
Benzo(a)pyrene	7.3E+00	N/A	N/A	N/A	B2	IRIS	10/01/00
Benzo(b)flouranthene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/0(
Benzo(k)flouranthene	7.3E-02	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/0(
Beryllium	N/A	N/A	N/A	N/A	B1	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
delta-BHC (3)	1.8E+00	90%	2.00E+00	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/01/00
Dieldrin	1.6E+01	90%	1.78E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	9.1E+00	90%	1.01E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/0(
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
MCPP	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mercury	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Methylmercury	N/A	N/A	N/A	N/A	C	IRIS	10/01/00
Nickel	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
N/A= Not Available
(1) Adjusted $SF_d = Sf_o$ / GI Absorption Factor
(2) The date IRIS was searched.
The date of HEAST.
The date of article provided by NCEA.
(3) beta-BHC was used as a surrogate for delta-BHC.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity
Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 3c
CANCER TOXICITY DATA -- INHALATION
LF-18, Langley Air Force Base

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	4.90E-03	$(ug/m^3)^{-1}$	3500	1.70E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
alpha-BHC	1.8E-03	$(ug/m^3)^{-1}$	3500	6.30E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3500	1.51E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Benzo(a)pyrene	8.8E-04	$(ug/m^3)^{-1}$	3500	3.10E+00	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	11/18/94, 10/01/00
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Benzo(k)flouranthene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Beryllium	2.4E-03	$(ug/m^3)^{-1}$	3500	8.40E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	1.2E-02	$(ug/m^3)^{-1}$	3500	4.20E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
delta-BHC (3)	5.3E-04	$(ug/m^3)^{-1}$	3500	1.90E+00	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/01/00
Dieldrin	4.6E-03	$(ug/m^3)^{-1}$	3500	1.60E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	2.6E-03	$(ug/m^3)^{-1}$	3500	9.10E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
MCPP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mercury	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Methylmercury	N/A	N/A	N/A	N/A	N/A	C	IRIS	10/01/00
Nickel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
N/A= Not Available
Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor= 70kg x 1/20m^3/day x 1000ug/mg

(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(3) beta-BHC was used as a surrogate for delta-BHC.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 3d
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
LF-18, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Aldrin	Chronic	3.0E-05	mg/kg-day	90%	2.7E-05	mg/kg-day	liver	1000	IRIS	10/01/00
alpha-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	1.0E+00	mg/kg-day	27%	2.7E-01	mg/kg-day	Dev. NS	100	NCEA	08/26/96
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	skin/vascular	3	IRIS	10/01/00
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beryllium	Chronic	2.0E-03	mg/kg-day	1%	2.0E-05	mg/kg-day	intestine	300	IRIS	10/01/00
Chromium III	Chronic	1.5E+00	mg/kg-day	1%	1.5E-02	mg/kg-day	spleen/liver	1000	IRIS	10/01/00
Chromium VI	Chronic	3.0E-03	mg/kg-day	1%	3.0E-05	mg/kg-day	GI tract/fetus/bone marrow/liver	900	IRIS	10/01/00
delta-BHC (4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dieldrin	Chronic	5.0E-05	mg/kg-day	90%	4.5E-05	mg/kg-day	liver	100	IRIS	10/01/00
Heptachlor Epoxide	Chronic	1.3E-05	mg/kg-day	90%	1.2E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	Chronic	3.0E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	blood/liver/GI tract	1	NCEA	01/05/99
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	Chronic	1.4E-01	mg/kg-day	N/A	N/A	N/A	CNS	1	IRIS	10/01/00
Manganese (non-food)	Chronic	2.0E-02	mg/kg-day	5%	1.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
MCPP	Chronic	1.0E-03	mg/kg-day	90%	9.0E-04	mg/kg-day	kidney	3000	IRIS	10/01/00
Mercury (5)	Chronic	3.0E-04	mg/kg-day	15%	4.5E-05	mg/kg-day	Immune system	1000	IRIS	10/01/00
Methylmercury (6)	Chronic	1.0E-04	mg/kg-day	15%	1.5E-05	mg/kg-day	Dev. NS	10	IRIS	10/01/00
Nickel	Chronic	2.0E-02	mg/kg-day	0.43%	8.6E-05	mg/kg-day	heart/liver	300	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	Chronic	7.0E-05	mg/kg-day	100%	7.0E-05	mg/kg-day	blood/liver	3000	OTHER	10/01/98
Vanadium	Chronic	7.0E-03	mg/kg-day	2%	1.4E-04	mg/kg-day	GI tract/nervous system/kidney/bone marrow/liver	100	HEAST	07/31/97

N/A = Not Available

(1) Refer to RAGS, Part A

(2) Adjusted Dermal $RfD_{chemical}$ = Oral Chronic RfDchemical x GI Absorption $Factor_{chemical}$

(3) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(4) beta-BHC was used as a surrogate for delta-BHC.

(5) Mercuric chloride oral RfD was used as a surrogate for inorganic mercury in soil and sediment exposure pathways.

(6) Methylmercury RfD was used to evaluate hazards associated with oral exposure to mercury in fish, surface water, and groundwater.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
NCEA - National Center for Environmental Assessment
OTHER - EPA Region III RBC Table, Oct. 1998.

TABLE 3e
NON-CANCER TOXICITY DATA -- INHALATION
LF-18, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
Aldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
alpha-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	5.00E-03	mg/m^3	1.00E-03	mg/kg-day	Dev. NS	300	NCEA	06/20/97
Arsenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beryllium	Chronic	2.00E-05	mg/m^3	5.70E-06	mg/kg-day	lungs	10	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium VI	Chronic	1.00E-04	mg/m^3	2.86E-05	mg/kg-day	respiratory tract	300	IRIS	10/01/00
delta-BHC (3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dieldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor Epoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (non-food)	Chronic	5.00E-05	mg/m^3	1.43E-05	mg/kg-day	CNS	1000	IRIS	10/01/00
MCPP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mercury (4)	Chronic	3.00E-04	mg/m^3	8.57E-05	mg/kg-day	Nervous system	30	IRIS	10/01/00
Methylmercury (4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nickel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Available

NCEA = National Center for Environmental Assessment

(1) Doses were derived from inhalation reference concentrations (mg/m^3) from IRIS and HEAST by multiplying a conversion factor of 20 m^3/day per 70 kg by the reference concentraions.

(2) The date IRIS was searched.

The date of HEAST.

The date of the article provided by NCEA.

(3) beta-BHC was used as a surrogate for delta-BHC.

(4) Elementary mercury inhalation RfD is used to evaluate the inhalation exposures to mercury.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
IRIS - Integrated Risk Information System
NCEA - National Center for Environmental Assessment

TABLE 3f
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-18, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Hunter
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at LF-18	None	--	--	--	--	None	--	--	--	--	--
			(Total)	--	--	--	--	(Total)		--	--	--	--
	Plant Tissue	Ingestion of Wild Berries grown in surface soil at LF-18	None	--	--	--	--	None	--	--	--	--	--
			(Total)	--	--	--	--	(Total)		--	--	--	--
	Animal Tissue	Ingestion of Venison hunted at LF-18	Benzo(a)pyrene	1.9E-06	--	--	2E-06	Benzo(a)pyrene	--	--	--	--	--
			Beno(b)fluoranthene	1.4E-06	--	--	1E-06	Beno(b)fluoranthene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	2.7E-05	--	--	3E-05	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	3E-05	--	--	3E-05	(Total)		--	--	--	--
						Total Risk Across Surface Soil	3E-05					Total Hazard Index Across Surface Soil	--
						Total Risk Across All Media and All Exposure Routes	3E-05					Total Hazard Index Across All Media and All Exposure Routes	--

Note: On-site sediment and surface water are inaccessible due to dense vegetation; these media were not evaluated.
Note: The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.

TABLE 3g
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-18, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Hunter
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Animal Tissue	Ingestion of Venison hunted at LF-18	None	NA	NA	NA	NA	None	None	0.0002	NA	NA	0.0002
			(Total)	NA	NA	NA	NA	(Total)		0.0002	NA	NA	0.0002
							Total Risk Across Surface Soil	NA					Total Hazard Index Across Surface Soil	0.0002
							Total Risk Across All Media and All Exposure Routes	NA					Total Hazard Index Across All Media and All Exposure Routes	0.0002

Note: On-site sediment and surface water are inaccessible due to dense vegetation; these media were not evaluated.
Note: The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.
NA = Not applicable; pathway not evaluated

Table 3h
Occurrence, Distribution, and Selection of
Chemicals of Ecological Concern
LF-18, Langley Air Force Base

Exposure Medium: Surface Soil								
Chemical of Concern	**Minimum Concentration [1] (ppm)**	**Maximum Concentration [1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean [2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source [3]**	**COPEC[4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	2.17E+03	8.63E+03	4.60E+03	-	8.82E+03	1.00E+00	Region III BTAG	Y
Antimony	7.64E-01	1.13E+00	6.88E-01	-	3.74E-01	4.80E-01	Region III BTAG	Y
Arsenic	1.65E+00	1.77E+01	6.71E+00	-	8.99E+00	3.28E+02	Region III BTAG	N
Barium	1.42E+01	1.96E+02	5.02E+01	-	3.42E+01	4.40E+02	Region III BTAG	N
Beryllium	4.73E-01	7.24E-01	5.84E-01	-	6.15E-01	2.00E-02	Region III BTAG	Y
Cadmium	3.58E-02	1.24E+00	2.79E-01	-	2.00E-01	2.50E+00	Region III BTAG	N
Calcium	5.03E+02	1.96E+05	2.89E+04	-	2.52E+03	-	Region III BTAG	Y
Chromium	3.13E+00	3.17E+01	1.10E+01	-	1.63E+01	7.50E-03	Region III BTAG	Y
Cobalt	4.66E-01	4.38E+00	2.05E+00	-	3.08E+00	2.00E+02	Region III BTAG	N
Copper	2.33E+00	4.61E+01	8.97E+00	-	3.97E+00	1.50E+01	Region III BTAG	Y
Cyanide	3.19E-01	1.44E+00	4.81E-01	-	1.93E-01	5.00E-03	Region III BTAG	Y
Iron	3.56E+03	2.65E+04	1.15E+04	-	1.91E+04	1.20E+01	Region III BTAG	Y
Lead	7.69E+00	2.69E+02	4.60E+01	-	3.77E+01	1.00E-02	Region III BTAG	Y
Magnesium	2.01E+02	1.77E+03	7.37E+02	-	7.60E+02	4.40E+03	Region III BTAG	N
Manganese	2.70E+01	3.40E+02	1.04E+02	-	1.16E+02	3.30E+02	Region III BTAG	Y
Mercury	4.28E-02	2.70E-01	1.11E-01	-	3.20E-02	5.80E-02	Region III BTAG	Y
Nickel	1.30E+00	9.29E+00	4.30E+00	-	4.61E+00	2.00E+00	Region III BTAG	Y
Potassium	1.46E+02	1.04E+03	4.93E+02	-	4.68E+02	-	Region III BTAG	Y
Silver	4.11E-01	4.11E-01	8.91E-02	-	-	9.00E-06	Region III BTAG	Y
Sodium	9.13E+01	1.41E+03	2.67E+02	-	9.20E+01	-	Region III BTAG	Y
Vanadium	8.91E+00	3.65E+01	1.95E+01	-	3.43E+01	5.80E+01	Region III BTAG	N
Zinc	7.73E+00	1.07E+02	3.85E+01	-	2.72E+01	1.00E+01	Region III BTAG	Y
Volatile Organic Compounds								
Acetone	4.02E-03	6.46E-03	2.76E-03	-	1.21E-03	-	Region III BTAG	Y
Styrene	2.36E-02	2.36E-02	3.51E-03	-	-	-	Region III BTAG	Y
Semivolatile Organic Compounds								
Anthracene	6.70E-02	6.70E-02	1.50E-01	-	4.53E-02	1.00E-01	Region III BTAG	N
Benzo(a)anthracene	8.58E-02	5.05E+00	6.88E-01	-	5.37E-02	1.00E-01	Region III BTAG	Y
Benzo(a)pyrene	7.59E-02	5.94E+00	8.27E-01	-	9.18E-02	1.00E-01	Region III BTAG	Y
Benzo(b)fluoranthene	1.55E-01	1.26E+01	1.68E+00	-	1.03E-01	1.00E-01	Region III BTAG	Y
Benzo(g,h,i)perylene	4.27E-02	3.98E+00	5.60E-01	-	6.31E-02	1.00E-01	Region III BTAG	Y
Benzo(k)fluoranthene	1.43E-01	1.26E+01	1.65E+00	-	9.66E-02	1.00E-01	Region III BTAG	Y
Chrysene	9.38E-02	7.62E+00	1.02E+00	-	7.21E-02	1.00E-01	Region III BTAG	Y
Fluoranthene	1.51E-01	1.48E+01	1.93E+00	-	8.81E-02	1.00E-01	Region III BTAG	Y
Indeno(1,2,3-cd)pyrene	3.89E-02	3.55E+00	4.99E-01	-	5.50E-02	1.00E-01	Region III BTAG	Y
Phenanthrene	5.68E-02	7.94E+00	1.08E+00	-	7.27E-02	1.00E-01	Region III BTAG	Y
Pyrene	1.48E-01	1.14E+01	1.49E+00	-	8.73E-02	1.00E-01	Region III BTAG	Y
Pesticides & PCBs								
4,4'-DDE	5.45E-03	5.45E-03	9.22E-03	-	1.05E-02	1.00E-01	Region III BTAG	N
4,4'-DDT	9.49E-03	9.49E-03	7.95E-03	-	8.08E-03	1.00E-01	Region III BTAG	N
Endosulfan Sulfate	3.77E-02	3.77E-02	1.47E-02	-	-	-	Region III BTAG	Y
Endrin Ketone	2.44E-02	2.44E-02	1.31E-02	-	2.67E-03	-	Region III BTAG	Y
Herbicides								
2,4-DB	2.32E-02	2.32E-02	1.32E-02	-	-	-	Region III BTAG	Y

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels, *U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 3i
Ecological Exposure
Pathways of Concern
Operable Unit 35 (LF-18)
Langley Air Force Base, Virginia

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/ Threatened Special Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Soil Invertebrate Communities	N	Ingestion, respiration, and direct contact with chemcials in soil	Maintain species diversity and nutrient cycling.	A 14-day and 28-day toxicity/bioaccumulation study was conducted with earthworm *Eisenia foetida* . The endpoint of the test was mortality and COPEC tissue concentration.
	N	Small Insectivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Large Omnivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Insectivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to worm-eating birds that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
		Carnivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to carnivorous birds that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.

Table 3j
Mean LOAEL Hazard Quotients >1
for Ecological Receptors
Operable Unit 35 (LF-18)
Langley Air Force Base

Receptor Name	Exposure Medium	Analyte	Hazard Quotient[1]	COC?	Rationale
Earthworm	Surface Soil	Antimony	2.22E+00	No	Concentrations consistent with background conditions
		Cyanide	1.55E+00	**Yes**	Concentrations higher than background levels
		Benzo(b)fluoranthene	1.53E+00	No	Low detection frequency; concentrations consistent with those observed in background data set
		Benzo(k)fluoranthene	1.65E+00	No	Low detection frequency; concentrations consistent with those observed in background data set
		Endosulfan sulfate	1.05E+01	No	Low detection frequency
Deer Mouse	Surface Soil [2]	Aluminum	2.88E+01	No	Concentrations consistent with background conditions
		Antimony	1.56E+00	No	Concentrations consistent with background conditions
		Arsenic	1.94E+01	No	Concentrations consistent with background conditions
		Barium	5.38E+01	No	Concentrations consistent with background conditions
		Calcium	5.51E+01	No	Essential nutrient
		Copper	1.09E+00	No	Concentrations consistent with background conditions
		Lead	4.79E+00	No	Concentrations consistent with background conditions
		Sodium	6.25E+00	No	Concentrations consistent with background conditions
		Vanadium	1.72E+00	No	Concentrations consistent with background conditions
		Zinc	1.64E+00	No	Concentrations consistent with background conditions
		Benzo(b)fluoranthene	4.50E+00	No	Low detection frequency; concentrations consistent with those observed in background data set
		Benzo(k)fluoranthene	8.01E+00	No	Low detection frequency; concentrations consistent with those observed in background data set
American Robin	Surface Soil [2]	Antimony	7.53E+01	No	Concentrations consistent with background conditions
		Beryllium	1.09E+01	No	Concentrations consistent with background conditions
		Calcium	6.82E+00	No	Essential nutrient
		Lead	4.75E+00	No	Concentrations consistent with background conditions
		Sodium	6.54E+00	No	Concentrations consistent with background conditions
		Zinc	8.61E+00	No	Concentrations consistent with background conditions
		Benzo(b)fluoranthene	6.49E+00	No	Low detection frequency; concentrations consistent with those observed in background data set
		Benzo(k)fluoranthene	2.61E+01	No	Low detection frequency; concentrations consistent with those observed in background data set
		MCPP	1.86E+00	No	Not detected in soil
Red-tailed Hawk	Surface Soil [2]	Antimony	2.02E+00	No	Concentrations consistent with background conditions
Red Fox	Surface Soil [2]	Calcium	1.19E+00	No	Essential nutrient

Notes:
1 - Hazard Quotients presented are based on mean COC concentrations and LOAEL values, using Langley site-specific toxicological data for earthworms.
2 - All receptors, other than the earthworm, have been exposed to surface water as well as soil.

TABLE 4a
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
LF-22, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil at LF-22

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	EPC Units	Reasonable Maximum Exposure			Central Tendency		
						Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics											
Aluminum T	mg/kg	6.21E+03	7.84E+03	1.04E+04	mg/kg	7.84E+03	95% UCL-N	W-Test (3)	6.21E+03	Mean-N	W-Test (3)
Antimony	mg/kg	1.43E+00	4.04E+03	5.30E+00	mg/kg	5.30E+00	Max	W-Test (2)	1.40E+00	Mean-T	W-Test (1)
Arsenic T	mg/kg	8.62E+00	1.11E+01	1.53E+01	mg/kg	1.11E+01	95% UCL-N	W-Test (3)	8.62E+00	Mean-N	W-Test (3)
Cadmium	mg/kg	2.69E+00	5.10E+01	1.44E+01	mg/kg	1.44E+01	Max	W-Test (2)	1.93E+00	Mean-T	W-Test (1)
Chromium T	mg/kg	1.64E+01	2.09E+01	2.97E+01	mg/kg	2.09E+01	95% UCL-N	W-Test (3)	1.64E+01	Mean-N	W-Test (3)
Copper	mg/kg	8.76E+01	2.01E+02	4.97E+02	mg/kg	2.01E+02	95% UCL-N	W-Test (4)	8.76E+01	Mean-N	W-Test (4)
Iron T	mg/kg	1.33E+04	1.76E+04	2.68E+04	mg/kg	1.76E+04	95% UCL-N	W-Test (3)	1.33E+04	Mean-N	W-Test (3)
Lead	mg/kg	1.98E+02	1.78E+03	9.98E+02	mg/kg	1.75E+02	Mean-T	W-Test (1)	1.75E+02	Mean-T	W-Test (1)
Manganese	mg/kg	1.73E+02	4.75E+02	6.81E+02	mg/kg	4.75E+02	95% UCL-T	W-Test (1)	1.61E+02	Mean-T	W-Test (1)
Mercury	mg/kg	2.47E-01	1.86E+00	1.32E+00	mg/kg	1.32E+00	Max	W-Test (2)	2.08E-01	Mean-T	W-Test (1)
Organics											
Benzo(a)anthracene	mg/kg	8.38E-01	1.23E+00	1.74E+00	mg/kg	1.23E+00	95% UCL-N	W-Test (3)	8.38E-01	Mean-N	W-Test (3)
Benzo(a)pyrene	mg/kg	1.16E+00	1.77E+00	2.42E+00	mg/kg	1.77E+00	95% UCL-N	W-Test (3)	1.16E+00	Mean-N	W-Test (3)
Benzo(b)fluoranthene	mg/kg	2.11E+00	3.21E+00	4.77E+00	mg/kg	3.21E+00	95% UCL-N	W-Test (3)	2.11E+00	Mean-N	W-Test (3)
Dibenz(a,h)anthracene	mg/kg	1.84E-01	3.04E-01	5.91E-01	mg/kg	3.04E-01	95% UCL-N	W-Test (4)	1.84E-01	Mean-N	W-Test (4)
Dieldrin	mg/kg	3.03E-02	3.26E-01	1.19E-01	mg/kg	1.19E-01	Max	W-Test (2)	3.21E-02	Mean-T	W-Test (1)
Indeno(1,2,3-cd)pyrene	mg/kg	6.32E-01	9.56E-01	1.50E+00	mg/kg	9.56E-01	95% UCL-N	W-Test (3)	6.32E-01	Mean-N	W-Test (3)

NOTE: The mean of the log-transformed data was used in the EPA Adult Lead Model to evaluate adult exposure to lead.

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 4b
CANCER TOXICITY DATA -- ORAL/DERMAL
LF-22, Langley Air Force Base

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	1.7E+01	90%	1.9E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
alpha-BHC	6.3E+00	90.0%	7.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	1.5E+00	95%	1.6E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benz(a)anthracene	7.3E-01	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
Benz(a)pyrene	7.3E+00	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Benzo(b)flouranthene	7.3E-01	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
bis(2-Ethylhexyl)phthalate	1.4E-02	55%	2.55E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Cadmium (food/soil)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (water)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chloroform	6.1E-03	90%	6.8E-03	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Copper	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
delta-BHC (3)	1.8E+00	90%	2.0E+00	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/01/00
Dibenz(a,h)anthracene	7.3E+00	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
Dieldrin	1.6E+01	90%	1.8E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor	4.5E+00	90%	5.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	9.1E+00	90%	1.0E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	7.3E-01	N/A	N/A	N/A	B2	NCEA, IRIS	07/01/93, 10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Mercury	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
NCEA - National Center for Environmental Assessment

(1) Adjusted $SF_d = Sf_o$ / GI Absorption Factor
(2) The date IRIS was searched.
The date of HEAST.
The date of article provided by NCEA.
(3) beta-BHC was used as a surrogate for delta-BHC.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity
Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 4c
CANCER TOXICITY DATA -- INHALATION
LF-22, Langley Air Force Base

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
Aldrin	4.9E-03	$(ug/m^3)^{-1}$	3,500	1.7E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
alpha-BHC	1.8E-03	$(ug/m^3)^{-1}$	3,500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3,500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Benz(a)pyrene	8.8E-04	$(ug/m^3)^{-1}$	3,500	3.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	11/18/94, 10/01/00
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
bis(2-Ethylhexyl)phthalate	4.0E-06	$(ug/m^3)^{-1}$	3500	1.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	09/20/95, 10/01/00
Cadmium (food/soil)	1.8E-03	$(ug/m^3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/01/00
Cadmium (water)	1.8E-03	$(ug/m^3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/01/00
Chloroform	2.3E-05	$(ug/m^3)^{-1}$	3500	8.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	1.2E-02	$(ug/m^3)^{-1}$	3500	4.20E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Copper	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
delta-BHC (3)	5.3E-04	$(ug/m^3)^{-1}$	3500	1.90E+00	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/01/00
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Dieldrin	4.6E-03	$(ug/m^3)^{-1}$	3,500	1.6E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor	1.3E-03	$(ug/m^3)^{-1}$	3,500	4.6E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	2.6E-03	$(ug/m^3)^{-1}$	3,500	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Mercury	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
NCEA - National Center for Environmental Assessment
OTHER - EPA Region III RBC Table, Oct. 1998.

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor= 70kg x 1/20m3/day x 1000ug/mg
(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 4d
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
LF-22, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Aldrin	Chronic	3.0E-05	mg/kg-day	90%	2.7E-05	mg/kg-day	liver	1000	IRIS	10/01/00
alpha-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	Chronic	4.0E-04	mg/kg-day	10%	4.0E-05	mg/kg-day	blood	1000	IRIS	10/01/00
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	skin/vascular	3	IRIS	10/01/00
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benz(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	55%	1.1E-02	mg/kg-day	liver	1000	IRIS	10/01/00
Cadmium (food/soil)	Chronic	1.0E-03	mg/kg-day	2.5%	2.5E-05	mg/kg-day	kidney	10	IRIS	10/01/00
Cadmium (water)	Chronic	5.0E-04	mg/kg-day	5%	2.5E-05	mg/kg-day	kidney	10	IRIS	10/01/00
Chloroform	Chronic	1.0E-02	mg/kg-day	90%	9.0E-03	mg/kg-day	liver	1000	IRIS	10/01/00
Chromium III	Chronic	1.5E+00	mg/kg-day	1%	1.5E-02	mg/kg-day	spleen/liver	1000	IRIS	10/01/00
Chromium VI	Chronic	3.0E-03	mg/kg-day	1%	3.0E-05	mg/kg-day	GI tract/fetus/bone marrow/liver	900	IRIS	10/01/00
Copper	Chronic	4.0E-02	mg/kg-day	60%	2.4E-02	mg/kg-day	GI tract	N/A	NCEA	04/29/97
delta-BHC (4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dieldrin	Chronic	5.0E-05	mg/kg-day	90%	4.5E-05	mg/kg-day	liver	100	IRIS	10/01/00
Heptachlor	Chronic	5.0E-04	mg/kg-day	90%	4.5E-04	mg/kg-day	liver	300	IRIS	10/01/00
Heptachlor Epoxide	Chronic	1.3E-05	mg/kg-day	90%	1.2E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	Chronic	3.0E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	blood/liver/GI tract	1	NCEA	01/05/99
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	Chronic	1.4E-01	mg/kg-day	N/A	N/A	N/A	CNS	1	IRIS	10/01/00
Manganese (non-food)	Chronic	2.0E-02	mg/kg-day	5%	1.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Mercury (5)	Chronic	3.0E-04	mg/kg-day	15%	4.5E-05	mg/kg-day	Immune system	1000	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	Chronic	7.0E-05	mg/kg-day	100%	7.0E-05	mg/kg-day	blood/liver	3000	OTHER	10/01/98
Vanadium	Chronic	7.0E-03	mg/kg-day	2%	1.4E-04	mg/kg-day	GI tract/nervous system/kidney/bone marrow/liver	100	HEAST	07/31/97

N/A = Not Available

(1) Refer to RAGS, Part A

(2) Adjusted Dermal $RfD_{chemical}$ = Oral Chronic RfDchemical x GI Absorption $Factor_{chemical}$

(3) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(4) beta-BHC was used as a surrogate for delta-BHC.

(5) Mercuric chloride oral RfD was used as a surrogate for inorganic mercury in soil and sediment exposure pathways.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
N/A = Not Available
NCEA - National Center for Environmental Assessment
OTHER - EPA Region III RBC Table, Oct. 1998.

TABLE 4e
NON-CANCER TOXICITY DATA -- INHALATION
LF-22, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
Aldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
alpha-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	5.00E-03	mg/m^3	1.00E-03	mg/kg-day	Dev. NS	300	NCEA	06/20/97
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benz(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benz(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (food/soil)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (water)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chloroform	Chronic	2.8E-04	mg/m^3	8.6E-05	mg/kg-day	liver/kidney	N/A	NCEA	N/A
Chromium III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium VI	Chronic	1.00E-04	mg/m^3	2.86E-05	mg/kg-day	respiratory tract	300	IRIS	10/01/00
Copper	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
delta-BHC (3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dieldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor Epoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (non-food)	Chronic	5.0E-05	mg/m^3	1.4E-05	mg/kg-day	CNS	1000	IRIS	10/01/00
Mercury (4)	Chronic	3.0E-04	mg/m^3	8.6E-05	mg/kg-day	Nervous system	30	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Available

(1) Doses were derived from inhalation reference concentrations (mg/m^3) from IRIS and HEAST by multiplying a conversion factor of 20 m^3/day per 70 kg by the reference concentraions.

(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(3) beta-BHC was used as a surrogate for delta-BHC.

(4) Elementary mercury inhalation RfD is used to evaluate the inhalation exposures to mercury.

CNS - Central Nervous System

Dev. NS - Developmental nervous system

GI tract - Gastrointestinal tract

IRIS - Integrated Risk Information System

HEAST - Health Effects Assessment Summary Tables

N/A = Not Available

NCEA - National Center for Environmental Assessment

OTHER - EPA Region III RBC Table, Oct. 1998.

TABLE 4f
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
LF-22, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Other Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at LF-22	Manganese	--	--	--	--	Manganese	CNS	0.002	--	0.004	0.006
			(Total)	--	--	--	--	(Total)		0.002	--	0.004	0.006
		Ambient Air above LF-22	Manganese	--	--	--	--	Manganese	CNS	--	0.13	--	0.1
			(Total)	--	--	--	--	(Total)		--	0.1	--	0.13
							Total Risk Across Surface Soil						Total Hazard Index Across Surface Soil
							--						0.14

Other Worker = Groundskeeper

Total Risk Across All Media and All Exposure Routes: --

Total Hazard Index Across All Media and All Exposure Routes: 0.1

NOTES:

Other worker exposures to surface water and sediment not evaluated: area maintained by the worker is elevated above marshland and contact with these media is unlikely.

The totals presented in thie table represent exposure to the risk drivers only.

The totals do not take into account the cumulative exposure to all the COPCs at the site, therefore, the results may not necessarily match the summary tables presented in the Final RI report.

Total CNS HI = 0.1

Table 4g
Occurrence, Distribution, and Selection
of Chemicals of Ecological Concern
LF-22, Langley Air Force Base

Exposure Medium: Surface Soil								
Chemical of Concern	**Minimum Concentration [1] (ppm)**	**Maximum Concentration [1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean [2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source [3]**	**COPEC[4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	2.70E+03	1.04E+04	6.21E+03	-	8.82E+03	1.00E+00	Region III BTAG	Y
Antimony	7.51E-01	5.30E+00	1.43E+00	-	3.74E-01	4.80E-01	Region III BTAG	Y
Arsenic	3.72E+00	1.53E+01	8.62E+00	-	8.99E+00	3.28E+02	Region III BTAG	N
Barium	2.68E+01	4.69E+02	1.16E+02	-	3.42E+01	4.40E+02	Region III BTAG	Y
Beryllium	3.56E-01	1.15E+00	6.71E-01	-	6.15E-01	2.00E-02	Region III BTAG	Y
Cadmium	2.53E-01	1.44E+01	2.69E+00	-	2.00E-01	2.50E+00	Region III BTAG	Y
Calcium	7.66E+02	1.04E+04	2.91E+03	-	2.52E+03	-	Region III BTAG	Y
Chromium	7.45E+00	2.97E+01	1.64E+01	-	1.63E+01	7.50E-03	Region III BTAG	Y
Cobalt	1.16E+00	5.97E+00	3.01E+00	-	3.08E+00	2.00E+02	Region III BTAG	N
Copper	1.28E+01	4.97E+02	8.76E+01	-	3.97E+00	1.50E+01	Region III BTAG	Y
Cyanide	3.31E-01	4.94E-01	3.29E-01	-	1.93E-01	5.00E-03	Region III BTAG	Y
Iron	6.36E+03	2.68E+04	1.33E+04	-	1.91E+04	1.20E+01	Region III BTAG	Y
Lead	1.04E+01	9.98E+02	1.98E+02	-	3.77E+01	1.00E-02	Region III BTAG	Y
Magnesium	3.22E+02	2.17E+03	1.00E+03	-	7.60E+02	4.40E+03	Region III BTAG	N
Manganese	3.12E+01	6.81E+02	1.73E+02	-	1.16E+02	3.30E+02	Region III BTAG	Y
Mercury	1.46E-02	1.32E+00	2.47E-01	-	3.20E-02	5.80E-02	Region III BTAG	Y
Nickel	2.46E+00	3.06E+01	8.93E+00	-	4.61E+00	2.00E+00	Region III BTAG	Y
Potassium	3.11E+02	1.35E+03	8.94E+02	-	4.68E+02	-	Region III BTAG	Y
Selenium	1.39E+00	1.39E+00	5.27E-01	-	-	1.80E+00	Region III BTAG	N
Silver	1.41E+00	6.94E+00	2.79E+00	-	-	9.00E-06	Region III BTAG	Y
Sodium	7.22E+01	1.48E+03	3.56E+02	-	9.20E+01	-	Region III BTAG	Y
Vanadium	1.19E+01	4.31E+01	2.55E+01	-	3.43E+01	5.80E+01	Region III BTAG	N
Zinc	2.52E+01	1.38E+03	2.60E+02	-	2.72E+01	1.00E+01	Region III BTAG	Y
Semivolatile Organic Compounds								
Anthracene	2.87E-01	3.69E-01	1.63E-01	-	4.53E-02	1.00E-01	Region III BTAG	Y
Benzo(a)anthracene	1.48E-01	1.74E+00	8.38E-01	-	5.37E-02	1.00E-01	Region III BTAG	Y
Benzo(a)pyrene	2.65E-01	2.42E+00	1.16E+00	-	9.18E-02	1.00E-01	Region III BTAG	Y
Benzo(b)fluoranthene	2.95E-01	4.77E+00	2.11E+00	-	1.03E-01	1.00E-01	Region III BTAG	Y
Benzo(g,h,i)perylene	1.83E-01	1.88E+00	7.23E-01	-	6.31E-02	1.00E-01	Region III BTAG	Y
Benzo(k)fluoranthene	2.95E-01	4.77E+00	2.11E+00	-	9.66E-02	1.00E-01	Region III BTAG	Y
Butylbenzylphthalate	2.55E-01	2.55E-01	1.45E-01	-	-	-	Region III BTAG	Y
Carbazole	2.00E-02	3.50E-01	8.38E-02	-	7.00E-03	-	Region III BTAG	Y
Chrysene	1.89E-01	2.76E+00	1.18E+00	-	7.21E-02	1.00E-01	Region III BTAG	Y
Di-n-butylphthalate	1.08E-01	1.08E-01	1.22E-01	-	-	-	Region III BTAG	Y
Dibenz(a,h)anthracene	4.23E-02	5.91E-01	1.84E-01	-	4.30E-02	1.00E-01	Region III BTAG	Y
Fluoranthene	2.97E-01	4.71E+00	1.81E+00	-	8.81E-02	1.00E-01	Region III BTAG	Y
Indeno(1,2,3-cd)pyrene	1.64E-01	1.50E+00	6.32E-01	-	5.50E-02	1.00E-01	Region III BTAG	Y
Phenanthrene	1.19E-01	2.23E+00	9.12E-01	-	7.27E-02	1.00E-01	Region III BTAG	Y
Pyrene	2.56E-01	4.57E+00	1.73E+00	-	8.73E-02	1.00E-01	Region III BTAG	Y
bis(2-Ethylhexyl)phthalate	4.73E-01	4.73E-01	2.24E-01	-	-	-	Region III BTAG	Y
Pesticides & PCBs								
4,4'-DDD	2.18E-02	4.33E-02	1.57E-02	-	1.59E-03	1.00E-01	Region III BTAG	N
4,4'-DDE	2.65E-02	1.18E-01	5.64E-02	-	1.05E-02	1.00E-01	Region III BTAG	Y
4,4'-DDT	2.02E-03	1.09E-01	5.29E-02	-	8.08E-03	1.00E-01	Region III BTAG	Y
Dieldrin	2.68E-03	1.19E-01	3.03E-02	-	7.86E-03	-	Region III BTAG	Y
Endrin Ketone	6.69E-03	1.07E-02	5.97E-03	-	2.67E-03	-	Region III BTAG	Y
Heptachlor epoxide	4.75E-04	2.28E-02	5.10E-03	-	-	1.00E-01	Region III BTAG	N
alpha-Chlordane	1.19E-03	1.97E-02	3.77E-03	-	-	1.00E-01	Region III BTAG	N
gamma-Chlordane	1.41E-03	1.35E-02	2.94E-03	-	-	1.00E-01	Region III BTAG	N

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels, *U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 4h
Ecological Exposure
Pathways of Concern
Operable Unit 37 (LF-22)
Langley Air Force Base, Virginia

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/ Threatened Special Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Soil Invertebrate Communities	N	Ingestion, respiration, and direct contact with chemcials in soil	Maintain species diversity and nutrient cycling.	A 14-day and 28-day toxicity/bioaccumulation study was conducted with earthworm *Eisenia foetida* . The endpoint of the test was mortality and COPEC tissue concentration.
	N	Small Insectivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Large Omnivorous Mammals	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Insectivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to worm-eating birds that utilize the site. A dietary does was calculated based on the ingestion of earthworms and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
		Carnivorous Birds	N	Ingestion, respiration, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to carnivorous birds that utilize the site. A dietary does was calculated based on the ingestion of mice and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.

Table 4i
Mean LOAEL Hazard Quotients >1
for Ecological Receptors
Operable Unit 37(LF-22)
Langley Air Force Base

Receptor Name	Exposure Medium	Analyte	Hazard Quotient[1]	COC?	Rationale
Earthworm	Surface Soil	Cadmium	1.04E+00	**Yes**	Site concentrations statistically greater than background levels
		Benzo(b)fluoranthene	1.72E+00	**Yes**	High detection frequency in soil samples
		Benzo(k)fluoranthene	1.89E+00	**Yes**	High detection frequency in soil samples
		Heptachlor epoxide	2.32E+00	**Yes**	High detection frequency in soil samples
Deer Mouse	Surface Soil [2]	Aluminum	3.31E+01	No	Concentrations consistent with background conditions; overestimation of bioavailability
		Arsenic	2.13E+01	No	Concentrations consistent with background conditions
		Barium	5.69E+01	**Yes**	Site concentrations statistically greater than background levels
		Cadmium	4.75E+00	**Yes**	Site concentrations statistically greater than background levels
		Lead	5.88E+00	**Yes**	Site concentrations statistically greater than background levels
		Sodium	3.34E+00	No	Essential nutrient
		Vanadium	1.97E+00	No	Concentrations consistent with background conditions
		Benzo(b)fluoranthene	5.05E+00	**Yes**	High detection frequency in soil samples
		Benzo(k)fluoranthene	9.09E+00	**Yes**	High detection frequency in soil samples
American Robin	Surface Soil [2]	Cadmium	1.56E+00	**Yes**	Site concentrations statistically greater than background levels
		Lead	5.84E+00	**Yes**	Site concentrations statistically greater than background levels
		Sodium	3.58E+00	No	Essential nutrient
		Benzo(b)fluoranthene	7.29E+00	**Yes**	High detection frequency in soil samples
		Benzo(k)fluoranthene	2.97E+01	**Yes**	High detection frequency in soil samples

Notes:
1 - Hazard Quotients presented are based on mean COC concentrations and LOAEL values, using Langley site-specific toxicological data for earthworms.
2 - All receptors, other than the earthworm, have been exposed to surface water as well as soil.

TABLE 5a
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FT-41, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil at FT-41

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum [T]	mg/kg	7.35E+03	8.98E+03	9.21E+03	K	mg/kg	8.98E+03	95% UCL-N	W-Test (3)	7.35E+03	Mean-N	W-Test (3)
Arsenic	mg/kg	1.47E+01	2.94E+01	4.05E+01		mg/kg	2.94E+01	95% UCL-N	W-Test (4)	1.47E+01	Mean-N	W-Test (4)
Chromium [T]	mg/kg	1.68E+01	2.21E+01	2.52E+01	K	mg/kg	2.21E+01	95% UCL-N	W-Test (3)	1.68E+01	Mean-N	W-Test (3)
Iron [T]	mg/kg	1.87E+04	2.75E+04	3.61E+04		mg/kg	2.75E+04	95% UCL-N	W-Test (3)	1.87E+04	Mean-N	W-Test (3)
Manganese	mg/kg	3.54E+02	4.21E+02	5.07E+02		mg/kg	4.21E+02	95% UCL-N	W-Test (4)	3.54E+02	Mean-N	W-Test (4)
Vanadium [T]	mg/kg	3.43E+01	4.83E+01	5.68E+01		mg/kg	4.83E+01	95% UCL-N	W-Test (3)	3.43E+01	Mean-N	W-Test (3)
Organics												
1,2,3,4,6,7,8,9-OCDD	ng/kg	3.59E+03	8.85E+04	1.50E+04		ng/kg	1.50E+04	Max	W-Test (2)	3.14E+03	Mean-T	W-Test (1)
Benzo(a)pyrene	mg/kg	1.59E-01	2.87E-01	4.06E-01		mg/kg	2.87E-01	95% UCL-N	W-Test (3)	1.59E-01	Mean-N	W-Test (3)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 5b
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FT-41, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Subsurface Soil at FT-41

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum [T]	mg/kg	1.08E+04	1.27E+04	1.29E+04	J	mg/kg	1.27E+04	95% UCL-N	W-Test (3)	1.08E+04	Mean-N	W-Test (3)
Arsenic	mg/kg	2.71E+01	1.94E+02	9.14E+01		mg/kg	9.14E+01	Max	W-Test (2)	2.55E+01	Mean-T	W-Test (1)
Chromium [T]	mg/kg	2.42E+01	3.47E+01	4.33E+01		mg/kg	3.47E+01	95% UCL-N	W-Test (3)	2.42E+01	Mean-N	W-Test (3)
Iron [T]	mg/kg	2.73E+04	8.73E+04	7.49E+04	K	mg/kg	7.49E+04	Max	W-Test (2)	2.64E+04	Mean-T	W-Test (1)
Manganese [T]	mg/kg	2.68E+02	5.16E+02	8.15E+02		mg/kg	5.16E+02	95% UCL-N	W-Test (3)	2.68E+02	Mean-N	W-Test (3)
Vanadium [T]	mg/kg	4.89E+01	7.56E+01	1.09E+02	K	mg/kg	7.56E+01	95% UCL-N	W-Test (3)	4.89E+01	Mean-N	W-Test (3)
Organics												
1,2,3,4,6,7,8,9-OCDD	ng/kg	6.49E+03	1.12E+04	1.73E+04		ng/kg	1.12E+04	95% UCL-N	W-Test (3)	6.49E+03	Mean-N	W-Test (3)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).
For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.
W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).
T - Total data set only.
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.
(3) Shapiro-Wilk W Test indicates data are normally distributed.
(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.
(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".
(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.
(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 5c
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMAR
FT-41 Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Surface Water at FT-41

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum	mg/L	4.96E+01	6.99E+01	7.07E+01		mg/L	6.99E+01	95% UCL-N	W-Test (3)	4.96E+01	Mean-N	W-Test (3)
Arsenic	mg/L	6.99E-02	2.24E-01	1.62E-01		mg/L	1.62E-01	Max	W-Test (2)	6.84E-02	Mean-T	W-Test (1)
Beryllium	mg/L	2.82E-03	5.63E-03	3.26E-03		mg/L	3.26E-03	Max	W-Test (2)	2.82E-03	Mean-N	W-Test (3)
Chromium	mg/L	4.44E-01	6.84E-01	8.08E-01		mg/L	6.84E-01	95% UCL-N	W-Test (3)	4.44E-01	Mean-N	W-Test (3)
Iron	mg/L	8.56E+01	1.52E+02	2.04E+02		mg/L	1.52E+02	95% UCL-N	W-Test (3)	8.56E+01	Mean-N	W-Test (3)
Lead	mg/L	4.43E-01	2.28E+00	1.17E+00		mg/L	1.17E+00	Max	W-Test (2)	4.23E-01	Mean-T	W-Test (1)
Magnesium	mg/L	3.88E+02	4.89E+02	4.85E+02		mg/L	4.85E+02	Max	W-Test (2)	3.88E+02	Mean-N	W-Test (3)
Manganese	mg/L	9.53E-01	1.28E+00	1.32E+00		mg/L	1.28E+00	95% UCL-N	W-Test (3)	9.53E-01	Mean-N	W-Test (3)
Mercury	mg/L	7.12E-04	2.16E-03	1.22E-03		mg/L	1.22E-03	Max	W-Test (2)	7.08E-04	Mean-T	W-Test (1)
Sodium	mg/L	2.82E+03	3.47E+03	3.35E+03		mg/L	3.35E+03	Max	W-Test (2)	2.82E+03	Mean-N	W-Test (4)
Vanadium	mg/L	1.83E-01	2.47E-01	2.63E-01		mg/L	2.47E-01	95% UCL-N	W-Test (3)	1.83E-01	Mean-N	W-Test (3)
Organics												
1,2,3,4,6,7,8,9-OCDD	pg/L	3.97E+04	7.60E+04	1.05E+05		pg/L	7.60E+04	95% UCL-N	W-Test (3)	3.97E+04	Mean-N	W-Test (3)
1,2,3,4,6,7,8,9-OCDF	pg/L	7.35E+02	1.10E+04	2.25E+03		pg/L	2.25E+03	Max	W-Test (2)	6.98E+02	Mean-T	W-Test (1)
1,2,3,4,6,7,8-HpCDD	pg/L	1.55E+03	2.45E+03	2.92E+03		pg/L	2.45E+03	95% UCL-N	W-Test (3)	1.55E+03	Mean-N	W-Test (3)
1,2,3,4,6,7,8-HpCDF	pg/L	3.26E+02	4.69E+02	3.91E+02		pg/L	3.91E+02	Max	W-Test (2)	3.26E+02	Mean-N	W-Test (3)
1,2,3,4,7,8,9-HpCDF	pg/L	1.63E+01	2.91E+01	2.62E+01		pg/L	2.62E+01	Max	W-Test (2)	1.63E+01	Mean-N	W-Test (3)
1,2,3,4,7,8-HxCDD	pg/L	3.64E+01	6.63E+01	7.28E+01		pg/L	6.63E+01	95% UCL-N	W-Test (3)	3.64E+01	Mean-N	W-Test (3)
1,2,3,4,7,8-HxCDF	pg/L	8.84E+01	2.00E+02	1.65E+02		pg/L	1.65E+02	Max	W-Test (2)	8.84E+01	Mean-N	W-Test (4)
1,2,3,6,7,8-HxCDD	pg/L	7.79E+01	1.21E+02	1.08E+02		pg/L	1.08E+02	Max	W-Test (2)	7.79E+01	Mean-N	W-Test (4)
1,2,3,6,7,8-HxCDF	pg/L	2.42E+01	4.36E+01	5.73E+01		pg/L	4.36E+01	95% UCL-N	W-Test (3)	2.42E+01	Mean-N	W-Test (3)
1,2,3,7,8,9-HxCDD	pg/L	8.25E+01	1.41E+02	1.52E+02		pg/L	1.41E+02	95% UCL-N	W-Test (3)	8.25E+01	Mean-N	W-Test (3)
1,2,3,7,8,9-HxCDF	pg/L	2.36E+00	3.76E+00	4.90E+00		pg/L	3.76E+00	95% UCL-N	W-Test (3)	2.36E+00	Mean-N	W-Test (3)
1,2,3,7,8-PeCDD	pg/L	2.06E+01	3.66E+01	4.77E+01		pg/L	3.66E+01	95% UCL-N	W-Test (3)	2.06E+01	Mean-N	W-Test (3)
1,2,3,7,8-PeCDF	pg/L	1.59E+01	2.89E+01	3.89E+01		pg/L	2.89E+01	95% UCL-N	W-Test (3)	1.59E+01	Mean-N	W-Test (3)
2,3,4,6,7,8-HxCDF	pg/L	5.48E+01	9.80E+01	8.43E+01		pg/L	8.43E+01	Max	W-Test (2)	5.48E+01	Mean-N	W-Test (3)
2,3,4,7,8-PeCDF	pg/L	1.82E+01	3.27E+01	4.32E+01		pg/L	3.27E+01	95% UCL-N	W-Test (3)	1.82E+01	Mean-N	W-Test (3)
2,3,7,8-TCDD	pg/L	4.29E+00	7.46E+00	8.20E+00		pg/L	7.46E+00	95% UCL-N	W-Test (3)	4.29E+00	Mean-N	W-Test (3)
2,3,7,8-TCDF	pg/L	2.71E+01	5.24E+01	4.42E+01		pg/L	4.42E+01	Max	W-Test (2)	2.71E+01	Mean-N	W-Test (3)
Benzo(a)anthracene	mg/L	5.63E-04	1.23E-03	1.82E-03		mg/L	1.23E-03	95% UCL-N	W-Test (4)	5.63E-04	Mean-N	W-Test (4)
Benzo(a)pyrene	mg/L	8.82E-04	1.65E-03	2.32E-03		mg/L	1.65E-03	95% UCL-N	W-Test (4)	8.82E-04	Mean-N	W-Test (4)
Benzo(b)fluoranthene	mg/L	1.49E-03	3.58E-03	5.41E-03	J	mg/L	3.58E-03	95% UCL-N	W-Test (4)	1.49E-03	Mean-N	W-Test (4)
Benzo(k)fluoranthene	mg/L	1.34E-03	3.50E-03	5.41E-03	J	mg/L	3.50E-03	95% UCL-N	W-Test (4)	1.34E-03	Mean-N	W-Test (4)
Chrysene	mg/L	8.54E-04	2.04E-03	3.08E-03		mg/L	2.04E-03	95% UCL-N	W-Test (4)	8.54E-04	Mean-N	W-Test (4)
Dieldrin	mg/L	2.50E-04	5.67E-04	8.30E-04		mg/L	5.67E-04	95% UCL-N	W-Test (4)	2.50E-04	Mean-N	W-Test (4)
Heptachlor epoxide	mg/L	3.79E-05	7.01E-05	9.09E-05		mg/L	7.01E-05	95% UCL-N	W-Test (3)	3.79E-05	Mean-N	W-Test (3)
Indeno(1,2,3-cd)pyrene	mg/L	6.63E-04	1.26E-03	1.78E-03		mg/L	1.26E-03	95% UCL-N	W-Test (4)	6.63E-04	Mean-N	W-Test (4)
alpha-BHC	mg/L	5.92E-05	1.24E-04	1.72E-04		mg/L	1.24E-04	95% UCL-N	W-Test (4)	5.92E-05	Mean-N	W-Test (4)
beta-BHC	mg/L	6.47E-05	1.18E-04	1.50E-04		mg/L	1.18E-04	95% UCL-N	W-Test (3)	6.47E-05	Mean-N	W-Test (3)
delta-BHC	mg/L	1.76E-02	7.05E-02	4.56E-02		mg/L	4.56E-02	Max	W-Test (2)	1.69E-02	Mean-T	W-Test (1)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 5d
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FT-41, Langley Air Force Base

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Sediment at FT-41

Chemical of Potential Concern (a)	Units	Arithmetic Mean	95% UCL of Normal Data (b)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value (c)	Medium EPC Statistic	Medium EPC Rationale
Inorganics												
Aluminum	mg/kg	1.67E+04	2.84E+04	4.08E+04		mg/kg	2.84E+04	95% UCL-N	W-Test (3)	1.67E+04	Mean-N	W-Test (3)
Arsenic	mg/kg	1.31E+01	2.25E+01	3.37E+01		mg/kg	2.25E+01	95% UCL-N	W-Test (3)	1.31E+01	Mean-N	W-Test (3)
Barium	mg/kg	2.08E+02	9.97E+03	1.01E+03		mg/kg	1.01E+03	Max	W-Test (2)	1.58E+02	Mean-T	W-Test (1)
Chromium	mg/kg	9.49E+01	3.90E+02	2.15E+02		mg/kg	2.15E+02	Max	W-Test (2)	9.35E+01	Mean-T	W-Test (1)
Iron	mg/kg	1.95E+04	2.98E+04	3.72E+04		mg/kg	2.98E+04	95% UCL-N	W-Test (3)	1.95E+04	Mean-N	W-Test (3)
Manganese	mg/kg	1.07E+02	1.61E+02	2.08E+02		mg/kg	1.61E+02	95% UCL-N	W-Test (3)	1.07E+02	Mean-N	W-Test (3)
Vanadium	mg/kg	4.95E+01	7.86E+01	1.08E+02		mg/kg	7.86E+01	95% UCL-N	W-Test (3)	4.95E+01	Mean-N	W-Test (3)
Organics												
1,2,3,4,6,7,8,9-OCDD	ng/kg	6.19E+03	1.08E+04	1.64E+04		ng/kg	1.08E+04	95% UCL-N	W-Test (3)	6.19E+03	Mean-N	W-Test (3)
1,2,3,4,6,7,8-HpCDD	ng/kg	2.75E+02	4.22E+02	5.19E+02		ng/kg	4.22E+02	95% UCL-N	W-Test (3)	2.75E+02	Mean-N	W-Test (3)
Benzo(a)anthracene	mg/kg	1.05E+00	2.79E+00	5.35E+00		mg/kg	2.79E+00	95% UCL-N	W-Test (4)	1.05E+00	Mean-N	W-Test (4)
Benzo(a)pyrene	mg/kg	1.41E+00	3.71E+00	7.08E+00		mg/kg	3.71E+00	95% UCL-N	W-Test (4)	1.41E+00	Mean-N	W-Test (4)
Benzo(b)fluoranthene	mg/kg	2.82E+00	6.57E+02	1.43E+01	J	mg/kg	1.43E+01	Max	W-Test (2)	1.97E+00	Mean-T	W-Test (1)
Benzo(k)fluoranthene	mg/kg	2.82E+00	9.12E+02	1.43E+01	J	mg/kg	1.43E+01	Max	W-Test (2)	1.97E+00	Mean-T	W-Test (1)
Dieldrin	mg/kg	2.42E+00	6.67E+05	1.21E+01		mg/kg	1.21E+01	Max	W-Test (2)	2.90E+00	Mean-T	W-Test (1)
Indeno(1,2,3-cd)pyrene	mg/kg	6.73E-01	1.76E+00	3.35E+00		mg/kg	1.76E+00	95% UCL-N	W-Test (4)	6.73E-01	Mean-N	W-Test (4)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

For non-detects, 1/2 sample-specific method detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Normal Data (Mean-N); Mean of Log-transformed Data (Mean-T).

T - Total data set only.

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilk W Test indicates data are normally distributed.

(4) Shapiro-Wilk W Test indicates data are neither log-normally distributed or normally distributed. Therefore, normal distribution equations used as default.

(a) All chemicals are in the site and total data sets unless otherwise footnoted with the letter "T".

(b) 95% UCL of Normal Data defined as the 95% UCL associated with the data's distribution.

(c) See Statistics Section of the report for more information on the calculation of the 95% UCL and the mean.

TABLE 5e
CANCER TOXICITY DATA -- ORAL/DERMAL
FT-41, Langley Air Force Base

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
alpha-BHC	6.3E+00	90%	7.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	1.5E+00	95%	1.6E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Barium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Benzene	2.9E-02	90%	3.2E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benzo(a)anthracene	7.3E-01	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
Benzo(a)pyrene	7.3E+00	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Benzo(b)flouranthene	7.3E-01	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
Beryllium	N/A	N/A	N/A	N/A	B1	IRIS	10/01/00
bis(2-Ethylhexyl)phthalate	1.4E-02	55%	2.5E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Cadmium (food/soil)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (water)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chloroform	6.1E-03	90%	6.8E-03	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chrysene	7.3E-03	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
Dibenz(a,h)anthracene	7.3E+00	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
1,2-Dicholoroethane	9.1E-02	90%	1.0E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Dieldrin	1.6E+01	90%	1.8E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor	4.5E+00	90%	5.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	9.1E+00	90%	1.0E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	7.3E-01	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	07/01/93, 10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Mercury	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Methylmercury	N/A	N/A	N/A	N/A	C	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vinyl chloride	1.9E+00	90%	2.11E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
beta-BHC	1.8E+00	90%	2.0E+00	$(mg/kg\text{-}day)^{-1}$	C	IRIS	10/01/00
delta-BHC	1.8E+00	90%	2.0E+00	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/01/00
1,2,3,4,6,7,8,9-OCDD	1.5E+02	90%	1.67E+02	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,4,6,7,8,9-OCDF	1.5E+02	90%	1.67E+02	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,4,6,7,8-HpCDD	1.5E+03	90%	1.67E+03	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,4,6,7,8-HpCDF	1.5E+03	90%	1.67E+03	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,4,7,8,9-HpCDF	1.5E+03	90%	1.67E+03	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,4,7,8-HxCDD	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,4,7,8-HxCDF	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,6,7,8-HxCDD	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,6,7,8-HxCDF	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,7,8,9-HxCDD	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,7,8,9-HxCDF	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,7,8-PeCDD	7.5E+04	90%	8.33E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
1,2,3,7,8-PeCDF	7.5E+03	90%	8.33E+03	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
2,3,4,6,7,8-HxCDF	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
2,3,4,7,8-PeCDF	7.5E+04	90%	8.33E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00
2,3,7,8-TCDD	1.5E+05	90%	1.67E+05	$(mg/kg\text{-}day)^{-1}$	B2	HEAST	07/31/97
2,3,7,8-TCDF	1.5E+04	90%	1.67E+04	$(mg/kg\text{-}day)^{-1}$	B2	OTHER	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
OTHER = Estimated based on oral slope factor for 2,3,7,8-TCDD and congener-specific TEFs.
(1) Adjusted $SF_d = Sf_o$ / GI Absorption Factor
(2) The date IRIS was searched.
The date of HEAST.
The date of article provided by NCEA.

NCEA - National Center for Environmental Assessment

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 5f
CANCER TOXICITY DATA -- INHALATION
FT-41, Langley Air Force Base

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2) (MM/DD/YY)
alpha-BHC	1.8E-03	$(ug/m^3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Barium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Benzene	7.8E-06	$(ug/m^3)^{-1}$	3500	2.9E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Benzo(a)pyrene	8.8E-04	$(ug/m^3)^{-1}$	3500	3.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	11/18/94, 10/01/00
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Beryllium	2.4E-03	$(ug/m^3)^{-1}$	3500	8.4E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/01/00
bis(2-Ethylhexyl)phthalate	4.0E-06	$(ug/m^3)^{-1}$	3500	1.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	NCEA, IRIS	09/20/95, 10/01/00
Cadmium (food/soil)	1.8E-03	$(ug/m^3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/01/00
Cadmium (water)	1.8E-03	$(ug/m^3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/01/00
Chloroform	2.3E-05	$(ug/m^3)^{-1}$	3500	8.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Chromium III	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Chromium VI	1.2E-02	$(ug/m^3)^{-1}$	3500	4.2E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
Chrysene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	01/18/99
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
1,2-Dichloroethane	2.6E-05	$(ug/m^3)^{-1}$	3500	9.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Dieldrin	4.6E-03	$(ug/m^3)^{-1}$	3500	1.6E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor	1.3E-03	$(ug/m^3)^{-1}$	3500	4.5E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Heptachlor Epoxide	2.6E-03	$(ug/m^3)^{-1}$	3500	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	B2	IRIS	10/01/00
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Manganese (non-food)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Mercury	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Methylmercury	N/A	N/A	N/A	N/A	N/A	C	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vanadium	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/01/00
Vinyl chloride	8.6E-05	$(ug/m^3)^{-1}$	3500	3.0E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/01/00
beta-BHC	5.3E-04	$(ug/m^3)^{-1}$	3500	1.8E+00	$(mg/kg\text{-}day)^{-1}$	C	IRIS	10/01/00
delta-BHC	5.3E-04	$(ug/m^3)^{-1}$	3500	1.8E+00	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/01/00
1,2,3,4,6,7,8,9-OCDD	N/A	N/A	N/A	1.5E+02	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,4,6,7,8,9-OCDF	N/A	N/A	N/A	1.5E+02	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,4,6,7,8-HpCDD	N/A	N/A	N/A	1.5E+03	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,4,6,7,8-HpCDF	N/A	N/A	N/A	1.5E+03	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,4,7,8,9-HpCDF	N/A	N/A	N/A	1.5E+03	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,4,7,8-HxCDD	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,4,7,8-HxCDF	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,6,7,8-HxCDD	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,6,7,8-HxCDF	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,7,8,9-HxCDD	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,7,8,9-HxCDF	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,7,8-PeCDD	N/A	N/A	N/A	7.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
1,2,3,7,8-PeCDF	N/A	N/A	N/A	7.5E+03	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
2,3,4,6,7,8-HxCDF	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
2,3,4,7,8-PeCDF	N/A	N/A	N/A	7.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00
2,3,7,8-TCDD	3.3E+01	$(ug/m^3)^{-1}$	3500	1.5E+05	$(mg/kg\text{-}day)^{-1}$	B2	HEAST	07/31/97
2,3,7,8-TCDF	N/A	N/A	N/A	1.5E+04	$(mg/kg\text{-}day)^{-1}$	N/A	OTHER	10/01/00

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
N/A= Not Available
NCEA - National Center for Environmental Assessment
OTHER = Estimated based on inhalation slope factor for 2,3,7,8-TCDD and congener-specific TEFs.

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor=
70kg x 1/20m3/day x 1000ug/mg
(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Weight of Evidence:
Known/Likely
Cannot be Determined
Not Likely

TABLE 5g
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
FT-41, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
alpha-BHC	N/A	N/A	N/A	NA	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	1.0E+00	mg/kg-day	27%	2.7E-01	mg/kg-day	Dev. NS	100	NCEA	08/26/96
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	skin/vascular	3	IRIS	10/01/00
Barium	Chronic	7.0E-02	mg/kg-day	100%	7.0E-02	mg/kg-day	kidney	3	IRIS	10/01/00
Benzene	Chronic	3.0E-03	mg/kg-day	90%	2.7E-03	mg/kg-day	blood/Immune system	3000	NCEA	07/02/96
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beryllium	Chronic	2.0E-03	mg/kg-day	1%	2.0E-05	mg/kg-day	intestine	300	IRIS	10/01/00
bis(2-ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	55%	1.1E-02	mg/kg-day	liver	1000	IRIS	10/01/00
Cadmium (food/soil)	Chronic	1.0E-03	mg/kg-day	2.5%	2.5E-05	mg/kg-day	kidney	10	IRIS	10/01/00
Cadmium (water)	Chronic	5.0E-04	mg/kg-day	5%	2.5E-05	mg/kg-day	kidney	10	IRIS	10/01/00
Chloroform	Chronic	1.0E-02	mg/kg-day	90%	9.0E-03	mg/kg-day	liver	1000	IRIS	10/01/00
Chromium III	Chronic	1.5E+00	mg/kg-day	1%	1.5E-02	mg/kg-day	spleen/liver	1000	IRIS, NCEA	10/01/00, 12/10/98
Chromium VI	Chronic	3.0E-03	mg/kg-day	1%	3.0E-05	mg/kg-day	liver/fetus/bone marrow/GI tract	900	IRIS	10/01/00
Chrysene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dicholoroethane	Chronic	3.0E-02	mg/kg-day	90%	2.7E-02	mg/kg-day	Nervous system/GI tract/thymus	1000	NCEA	04/28/97
Dieldrin	Chronic	5.0E-05	mg/kg-day	90%	4.5E-05	mg/kg-day	liver	100	IRIS	10/01/00
Heptachlor	Chronic	5.0E-04	mg/kg-day	90%	4.5E-04	mg/kg-day	liver	300	IRIS	10/01/00
Heptachlor Epoxide	Chronic	1.3E-05	mg/kg-day	90%	1.2E-05	mg/kg-day	liver	1000	IRIS	10/01/00
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	Chronic	3.0E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	blood/liver/GI tract	1	NCEA	01/05/99
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	Chronic	1.4E-01	mg/kg-day	5%	7.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Manganese (non-food)	Chronic	2.0E-02	mg/kg-day	5%	1.0E-03	mg/kg-day	CNS	1	IRIS	10/01/00
Mercury (4)	Chronic	3.0E-04	mg/kg-day	15%	4.5E-05	mg/kg-day	Immune system	1000	IRIS	10/01/00
Methylmercury (5)	Chronic	1.0E-04	mg/kg-day	15%	1.5E-05	mg/kg-day	Dev. NS	10	IRIS	10/01/00
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	Chronic	7.0E-03	mg/kg-day	2%	1.4E-04	mg/kg-day	GI tract/nervous system/kidney/bone marrow/liver	100	HEAST	07/31/97
Vinyl Chloride	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
beta-BHC	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
delta-BHC	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,6,7,8,9-OCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,6,7,8,9-OCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,6,7,8-HpCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,6,7,8-HpCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,7,8,9-HpCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,7,8-HxCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,4,7,8-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,6,7,8-HxCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,6,7,8-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,7,8,9-HxCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,7,8,9-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,7,8-PeCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
1,2,3,7,8-PeCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
2,3,4,6,7,8-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
2,3,4,7,8-PeCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
2,3,7,8-TCDD	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
2,3,7,8-TCDF	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A

N/A = Not Available

(1) Refer to RAGS, Part A

(2) Adjusted Dermal $RfD_{chemical}$ = Oral Chronic RfDchemical x GI Absorption $Factor_{chemical}$

(3) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(4) Mercuric chloride oral RfD was used as a surrogate for inorganic mercury in soil and sediment exposure pathways.

(5) Methylmercury RfD was used to evaluate hazards associated with oral exposure to mercury in fish, surface water, and groundwater.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
N/A = Not Available
NCEA - National Center for Environmental Assessment

TABLE 5h
NON-CANCER TOXICITY DATA -- INHALATION
FT-41, Langley Air Force Base

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
alpha-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	5.0E-03	mg/m^3	1.0E-03	mg/kg-day	Dev. NS	300	NCEA	06/20/97
Arsenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barium	Chronic	5.0E-04	mg/m^3	1.4E-04	mg/kg-day	fetus	1000	HEAST	07/31/97
Benzene	Chronic	6.0E-03	mg/m^3	1.7E-03	mg/kg-day	blood	1000	NCEA	07/02/96
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benz(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beryllium	Chronic	2.0E-05	mg/m^3	5.7E-06	mg/kg-day	lungs	10	IRIS	10/01/00
bis(2-Ethylhexyl)phthalate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (food/soil)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (water)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chloroform	Chronic	2.8E-04	mg/m^3	8.6E-05	mg/kg-day	liver/kidney	NA	NCEA	N/A
Chromium III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium VI	Chronic	1.0E-04	mg/m^3	2.9E-05	mg/kg-day	respiratory tract	300	IRIS	10/01/00
Chrysene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dichloroethane	Chronic	5.0E-03	mg/m^3	1.4E-03	mg/kg-day	GI tract/liver/gallbladder	3000	NCEA	04/05/93
Dieldrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heptachlor Epoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Magnesium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (food)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (non-food)	Chronic	5.0E-05	mg/m^3	1.4E-05	mg/kg-day	CNS	1000	IRIS	10/01/00
Mercury (3)	Chronic	3.0E-04	mg/m^3	8.6E-05	mg/kg-day	Nervous system	30	IRIS	10/01/00
Methylmercury (3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sodium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl Chloride	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
beta-BHC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
delta-BHC (4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,6,7,8,9-OCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,6,7,8,9-OCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,6,7,8-HpCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,6,7,8-HpCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,7,8,9-HpCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,7,8-HxCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,4,7,8-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,6,7,8-HxCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,6,7,8-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,7,8,9-HxCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,7,8,9-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,7,8-PeCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3,7,8-PeCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,3,4,6,7,8-HxCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,3,4,7,8-PeCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,3,7,8-TCDD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,3,7,8-TCDF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Available

(1) Doses were derived from inhalation reference concentrations (mg/m^3) from IRIS and HEAST by multiplying a conversion factor of 20 m^3/day per 70 kg by the reference concentraions.

(2) The date IRIS was searched.
The date of HEAST.
The date of the article provided by NCEA.

(3) Elementary mercury inhalation RfD is used to evaluate the inhalation exposures to mercury.

(4) beta-BHC was used as a surrogate for delta-BHC.

CNS - Central Nervous System
Dev. NS - Developmental nervous system
GI tract - Gastrointestinal tract
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
N/A = Not Available
NCEA - National Center for Environmental Assessment

TABLE 5i
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FT-41, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Other Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at FT-41	Arsenic	1.5E-06	--	4.2E-07	2E-06	Arsenic	skin/vascular	0.0096	--	0.0026	0.012
			Manganese	--	--	--	--	Manganese	CNS	0.002	--	0.0033	0.005
			(Total)	2E-06	--	4E-07	2E-06	(Total)		0.012	--	0.0059	0.018
	Air	Ambient Air above FT-41	Arsenic	--	6.2E-07	--	6E-07	Arsenic	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	0.12	--	0.12
			(Total)	--	6E-07	--	6E-07	(Total)		--	0.12	--	0.12
						Total Risk Across Surface Soil	3E-06					Total Hazard Index Across Surface Soil	0.13

Other Worker = Groundskeeper/Fire Crew

Total Risk Across All Media and All Exposure Routes: 3E-06

Total Hazard Index Across All Media and All Exposure Routes: 0.1

NOTE:
The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.

Total CNS HI = 0.1
Total skin HI = 0.01
Total vascular HI = 0.01

TABLE 5j
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FT-41, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at FT-41	Arsenic	4.9E-07	--	8.3E-08	1E-06	Arsenic	skin/vascular	0.076	--	0.013	0.089
			Manganese	--	--	--	--	Manganese	CNS	0.002	--	0.002	0.0047
			(Total)	5E-07	--	8E-08	1E-06	(Total)		0.078	--	0.02	0.09
	Air	Ambient Air above FT-41	Arsenic	--	7.3E-07	--	7E-07	Arsenic	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	3.39	--	3.4
			(Total)	--	7E-07	--	7E-07	(Total)		--	3.4	--	3.4
Subsurface Soil	Subsurface Soil	Subsurface Soil	Arsenic	1.5E-06	--	2.6E-07	2E-06	Arsenic	skin/vascular	0.24	--	0.04	0.28
			(Total)	2E-06	--	3E-07	2E-06	(Total)		0.24	--	0.04	0.28
	Air	Ambient Air above FT-41	Arsenic	--	2.3E-06	--	2E-06	Arsenic	--	--	--	--	--
			(Total)	--	2E-06	--	2E-06	(Total)		--	--	--	--
						Total Risk Across Surface Soil	2E-06					Total Hazard Index Across Surface Soil	3.5
						Total Risk Across Subsurface Soil	4E-06					Total Hazard Index Across Subsurface Soil	0.3
						Total Risk Across All Media and All Exposure Routes	6E-06					Total Hazard Index Across All Media and All Exposure Routes	4

NOTE:
The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.

Total CNS HI =	3.4
Total skin HI =	0.4
Total vascular HI =	0.4

TABLE 5k
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
FT-41, Langley Air Force Base

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil at FT-41	Manganese	--	--	--	--	Manganese	CNS	0.001	--	0.009	0.010
			(Total)	--	--	--	--	(Total)		0.001	--	0.009	0.010
	Air	Ambient Air above FT-41	Manganese	--	--	--	--	Manganese	CNS	--	0.11	--	0.1
			(Total)	--	--	--	--	(Total)		--	0.1	--	0.1
Surface Water	Surface Water	Surface Water	Arsenic	--	--	2.4E-06	2E-06	Arsenic	skin/vascular	--	--	0.03	0.03
			Chromium	--	--	--	--	Chromium	liver/fetus/bone marrow/GI tract	--	--	1.3	1.3
			Dieldrin	--	--	1.6E-05	2E-05	Dieldrin	liver	--	--	0.11	0.11
			Heptchlor epoxide	--	--	1.3E-06	1E-06	Heptchlor epoxide	liver	--	--	0.06	0.06
			delta-BHC	--	--	1.2E-04	1E-04	delta-BHC	--	--	--	--	--
			1,2,3,4,6,7,8,9-OCDD	--	--	2.1E-05	2E-05	1,2,3,4,6,7,8,9-OCDD	--	--	--	--	--
			1,2,3,4,6,7,8-HpCDD	--	--	8.2E-06	8E-06	1,2,3,4,6,7,8-HpCDD	--	--	--	--	--
			1,2,3,4,6,7,8-HpCDF	--	--	1.3E-06	1E-06	1,2,3,4,6,7,8-HpCDF	--	--	--	--	--
			1,2,3,4,7,8-HxCDD	--	--	2.2E-06	2E-06	1,2,3,4,7,8-HxCDD	--	--	--	--	--
			1,2,3,4,7,8-HxCDF	--	--	5.1E-06	5E-06	1,2,3,4,7,8-HxCDF	--	--	--	--	--
			1,2,3,6,7,8-HxCDD	--	--	3.6E-06	4E-06	1,2,3,6,7,8-HxCDD	--	--	--	--	--
			1,2,3,6,7,8-HxCDF	--	--	1.4E-06	1E-06	1,2,3,6,7,8-HxCDF	--	--	--	--	--
			1,2,3,7,8,9-HxCDD	--	--	4.7E-06	5E-06	1,2,3,7,8,9-HxCDD	--	--	--	--	--
			1,2,3,7,8-PeCDD	--	--	4.9E-06	5E-06	1,2,3,7,8-PeCDD	--	--	--	--	--
			2,3,4,6,7,8-HxCDF	--	--	2.6E-06	3E-06	2,3,4,6,7,8-HxCDF	--	--	--	--	--
			2,3,4,7,8-PeCDF	--	--	4.8E-06	5E-06	2,3,4,7,8-PeCDF	--	--	--	--	--
			2,3,7,8-TCDD	--	--	2.2E-06	2E-06	2,3,7,8-TCDD	--	--	--	--	--
			2,3,7,8-TCDF	--	--	1.3E-06	1E-06	2,3,7,8-TCDF	--	--	--	--	--
			(Total)	--	--	2E-04	2E-04	(Total)		--	--	1.5	1.5
Sediment	Sediment	Sediment	Arsenic	1.5E-07	--	1.6E-06	2E-06	Arsenic	skin/vascular	0.002	--	0.021	0.02
			Chromium	--	--	--	--	Chromium	liver/fetus/bone marrow/GI tract	0.002	--	0.6	0.6
			Dieldrin	8.5E-07	--	3.1E-05	3E-05	Dieldrin	liver	0.006	--	0.22	0.23
			(Total)	1E-06	--	3E-05	3E-05	(Total)		0.01	--	0.8	0.9

Total Risk Across Surface Soil	--	Total Hazard Index Across Surface Soil	0.1
Total Risk Across Surface Water	2E-04	Total Hazard Index Across Surface Water	1.5
Total Risk Across Sediment	3E-05	Total Hazard Index Across Sedimen	0.9
Total Risk Across All Media and All Exposure Routes	2E-04	Total Hazard Index Across All Media and All Exposure Routes	2

NOTE:
The totals presented in thie table represent exposure to the risk drivers only.
The totals do not take into account the cumulative exposure to all the COPCs at the site,
therefore, the results may not necessarily match the summary tables presented in the Final RI report.

Total bone marrow HI =	2
Total CNS HI =	0.1
Total fetus HI =	2
Total GI tract HI =	2
Total liver HI =	2
Total skin HI =	0.05
Total vascular HI =	0.05

Table 5I
Occurrence, Distribution, and Selection of
Chemicals of Ecological Concern
FT-41, Langley Air Force Base

Exposure Medium: Surface Soil								
Chemical of Concern	**Minimum Concentration[1] (ppm)**	**Maximum Concentration[1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean[2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source[3]**	**COPEC[4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	4.56E+03	9.21E+03	7.35E+03	-	8.82E+03	1.00E+00	Region III BTAG	Y
Arsenic	2.32E+00	4.05E+01	1.47E+01	-	8.99E+00	3.28E+02	Region III BTAG	N
Barium	3.48E+01	8.90E+01	6.04E+01	-	3.42E+01	4.40E+02	Region III BTAG	N
Beryllium	6.13E-01	1.09E+00	8.22E-01	-	6.15E-01	2.00E-02	Region III BTAG	Y
Calcium	3.82E+03	2.31E+04	1.14E+04	-	2.52E+03	-	Region III BTAG	Y
Chromium	7.92E+00	2.52E+01	1.68E+01	-	1.63E+01	7.50E-03	Region III BTAG	Y
Cobalt	2.30E+00	5.24E+00	4.01E+00	-	3.08E+00	2.00E+02	Region III BTAG	N
Copper	3.58E+00	1.92E+01	8.29E+00	-	3.97E+00	1.50E+01	Region III BTAG	Y
Iron	8.86E+03	3.61E+04	1.87E+04	-	1.91E+04	1.20E+01	Region III BTAG	Y
Lead	6.21E+00	1.98E+01	1.19E+01	-	3.77E+01	1.00E-02	Region III BTAG	Y
Magnesium	1.56E+03	4.23E+03	2.62E+03	-	7.60E+02	4.40E+03	Region III BTAG	N
Manganese	3.00E+02	5.07E+02	3.54E+02	-	1.16E+02	3.30E+02	Region III BTAG	Y
Mercury	1.68E-02	4.90E-02	1.47E-02	-	3.20E-02	5.80E-02	Region III BTAG	N
Nickel	2.67E+00	8.34E+00	5.87E+00	-	4.61E+00	2.00E+00	Region III BTAG	Y
Potassium	1.44E+03	5.04E+03	2.60E+03	-	4.68E+02	-	Region III BTAG	Y
Sodium	8.57E+01	1.28E+03	3.83E+02	-	9.20E+01	-	Region III BTAG	Y
Thallium	1.59E-01	3.16E-01	1.36E-01	-	1.64E-01	1.00E-03	Region III BTAG	Y
Vanadium	1.59E+01	5.68E+01	3.43E+01	-	3.43E+01	5.80E+01	Region III BTAG	N
Zinc	2.73E+01	7.56E+01	3.99E+01	-	2.72E+01	1.00E+01	Region III BTAG	Y
Volatile Organic Compounds								
Carbon disulfide	2.15E-03	2.67E-03	1.68E-03	-	1.82E-03	-	Region III BTAG	Y
Semivolatile Organic Compounds								
Anthracene	4.83E-02	4.83E-02	4.79E-02	-	4.53E-02	1.00E-01	Region III BTAG	N
Benzo(a)anthracene	3.13E-02	3.15E-01	1.11E-01	-	5.37E-02	1.00E-01	Region III BTAG	Y
Benzo(a)pyrene	4.13E-02	4.06E-01	1.59E-01	-	9.18E-02	1.00E-01	Region III BTAG	Y
Benzo(b)fluoranthene	9.24E-02	7.65E-01	2.91E-01	-	1.03E-01	1.00E-01	Region III BTAG	Y
Benzo(g,h,i)perylene	3.37E-02	2.69E-01	1.12E-01	-	6.31E-02	1.00E-01	Region III BTAG	Y
Benzo(k)fluoranthene	9.24E-02	7.65E-01	2.80E-01	-	9.66E-02	1.00E-01	Region III BTAG	Y
Carbazole	5.00E-02	5.00E-02	8.33E-03	-	7.00E-03	-	Region III BTAG	Y
Chrysene	5.64E-02	4.93E-01	1.68E-01	-	7.21E-02	1.00E-01	Region III BTAG	Y
Dibenz(a,h)anthracene	6.54E-02	6.54E-02	4.93E-02	-	4.30E-02	1.00E-01	Region III BTAG	N
Fluoranthene	1.01E-01	8.47E-01	2.76E-01	-	8.81E-02	1.00E-01	Region III BTAG	Y
Indeno(1,2,3-cd)pyrene	2.72E-02	2.45E-01	9.89E-02	-	5.50E-02	1.00E-01	Region III BTAG	Y
Phenanthrene	4.69E-02	3.93E-01	1.30E-01	-	7.27E-02	1.00E-01	Region III BTAG	Y
Pyrene	9.59E-02	6.85E-01	2.42E-01	-	8.73E-02	1.00E-01	Region III BTAG	Y
bis(2-Ethylhexyl)phthalate	9.76E-02	9.76E-02	1.16E-01	-	-	-	Region III BTAG	Y
Pesticides & PCBs								
4,4'-DDD	2.20E-03	1.37E-02	8.69E-03	-	1.59E-03	1.00E-01	Region III BTAG	N
4,4'-DDE	3.38E-03	1.46E-02	8.13E-03	-	1.05E-02	1.00E-01	Region III BTAG	N
4,4'-DDT	2.06E-03	1.75E-02	4.23E-03	-	8.08E-03	1.00E-01	Region III BTAG	N
Dieldrin	4.41E-04	6.35E-03	1.96E-03	-	7.86E-03	-	Region III BTAG	Y
Heptachlor epoxide	1.46E-03	1.46E-03	4.54E-04	-	-	1.00E-01	Region III BTAG	N
alpha-Chlordane	3.78E-04	3.25E-02	6.40E-03	-	-	1.00E-01	Region III BTAG	N
gamma-Chlordane	1.21E-03	1.86E-02	3.49E-03	-	-	1.00E-01	Region III BTAG	N
Dioxins/Furans								
1,2,3,4,6,7,8,9-OCDD	3.00E-04	1.50E-02	3.59E-03	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8,9-OCDF	3.50E-06	9.00E-06	5.86E-06	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8-HpCDD	1.47E-05	8.28E-05	5.43E-05	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8-HpCDF	9.50E-07	5.80E-06	3.37E-06	-	-	-	Region III BTAG	Y
1,2,3,4,7,8-HxCDD	5.90E-07	3.10E-06	1.51E-06	-	-	-	Region III BTAG	Y
1,2,3,4,7,8-HxCDF	5.30E-07	2.60E-06	1.19E-06	-	-	-	Region III BTAG	Y
1,2,3,6,7,8-HxCDD	6.60E-07	4.70E-06	2.10E-06	-	-	-	Region III BTAG	Y
1,2,3,6,7,8-HxCDF	2.30E-07	8.70E-07	4.53E-07	-	-	-	Region III BTAG	Y
1,2,3,7,8,9-HxCDD	9.95E-07	6.50E-06	2.92E-06	-	-	-	Region III BTAG	Y
1,2,3,7,8,9-HxCDF	4.50E-07	4.50E-07	2.33E-07	-	-	-	Region III BTAG	Y
1,2,3,7,8-PeCDD	7.50E-07	3.60E-06	1.32E-06	-	-	-	Region III BTAG	Y
1,2,3,7,8-PeCDF	6.60E-07	6.60E-07	2.60E-07	-	-	-	Region III BTAG	Y
2,3,4,6,7,8-HxCDF	4.30E-07	1.40E-06	7.39E-07	-	-	-	Region III BTAG	Y
2,3,4,7,8-PeCDF	9.10E-07	1.00E-06	4.27E-07	-	-	-	Region III BTAG	Y
2,3,7,8-TCDD	2.00E-07	2.00E-07	1.92E-07	-	-	-	Region III BTAG	Y
2,3,7,8-TCDF	2.80E-07	9.50E-07	5.23E-07	-	-	-	Region III BTAG	Y

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels, *U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 5m
Occurrence, Distribution, and Selection of
Chemicals of Ecological Concern
FT-41, Langley Air Force Base

Exposure Medium: Sediment								
Chemical of Concern	**Minimum Concentration [1] (ppm)**	**Maximum Concentration [1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean [2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source [3]**	**COPEC [4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	3.12E+03	4.08E+04	1.67E+04	-	1.27E+04	-	Region III BTAG	Y
Antimony	1.20E+00	1.20E+00	4.69E-01	-	7.50E+00	1.50E+02	Region III BTAG	N
Arsenic	4.16E+00	3.37E+01	1.31E+01	-	6.80E+00	8.20E+00	Region III BTAG	Y
Barium	9.10E+00	1.01E+03	2.08E+02	-	-	-	Region III BTAG	Y
Beryllium	4.76E-01	1.64E+00	1.01E+00	-	3.43E+00	-	Region III BTAG	Y
Cadmium	3.11E-01	9.85E-01	5.36E-01	-	7.73E+00	1.20E+00	Region III BTAG	N
Calcium	1.28E+03	7.76E+03	4.21E+03	-	-	-	Region III BTAG	Y
Chromium	2.30E+01	2.15E+02	9.49E+01	-	2.43E+01	2.60E+02	Region III BTAG	N
Cobalt	8.07E-01	7.50E+00	4.57E+00	-	-	-	Region III BTAG	Y
Copper	5.15E+00	2.82E+01	1.90E+01	-	1.49E+01	3.40E+01	Region III BTAG	N
Iron	5.66E+03	3.72E+04	1.95E+04	-	1.87E+04	-	Region III BTAG	Y
Lead	2.99E+01	1.40E+02	8.06E+01	-	1.91E+01	4.67E+01	Region III BTAG	Y
Magnesium	1.10E+03	7.95E+03	4.28E+03	-	-	-	Region III BTAG	Y
Manganese	2.51E+01	2.08E+02	1.07E+02	-	1.06E+02	-	Region III BTAG	Y
Mercury	5.69E-02	2.18E-01	1.24E-01	-	1.91E-01	1.50E-01	Region III BTAG	Y
Nickel	3.02E+00	2.13E+01	1.19E+01	-	1.33E+01	2.09E+01	Region III BTAG	Y
Potassium	4.28E+02	4.55E+03	2.32E+03	-	-	-	Region III BTAG	Y
Selenium	1.52E+00	2.53E+00	1.22E+00	-	2.65E+00	-	Region III BTAG	Y
Silver	3.98E-01	4.13E+00	1.64E+00	-	-	1.00E+00	Region III BTAG	Y
Sodium	2.40E+03	2.61E+04	1.24E+04	-	-	-	Region III BTAG	Y
Vanadium	1.45E+01	1.08E+02	4.95E+01	-	-	-	Region III BTAG	Y
Zinc	2.14E+01	1.52E+02	1.02E+02	-	6.61E+01	1.50E+02	Region III BTAG	Y
Volatile Organic Compounds								
2-Butanone(MEK)	3.52E-02	4.03E-02	1.33E-02	-	-	-	Region III BTAG	Y
Acetone	1.28E-02	1.67E-01	5.35E-02	-	-	-	Region III BTAG	Y
Carbon disulfide	3.82E-02	4.19E-02	1.52E-02	-	-	-	Region III BTAG	Y
Methylene chloride	2.01E-02	2.01E-02	1.04E-02	-	-	-	Region III BTAG	Y
Semivolatile Organic Compounds								
Anthracene	4.99E-02	4.99E-02	2.00E-01	-	5.43E-03	8.53E-02	Region III BTAG	N
Benzo(a)anthracene	3.34E-02	5.35E+00	1.05E+00	-	3.45E-02	2.61E-01	Region III BTAG	Y
Benzo(a)pyrene	8.35E-01	7.08E+00	1.41E+00	-	6.08E-02	4.30E-01	Region III BTAG	Y
Benzo(b)fluoranthene	8.63E-02	1.43E+01	2.82E+00	-	8.97E-02	3.20E+00	Region III BTAG	Y
Benzo(g,h,i)perylene	3.53E-01	3.32E+00	6.79E-01	-	2.70E-02	6.70E-01	Region III BTAG	Y
Benzo(k)fluoranthene	8.63E-02	1.43E+01	2.82E+00	-	8.97E-02	-	Region III BTAG	Y
Carbazole	1.00E-01	1.00E-01	1.67E-02	-	-	-	Region III BTAG	Y
Chrysene	5.65E-02	8.61E+00	1.71E+00	-	3.56E-02	3.84E-01	Region III BTAG	Y
Di-n-butylphthalate	1.48E+00	1.48E+00	3.17E-01	-	-	-	Region III BTAG	Y
Fluoranthene	6.17E-02	1.64E+01	3.15E+00	-	6.96E-02	6.00E-01	Region III BTAG	Y
Indeno(1,2,3-cd)pyrene	3.42E-01	3.35E+00	6.73E-01	-	3.10E-02	6.00E-01	Region III BTAG	Y
Phenanthrene	1.84E-01	7.19E+00	1.40E+00	-	3.20E-02	2.40E-01	Region III BTAG	Y
Pyrene	6.52E-02	1.48E+01	2.86E+00	-	7.34E-02	6.65E-01	Region III BTAG	Y
bis(2-Ethylhexyl)phthalate	4.57E-01	1.19E+00	7.04E-01	-	-	-	Region III BTAG	Y
Pesticides & PCBs								
4,4'-DDD	6.90E-02	1.44E+00	4.83E-01	-	1.53E-04	1.60E-02	Region III BTAG	Y
4,4'-DDE	5.17E-02	8.06E-01	3.78E-01	-	3.50E-04	2.20E-03	Region III BTAG	Y
4,4'-DDT	9.50E-02	9.50E-02	3.71E-02	-	-	1.58E-03	Region III BTAG	Y
Aldrin	2.04E-02	2.04E-02	1.88E-02	-	-	-	Region III BTAG	Y
Dieldrin	8.50E-02	1.21E+01	2.42E+00	-	-	-	Region III BTAG	Y
alpha-Chlordane	4.72E-03	2.96E-02	2.50E-02	-	-	-	Region III BTAG	Y
gamma-Chlordane	7.93E-03	7.93E-03	1.71E-02	-	-	-	Region III BTAG	Y
Dioxins/Furans								
1,2,3,4,6,7,8,9-OCDD	1.29E-03	1.64E-02	6.19E-03	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8,9-OCDF	2.59E-05	2.21E-04	9.83E-05	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8-HpCDD	1.05E-04	5.19E-04	2.75E-04	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8-HpCDF	1.03E-05	7.05E-05	3.90E-05	-	-	-	Region III BTAG	Y
1,2,3,4,7,8,9-HpCDF	1.00E-06	6.40E-06	3.05E-06	-	-	-	Region III BTAG	Y
1,2,3,4,7,8-HxCDD	2.50E-06	1.01E-05	5.52E-06	-	-	-	Region III BTAG	Y
1,2,3,4,7,8-HxCDF	3.90E-06	2.31E-05	1.23E-05	-	-	-	Region III BTAG	Y
1,2,3,6,7,8-HxCDD	4.40E-06	2.09E-05	1.18E-05	-	-	-	Region III BTAG	Y
1,2,3,6,7,8-HxCDF	1.40E-06	8.60E-06	4.70E-06	-	-	-	Region III BTAG	Y
1,2,3,7,8,9-HxCDD	6.40E-06	3.39E-05	1.64E-05	-	-	-	Region III BTAG	Y
1,2,3,7,8,9-HxCDF	1.60E-06	1.60E-06	5.17E-07	-	-	-	Region III BTAG	Y
1,2,3,7,8-PeCDD	1.60E-06	6.85E-06	3.73E-06	-	-	-	Region III BTAG	Y
1,2,3,7,8-PeCDF	1.50E-06	8.00E-06	3.99E-06	-	-	-	Region III BTAG	Y
2,3,4,6,7,8-HxCDF	1.70E-06	1.06E-05	5.08E-06	-	-	-	Region III BTAG	Y
2,3,4,7,8-PeCDF	1.10E-06	6.20E-06	3.63E-06	-	-	-	Region III BTAG	Y
2,3,7,8-TCDD	5.40E-07	9.90E-07	5.52E-07	-	-	-	Region III BTAG	Y
2,3,7,8-TCDF	4.00E-06	8.70E-06	4.61E-06	-	-	-	Region III BTAG	Y

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels, *U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 5n
Occurrence, Distribution, and Selection of
Chemicals of Ecological Concern
FT-41, Langley Air Force Base

Exposure Medium: Surface Water								
Chemical of Concern	**Minimum Concentration [1] (ppm)**	**Maximum Concentration [1] (ppm)**	**Mean Concentration (ppm)**	**95% UCL of the Mean [2] (ppm)**	**Background Concentration (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source [3]**	**COPEC [4] Flag (Y or N)**
Inorganic Analytes								
Aluminum	1.73E+01	7.07E+01	4.96E+01	-	-	2.50E-02	Region III BTAG	Y
Arsenic	2.69E-02	1.62E-01	6.99E-02	-	1.05E-02	8.74E-01	Region III BTAG	N
Barium	1.63E-01	4.75E-01	2.80E-01	-	-	1.00E+01	Region III BTAG	N
Beryllium	2.37E-03	3.26E-03	2.82E-03	-	-	-	Region III BTAG	Y
Cadmium	1.25E-03	1.01E-02	3.97E-03	-	-	5.30E-04	Region III BTAG	Y
Calcium	1.46E+02	2.86E+02	2.27E+02	-	-	-	Region III BTAG	Y
Chromium	1.38E-01	8.08E-01	4.44E-01	-	1.26E-02	1.20E-01	Region III BTAG	Y
Cobalt	3.82E-03	5.00E-02	2.10E-02	-	-	3.50E+01	Region III BTAG	N
Copper	5.75E-02	2.28E-01	1.18E-01	-	5.64E-02	6.50E-03	Region III BTAG	Y
Iron	2.54E+01	2.04E+02	8.56E+01	-	8.19E-01	9.00E-01	Region III BTAG	Y
Lead	1.73E-01	1.17E+00	4.43E-01	-	1.37E-02	3.20E-03	Region III BTAG	Y
Magnesium	2.75E+02	4.85E+02	3.88E+02	-	-	-	Region III BTAG	Y
Manganese	3.89E-01	1.32E+00	9.53E-01	-	1.48E-01	1.45E+01	Region III BTAG	N
Mercury	3.30E-04	1.22E-03	7.12E-04	-	-	1.20E-05	Region III BTAG	Y
Nickel	1.82E-02	9.55E-02	5.11E-02	-	1.49E-02	1.60E-01	Region III BTAG	N
Potassium	1.10E+02	1.91E+02	1.55E+02	-	-	-	Region III BTAG	Y
Selenium	3.72E-03	6.41E-03	3.92E-03	-	2.53E-02	5.00E-03	Region III BTAG	Y
Silver	3.43E-03	2.61E-02	1.25E-02	-	-	-	Region III BTAG	Y
Sodium	1.98E+03	3.35E+03	2.82E+03	-	-	-	Region III BTAG	Y
Vanadium	8.53E-02	2.63E-01	1.83E-01	-	-	1.00E-02	Region III BTAG	Y
Zinc	2.99E-01	9.56E-01	5.86E-01	-	1.38E-02	1.10E-01	Region III BTAG	Y
Volatile Organic Compounds								
2-Butanone(MEK)	3.67E-03	3.15E-02	7.12E-03	-	-	-	Region III BTAG	Y
Acetone	2.29E-03	2.92E-02	8.78E-03	-	-	9.00E+03	Region III BTAG	N
Benzene	6.86E-05	8.73E-05	4.44E-05	-	-	5.30E+00	Region III BTAG	N
Carbon disulfide	2.02E-02	5.96E-01	1.99E-01	-	-	2.00E-03	Region III BTAG	Y
Chloromethane	1.09E-04	1.43E-04	1.03E-04	-	-	-	Region III BTAG	Y
Toluene	1.11E-04	1.58E-03	3.54E-04	-	-	1.70E+01	Region III BTAG	N
Semivolatile Organic Compounds								
4-Methylphenol/3-Methylphenol	3.53E-03	3.53E-03	9.17E-04	-	-	-	Region III BTAG	Y
Benzo(a)anthracene	1.82E-03	1.82E-03	5.63E-04	-	-	-	Region III BTAG	Y
Benzo(a)pyrene	2.32E-03	2.32E-03	8.82E-04	-	-	-	Region III BTAG	Y
Benzo(b)fluoranthene	5.41E-03	5.41E-03	1.49E-03	-	-	-	Region III BTAG	Y
Benzo(g,h,i)perylene	1.97E-03	1.97E-03	7.51E-04	-	-	-	Region III BTAG	Y
Benzo(k)fluoranthene	5.41E-03	5.41E-03	1.34E-03	-	-	-	Region III BTAG	Y
Carbazole	6.00E-04	6.00E-04	1.20E-04	-	-	-	Region III BTAG	Y
Chrysene	3.08E-03	3.08E-03	8.54E-04	-	-	-	Region III BTAG	Y
Fluoranthene	4.59E-03	4.59E-03	1.20E-03	-	-	-	Region III BTAG	Y
Indeno(1,2,3-cd)pyrene	1.78E-03	1.78E-03	6.63E-04	-	-	-	Region III BTAG	Y
Phenanthrene	1.74E-03	1.74E-03	6.81E-04	-	-	-	Region III BTAG	Y
Pyrene	4.20E-03	4.20E-03	1.01E-03	-	-	-	Region III BTAG	Y
Pesticides & PCBs								
Dieldrin	8.30E-04	8.30E-04	2.50E-04	-	-	1.90E-06	Region III BTAG	Y
Heptachlor epoxide	9.09E-05	9.09E-05	3.79E-05	-	-	-	Region III BTAG	Y
alpha-BHC	1.72E-04	1.72E-04	5.92E-05	-	-	-	Region III BTAG	Y
beta-BHC	1.50E-04	1.50E-04	6.47E-05	-	-	1.00E-01	Region III BTAG	N
delta-BHC	6.40E-03	4.56E-02	1.76E-02	-	-	1.00E-01	Region III BTAG	N
Herbicides								
2,4,5-T	3.29E-05	7.51E-05	4.13E-05	-	-	-	Region III BTAG	Y
Dioxins/Furans								
1,2,3,4,6,7,8,9-OCDD	1.10E-05	1.05E-04	3.97E-05	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8,9-OCDF	1.25E-07	2.25E-06	7.35E-07	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8-HpCDD	3.90E-07	2.92E-06	1.55E-06	-	-	-	Region III BTAG	Y
1,2,3,4,6,7,8-HpCDF	2.30E-07	3.91E-07	3.26E-07	-	-	-	Region III BTAG	Y
1,2,3,4,7,8,9-HpCDF	1.55E-08	2.62E-08	1.63E-08	-	-	-	Region III BTAG	Y
1,2,3,4,7,8-HxCDD	1.53E-08	7.28E-08	3.64E-08	-	-	-	Region III BTAG	Y
1,2,3,4,7,8-HxCDF	4.87E-08	1.65E-07	8.84E-08	-	-	-	Region III BTAG	Y
1,2,3,6,7,8-HxCDD	6.25E-08	1.08E-07	7.79E-08	-	-	-	Region III BTAG	Y
1,2,3,6,7,8-HxCDF	3.70E-09	5.73E-08	2.42E-08	-	-	-	Region III BTAG	Y
1,2,3,7,8,9-HxCDD	4.50E-08	1.52E-07	8.25E-08	-	-	-	Region III BTAG	Y
1,2,3,7,8,9-HxCDF	4.90E-09	4.90E-09	2.36E-09	-	-	-	Region III BTAG	Y
1,2,3,7,8-PeCDD	1.23E-08	4.77E-08	2.06E-08	-	-	-	Region III BTAG	Y
1,2,3,7,8-PeCDF	3.20E-09	3.89E-08	1.59E-08	-	-	-	Region III BTAG	Y
2,3,4,6,7,8-HxCDF	3.84E-08	8.43E-08	5.48E-08	-	-	-	Region III BTAG	Y
2,3,4,7,8-PeCDF	3.80E-09	4.32E-08	1.82E-08	-	-	-	Region III BTAG	Y
2,3,7,8-TCDD	7.60E-09	8.20E-09	4.29E-09	-	-	-	Region III BTAG	Y
2,3,7,8-TCDF	1.65E-08	4.42E-08	2.71E-08	-	-	-	Region III BTAG	Y

Key

- = Information not available.

ppm = parts per million

[1] Minimum/maximum detected concentration above the sample quantitation limit (SQL).

[2] The 95% Upper Confidence Limit (UCL) is not provided since ecological risks are based on maximum and mean concentrations.

[3] Region III BTAG = U.S. EPA Region III Biological Technical Assisstance Group (BTAG) screening levels, *U.S. EPA, Philadelphia, PA, August 1995.*

[4] COPEC = Constituent of Potential Ecological Concern.

N - If Maximum Concentration is less than Region III BTAG level.

Table 5o
Ecological Exposure
Pathways of Concern
Operable Unit 44 (LF-41)
Langley Air Force Base, Virginia

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/ Threatened Special Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Soil	N	Soil Invertebrate Communities	N	Ingestion and direct contact with chemcials in soil	Maintain species diversity and nutrient cycling.	A 14-day and 28-day toxicity/bioaccumulation study was conducted the with earthworm *Eisenia foetida*. The endpoint of the test was mortality and COPEC tissue concentration.
	N	Small Insectivorous Mammals	N	Ingestion and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of earthworms, water and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Large Omnivorous Mammals	N	Ingestion and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to small omnivorous mammals that utilize the site. A dietary does was calculated based on the ingestion of mice, water and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Insectivorous Birds	N	Ingestion, and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to worm-eating birds that utilize the site. A dietary does was calculated based on the ingestion of earthworms, water and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
		Carnivorous Birds	N	Ingestion and direct contact with chemcials in soil	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to carnivorous birds that utilize the site. A dietary does was calculated based on the ingestion of mice, water and soil. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
Sediment	N	Sediment Invertebrate Communities	N	Ingestion and direct contact with chemcials in sediment	Maintain species diversity and nutrient cycling.	A 10 day toxicity study was conducted with the amphipod *Leptocherius plumulosus*. The endpoint of the test was survival.
	N	Carnivorous Mammals	N	Ingestion and direct contact with chemcials in sediment and surface water	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to fish-eating semi-aquatic mammals that utilize the site. A dietary does was calculated based on the ingestion of fish, sediment and water. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
	N	Carnivorous Birds	N	Ingestion and direct contact with chemcials in sediment and surface water	Ensure the ingested contaminants do not have a negative impact on the species growth, reproduction, and survival.	A food chain model was selected to evaluate risk to fish-eating birds that utilize the site. A dietary does was calculated based on the ingestion of fish, sediment and water. The resulting total daily does was compared to existing toxicity data through the calculation of a HQ.
Surface Water	N	Fish communities	N	Ingestion and direct contact with chemicals in surface water.	Maintain species diversity and nutrient cycling.	A 7 day toxicity study was conducted using sheepshead minnow (*Cyprinondon variegatus*). The endpoints of the test were growth and survival. Killifish were sampled from the sites and tissue concentrations were reported.

Table 5p
Mean LOAEL Hazard Quotients >1
for Ecological Receptors
Operable Unit 44 (FT-41)
Langley Air Force Base

Receptor Name	Exposure Medium	Analyte	Mean LOAEL Hazard Quotient [1]	COC?	Rationale
Earthworm	Surface Soil	Manganese	1.31E+00	No	Lack of terrestrial habitat
Deer Mouse	Surface Soil [2]	Aluminum	4.32E+01	No	Concentrations consistent with background conditions
		Arsenic	4.24E+01	No	Concentrations consistent with background conditions
		Barium	6.47E+01	No	Lack of terrestrial habitat
		Lead	1.24E+00	No	Concentrations consistent with background conditions
		Magnesium	2.57E+00	No	Essential nutrient
		Vanadium	2.95E+00	No	Concentrations consistent with background conditions; low HQ
		Zinc	1.70E+00	No	Lack of terrestrial habitat
		Benzo(k)fluoranthene	1.36E+00	No	Low HQ
American Robin	Surface Soil [2]	Beryllium	3.82E+00	No	Lack of terrestrial habitat
		Thallium	1.08E+01	No	Low detection frequency (1/10); detection consistent with background values
		Zinc	2.23E+00	No	Lack of terrestrial habitat
		Benzo(k)fluoranthene	1.11E+00	No	Low HQ
Benthic Invertebrates	Sediment	Lead	1.02E+00	Maybe	Toxicity testing is recommended to determine whether chemicals in the sediment pose threat to benthic invertebrates
		Chrysene	1.22E+00	Maybe	
		4,4'-DDD	5.49E+00	Maybe	
		4,4'-DDE	2.70E+00	Maybe	
		Dieldrin	3.51E+00	Maybe	
Belted Kingfisher	Sediment and surface water[3]	Aluminum	1.21E+00	No	Sediment concentrations consistent with background conditions; overestimated bioavailability
		Antimony	2.92E+00	No	Low detection frequency in sediment (1/6); detection consistent with background values; not positively detected in surface water samples
		Beryllium	1.34E+00	No	Concentrations in sediment consistent with background conditions
		Lead	6.69E+00	Yes	Sediment concentrations above background values
		Magnesium	1.08E+00	No	Essential nutrient
Mink	Sediment and surface water[3]	Aluminum	4.23E+00	No	Sediment concentrations consistent with background conditions; overestimated bioavailability
		Arsenic	1.21E+00	Yes	Surface water concentrations greater than literature-based background values
		Lead	1.40E+00	Yes	Sediment concentrations above background values
		delta-BHC	1.35E+00	Yes	Detected in all surface water samples
Atlantic Croaker	Surface Water	Aluminum	4.96E+00	No	Overestimation of bioavailability
		Arsenic	1.17E+00	No	Habitat not suitable for fish; toxicity testing during RI demonstrated no decreased fish survival in site surface water
		Chromium	2.22E+00	No	
		Lead	6.33E+00	No	
		Manganese	4.33E+00	No	
		Mercury	3.39E+01	No	
		Nickel	2.04E+01	No	
		Selenium	2.18E+00	No	Concentration consistent with background values
		Silver	1.04E+01	No	Habitat not suitable for fish; toxicity testing during RI demonstrated no decreased fish survival in site surface water
		Vanadium	1.83E+00	No	
		Zinc	2.93E+00	No	
		Benzo(a)pyrene	1.40E+00	No	Low detection frequency (1/5); low HQ
		Benzo(b)fluoranthene	2.37E+00	No	Low detection frequency (1/5); low HQ
		Benzo(k)fluoranthene	2.13E+00	No	Low detection frequency (1/5); low HQ
		Dieldrin	1.39E+01	No	Habitat not suitable for fish; toxicity testing during RI demonstrated no decreased fish
		Heptachlor epoxide	3.79E-01	No	
		alpha-BHC	8.29E+01	No	Low detection frequency (1/5); absence in sediment
		delta-BHC	2.62E+01	No	Habitat not suitable for fish; toxicity testing during RI demonstrated no decreased fish survival in site surface water

Notes:
1 - Hazard Quotients presented are based on mean COC concentrations and LOAEL values, using Langley site-specific toxicological data for earthworms.
2 - The deer mouse and American robin have been exposed to surface water as well as soil.
3 - The belted kingfisher and mink have been exposed to surface water and sediment.

Table 6. Cost Estimate Summary for Selected Remedy for Site LF-01, Manage Waste in Place (Soil Cover and LUCs), Langley AFB, Virginia

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
REMEDIAL DESIGN				
Remedial Design	1	Lump Sum	$13,797	$13,797
Remedial Design Costs Subtotal				**$13.797**
REMEDIAL ACTIVITIES				
Preliminary Activities				
Develop Work Plans	1	Lump Sum	$16,556	$16,556
Mobilization	1	Lump Sum	$14,583	$14,584
Clearing and Erosion Control	1	Lump Sum	$26,368	$26,368
Institutional Controls				
File Use Restrictions (Completed by Langley)	0	Lump Sum	$0	$0
Property Boundary Survey (included in Construction Support)	0	Lump Sum	$0	$0
Add Soil Cover				
Fill and Topsoil Placement and Revegation	1	Lump Sum	$471,105	$471,105
Wetlands Restoration	1	Lump Sum	$283,615	$283,615
Construction Support (including site survey)	1	Lump Sum	$15,356	$15,356
Remedial Activities Cost Subtotal				**$827,584**
Additional Costs				
Project Management Costs	1	Lump Sum	$49,669	$49,669
Contingency Costs	1	Lump Sum	$70,004	$70,004
Site Closeout				
Cleanup and Demobilization	1	Lump Sum	$24,443	$24,443
As-Built Reports	1	Lump Sum	$19,315	$19,315
Fee				**$48,840**
Total Capital Cost				**$1,053,652**

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
Institutional Controls				
5-year Review	1	Lump Sum	$18,000	$18,000
O&M	30	Year	$6,000	$180,000
▸ Maintenance				
▸ Administrative Support				
▸ Site Inspection				
▸ Air Force Support				
▸ DSMOA				
▸ Potential Additional 5-year Reviews				
Institutional Controls (Present Worth)[1] Cost Subtotal				**$198,000**

Total Cost for Selected Remedy	**$1,251, 652**

[1] The present-worth calculation is based on annualized 3% inflation and a 5% discount factor to account for anticipated return on investment.

Table 7. Cost Estimate Summary for Selected Remedy for Site LF-05, Manage Waste in Place (Soil Cover and LUCs) Langley AFB, Virginia

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
REMEDIAL DESIGN				
Remedial Design	1	Lump Sum	$37,300	$37,300
Remedial Design Costs Subtotal				**$37,300**
REMEDIAL ACTIVITIES				
Preliminary Activities				
Develop Work Plans	1	Lump Sum	$37,200	$37,200
Institutional Controls				
File Use Restrictions (Completed by Langley)	0	Lump Sum	$0	$0
Property Boundary Survey (Included in Soil Cover work)	0	Lump Sum	$0	$0
Add Soil Cover				
Repair Nealy Avenue, Fill/topsoil, grade, revegetate, survey	1	Lump Sum	$464,300	$464,300
Remedial Activities Cost Subtotal				**$501,500**
Site Closeout				
As-Builts Report	1	Lump Sum	$12,000	$12,000
Total Capital Cost				**$550,800**

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
Institutional Controls				
5-year Review	1	Lump Sum	$18,500	$18,500
O&M ▸ Maintenance ▸ Administrative Support ▸ Site Inspection ▸ Air Force Support ▸ DSMOA ▸ Potential Additional 5-year Reviews	30	Year	$4,500	$103,600
Institutional Controls (Present Worth)[1] Cost Subtotal				**$122,100**

Total Cost for Selected Remedy	**$672,900**

[1] The present-worth calculation is based on annualized 3% inflation and a 5% discount factor to account for anticipated return on investment.

Table 8. Cost Estimate Summary for Selected Remedy for Site LF-18, Manage Waste in Place (Soil Cover and LUCs), Langley AFB, Virginia

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
REMEDIAL DESIGN				
Remedial Design	1	Lump Sum	$15,200	$15,200
Remedial Design Costs Subtotal				**$15,200**
REMEDIAL ACTIVITIES				
Preliminary Activities				
Develop Work Plans	1	Lump Sum	$45,800	$45,800
Institutional Controls				
File Use Restrictions (Completed by Langley)	0	Lump Sum	$0	$0
Property Boundary Survey (Included in Soil Cover work)	0	Lump Sum	$0	$0
Soil Cover				
Site preparation, fill/topsoil, grade, revegetate, survey	1	Lump Sum	$238,900	$238,900
Remedial Activities Cost Subtotal				**$284,700**
Site Closeout				
As-Built Reports	1	Lump Sum	$15,800	$15,800
Total Capital Cost				**$345,700**

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
Institutional Controls				
5-year Review	1	Lump Sum	$20,000	$18,500
O&M	30	Year	$4,500	$103,600
▸ Maintenance				
▸ Administrative Support				
▸ Site Inspection				
▸ Air Force Support				
▸ DSMOA				
▸ Potential Additional 5-year Reviews				
Institutional Controls (Present Worth)[1] Cost Subtotal				**$122,100**

Total Cost for Selected Remedy	**$467,800**

[1] The present-worth calculation is based on annualized 3% inflation and a 5% discount factor to account for anticipated return on investment.

Table 9. Cost Estimate Summary for Selected Remedy for Site LF-22, Manage Waste in Place (Soil Cover and LUCs), Langley AFB, Virginia

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
REMEDIAL DESIGN				
Remedial Design	1	Lump Sum	$40,000	$40,000
Remedial Design Costs Subtotal				**$40,000**
REMEDIAL ACTIVITIES				
Preliminary Activities				
Develop Work Plans and Design Supplement	1	Lump Sum	$91,253	$91,253
Institutional Controls				
File Use Restrictions (Completed by Langley)	0	Lump Sum	$0	$0
Property Boundary Survey (Included in Soil Cover work)	0	Lump Sum	$0	$0
Add Soil Cover				
Demolish former MLB foundation, surface debris removal, fill/topsoil, grade, revegetate, survey	1	Lump Sum	$1,493,956	$1,493,956
Remedial Activities Cost Subtotal				**$1,585,209**
Site Closeout				
As-Built Reports	1	Lump Sum	$182,510	$182,510
Total Capital Cost				**$1,807,719**

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
Institutional Controls				
5-year Review	1	Lump Sum	$20,000	$18,500
O&M	30	Year	$4,500	$103,600
▸ Maintenance				
▸ Administrative Support				
▸ Site Inspection				
▸ Air Force Support				
▸ DSMOA				
▸ Potential Additional 5-year Reviews				
Institutional Controls (Present Worth)[1] Cost Subtotal				**$122,100**

Total Cost for Selected Remedy	**$2,029,819**

[1] The present-worth calculation is based on annualized 3% inflation and a 5% discount factor to account for anticipated return on investment.

Table 10. Cost Estimate Summary for Selected Remedy for Site FT-41, Sediment Controls, LUCs, and Monitoring, Langley AFB, Virginia

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
REMEDIAL DESIGN				
Remedial Design	0	Lump Sum	$0	0
Remedial Design Costs Subtotal				**0**
REMEDIAL ACTIVITIES				
Preliminary Activities				
Develop Work Plans	1	Lump Sum	$14,500	$14,500
Institutional Controls				
File Use Restrictions (Completed by Langley)	0	Lump Sum	$0	$0
Property Boundary Survey	0	Lump Sum	$2,500	$2,500
Sediment Monitoring	5	Year	$15,000	$75,000
Erosion Control				
Sediment removal, contouring drainage channel, install sediment controls, site survey	0	Lump Sum	$8.900	$14,400
Remedial Activities Cost Subtotal				**$106,400**
Site Closeout				
As-Built Reports	1	Lump Sum	$6,400	$6,400
Total Capital Cost				**$112,800**

Item Description	Quantity	Units	Unit Cost ($)	Item Cost ($)
Institutional Controls				
5-year Review	1	Lump Sum	$20,000	$18,500
O&M	30	Year	$4,500	$103,600
▸ Maintenance				
▸ Administrative Support				
▸ Site Inspection				
▸ Air Force Support				
▸ DSMOA				
▸ Potential Additional 5-year Reviews				
Institutional Controls (Present Worth)[1] Cost Subtotal				**$122,100**

Total Cost for Selected Remedy	**$234,900**

[1] The present-worth calculation is based on annualized 3% inflation and a 5% discount factor to account for anticipated return on investment.

Table 11a
Federal Location-Specific ARARs
LF-01, LF-05, LF-18, LF-22, and FT-41
Langley Air Force Base

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Clean Water Act (Federal Water Pollution Control Act): 33 U.S.C. § 1344 (Section 404)					
Wetlands	Avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.	Action involving construction of facilities or management of property in wetlands. Wetland as defined by Executive Order 11990 Section 7 (protection of Wetlands).	*Section 404(B)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material*; 40 CFR 230 Executive Order 11990	Applicable	Portions of the LF-01 have been characterized as wetlands. Remedy implementation will be designed and constructed to mitigate wetland losses.
National Historic Preservation Act: 16 U.S.C. § 470 et. Seq;					
Historic district, site, building, structure, or object	Avoid impacts on cultural resources; recover and preserve artifacts and historic properties. Where impacts are unavoidable, mitigate through design and data recovery. Plan action to minimize harm to National Historic Landmarks.	Properties listed in the National Register of Historic Places, or eligible for such listing. Alteration of terrain that threatens significant scientific, prehistorical, historical or archaeological data.	*National Historic Landmarks Program* 36 CFR 65; *Protection of Historic Properties* 36 CFR 800	Relevant and Appropriate	Not applicable since no historic district, site, building, structure, or object have been identified at the sites.
Federal Endangered Species Act of 1973: 16 U.S.C. § 1536 (a) (1) and (2)					
Critical habitat of/or presence of an endangered or threatened species	Identify activities that may affect listed species. Actions must not threaten the continued existence of a listed species. Actions must not destroy critical habitat.	Presence of species or habitat listed as endangered or threatened.	*Interagency Cooperation Endangered Species Act of 1973, As Amended*; 50 CFR 402.10(a) and (c);	Relevant and Appropriate	Endangered or threatened species have not been documented as roosting, nesting or living on Langley AFB, but the possibility of an incidental occurrence exists. Of particular concern is the canebreak rattlesnake which has been documented on base.
National Environmental Policy Act of 1969					
Floodplain or area affecting stream or river	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values, including impacts to fish and wildlife and their habitats.	Action such as diversion, channeling or other activity that modifies a stream or river and affects fish or wildlife and their habitat.	*Procedure for Implementing the National Environmental Policy Act and Assessing the Environmental Effects Abroad of EPA Actions*; Executive Order 11988; 40 CFR 6, Appendix A; 40 CFR 6.302 (b), (d), and (g)	Applicable	The sites are within the 100-year floodplain. The Selected Remedy will be installed in the floodplain and will be designed and constructed to minimize impacts to floodplain resources.

Table 11b
Federal Chemical-Specific ARARs
LF-01, LF-05, LF-18, LF-22, and FT-41
Langley Air Force Base

Media	Requirement	Prerequisite	Citation	ARAR Determination	Comment
No Applicable Federal-Chemical Specific ARARs Idendified					

Table 11c
Federal Action-Specific ARARs
LF-01, LF-05, LF-18, LF-22, and FT-41
Langley Air Force Base

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Clean Air Act					
Air emissions	Ensure compliance with the Clean Air Act which regulates the various types of air emissions: mobile sources, hazardous air pollutants, acid deposition and electrical utility emissions, stationary sources, and stratospheric ozone. Requirements are based on the air quality designation of the site's location (i.e., attainment, non-attainment, unclassified, or transport) (see Federal Location-Specific ARARs) for each NAAQS, the classification of each area, the required control measures, and baseline emission estimates.	Air pollutant emissions during the response action, or during the operation and maintenance of the response action.	*National Primary and Secondary Ambient Air Quality Standards* 40 CFR 50.6, 7, 12 and 13	Relevant and Appropriate	Fugitive dust may be generated while constructing soil cover. Fugitive dust generation will be minimized by appropriate control measures (i.e., watering). However, VDEQ administers the requirements of the federal Clean Air Act.

Table 11d
Virginia Location-Specific ARARs
LF-01, LF-05, LF-18, LF-22, and FT-41
Langley Air Force Base

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
General Provisions Relating to Marine Resources Commission **[VA Code Ann. §§ 28.2-1300 to 1320 (1998)]**					
Wetlands	Mitigate or minimize the loss of wetlands and the adverse ecological effects of all permitted activities. To preserve the wetlands as much as possible in their natural state and to consider appropriate requirements for compensation only after it has been proven that the loss of the natural resource is unavoidable and that the project will have the highest public and private benefit. The determination as to whether compensation is warranted and permissible is conducted on a case-by-case basis. Commitments to preserve other existing wetlands shall not ordinarily be an acceptable form of compensation.	If a wetlands zoning ordinance has been adopted by local government, in accordance with the *General Provisions Relating to Marine Resources Commission*, and the response action is not exempt from its provisions, the project must comply with the requirements of the ordinance. In the case of absence of an ordinance, or of an exemption to it, VMRC can exercise jurisdiction over tidal wetlands.	*Wetlands Mitigation Compensation Policy*, 4 VAC 20-390-10 to 50	Applicable	Soil cover at LF-01 will extend over existing wetlands which will be mitigated by creation of new wetlands in designated areas of the base or through compensation mechanisms for creating or enhancing off-base wetlands. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act.
Chesapeake Bay Preservation Act **[VA Code Ann. §§ 10.1-2100 to 2116]**					
Chesapeake Bay and its tributaries	Criteria that provide for the protection of water quality of the Chesapeake Bay and its tributaries, that will also accommodate economic development in Tidewater Virginia. Under these requirements, certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, may be subject to limitations regarding land-disturbing activities, removal of vegetation, use of impervious cover, erosion and sediment control, stormwater management, and other aspects of land use that may have effects on water quality.	Location is within a Chesapeake Bay Preservation Area.	*Chesapeake Bay Preservation Area Designation and Management Regulations*, 9 VAC 10-20-10 to 260	Applicable	The waters surrounding Langley AFB are tributaries of the Chesapeake Bay. Virginia administers the Chesapeake Bay Preservation Act as part of its "enforceable" policies under the Virginia Coastal Program (VCP) under authority delegated to it under the Coastal Zone Management Act umbrella.
Endangered Species **[VA Code Ann. §§ 29.1-563 to 570 (1998)]**					
Presence of any threatened or endangered species of fish or wildlife	Prohibits taking, transporting, processing, selling, or offering for sale within the Commonwealth any threatened or endangered species of fish or wildlife except as authorized by law.	Habitat of endangered species of fish or wildlife.	*Definitions and Miscellaneous in General*, 4 VAC 15-20-130 to 140	Relevant and Appropriate	Not applicable since no endangered or threatened species are anticipated at the sites.
Endangered Plant and Insect Species Act **[VA Code Ann. §§ 3.1-1020 to 1030 (1998)]**					
Presence of any threatened or endangered species of plant or insect	Prohibits taking, transporting, processing, selling, or offering for sale within the Commonwealth any threatened or endangered species of plant or insect except as authorized by law.	Habitat of endangered species of plant or insect.	*Rules and Regulations for the Enforcement of the Endangered Plant and Insect Species Act*, 2 VAC 5-320-10	Relevant and Appropriate	Not applicable since no endangered plant or insect are anticipated at the sites.
State Water Control Law					
Surface Water	The Code of Virginia directs DEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop Implementation Plans for the TMDLs. DEQ administers the TMDL process including the public participation component and formally submits the TMDL.	Development of implementation plan and sets numeric limits for specific physical, chemical, biological or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming	*Water Quality Management Planning Regulation, 9 VAC 25-720-10 through 40, and -110*	Relevant and Appropriate	This ARAR is relevant and appropriate in the event ERP Sites LF-01, LF-05, LF-18, LF-22, and FT-41 become subject to TMDLs for the Back River. Back River is on the 2006 list of impaired waters for Fecal Coliform and *Enterococci*. However, fecal coliform and Enterococci are not site COCs, are excluded from CERCLA, and were not sampled for during investigation activities.

Table 11e
Virginia Action-Specific ARARs
LF-01, LF-05, LF-18, LF-22, and FT-41
Langley Air Force Base

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
State Water Control Law **[VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]**					
Dredging, filling, and/or discharging pollutants into, or adjacent to, surface waters (including wetlands)	Permitting requirements in addition to complying with USACE requirements (Nationwide Permits) and *Virginia Wetlands Mitigation Policy* . Administered by local wetlands boards and/or VMRC.	Activities requiring a permit include dredging, filling, or discharging any pollutant into or adjacent to surface waters, or otherwise altering the physical, chemical or biological properties of surface waters, excavating in wetlands, or conducting the following activities in a wetland: 1. New activities to cause draining that significantly alters or degrades existing wetland acreage or functions. 2. Filling or dumping. 3. Permanent flooding or impounding. 4. New activities that cause significant alteration or degradation of existing wetland acreage or functions. This would include any project that requires a *Clean Water Act* Section 404 permit or a *Rivers and Harbors Act* Section 10 permit, or a water withdrawal that also requires a Section 404 permit or a Federal Energy Regulatory Commission license or license re-issuance, as well as the same projects that do not require a Federal permit.	*Virginia Water Protection Permit Program Regulation* , 9 VAC 25-210-10 to 260	Applicable	Soil cover at LF-01 will extend over existing wetlands which will be mitigated by creation of new wetlands in designated areas of the base or through compensation mechanisms for creating or enhancing off-base wetlands. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act.
Discharge of stormwater from construction activities to a surface water or through a municipal or non-municipal separate storm sewer system to surface waters	This general permit regulation governs stormwater discharges from construction activities.	Discharges are defined as storm water discharges associated with industrial activity, and storm water discharges associated with small construction activity. Storm water discharges associated with other types of industrial activity shall not have coverage under this general permit. This general permit covers only discharges through a point source to a surface water or through a municipal or non-municipal separate storm sewer system to surface waters. Storm water discharges associated with industrial activity that originate from the site after construction activities have been completed and the site has undergone final stabilization are not authorized by this permit.	*VPDES General Permit Regulation for Discharges of Storm Water from Construction Activities* , 9 VAC 25-180-10 to 70	Applicable	Erosion and sediment control measures will be implemented during construction activities associated with the Selected Remedy. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act.
Virginia Solid Waste Regulations [VA Code Ann. §§ 10.1-1402 (2003)]					
Closure of Construction/Demolition Debris Landfills	Closure and post-closure care requirements for construction/demolition debris landfills	Landfills used to dispose construction/demolition debris	*9 VAC 20-80-260 Section E 1, except b(1)(a)* *9 VAC 20-80-260 Section F 1a, 1c, 2 and 3*	Relevant and appropriate	Construction/demolition debris landfill requirements for soil cover, infiltration/run-off, site access, and post-closure care are relevant and appropriate to LF-01, LF-05, LF-18, and LF-22. The requirements are not applicable to the landfills because they ceased operation prior to promulgation of these requirements.
Air Pollution Control Board **[VA Code Ann. §§ 10.1-1300 to 1326 (1998)]**					
Air emissions from disturbance of soil, treatment of soil or water, or other pollutant management activities	Standards for visible emissions, fugitive dust/emissions, hazardous air pollutants, and toxic pollutants from new and modified sources.	Source of visible emissions, fugitive dust/emissions, and/or a stationary source that emits or may emit any toxic pollutant.	*Standards of Performance for Visible Emissions and Fugitive Dust/Emissions [Rule 5-1]* , 9 VAC 5-50-60 to 120; *EPA National Emission Standards for Hazardous Air Pollutants [Rule 6-1]* , 9 VAC 5-60-60 to 80; *Emission Standards for Toxic Pollutants from New and Modified Sources [Rule 6-5]* , 9 VAC 5-50-60-300 to 370	Applicable	The Selected Remedy may generate fugitive dust during construction; however, mitigation measures such as watering will be undertaken.
Stormwater Management Act **[VA Code Ann. §§ 10.1-603.1 to 603.15 (2001)]**					
Stormwater runoff caused by development of land that contributes to water pollution, erosion, and localized flooding	Procedures and requirements to be followed in connection with establishment of surface water management areas, the issuance of surface water withdrawal permits and the issuance of surface water withdrawal certificates to provide for the protection of beneficial uses during periods of low streamflow.	Every locality that establishes a local stormwater management program; and every state project. If a local stormwater management program has been adopted in accordance with the *Stormwater Management Act*, and the *Stormwater Management Regulations* , and the response action is not exempt under the local program, the project must comply with the program. In the case of absence of a local program, or of an exemption to it, the standards and regulations should be followed.	*Stormwater Management Regulations*, 4 VAC 3-20-10 to 251	Applicable	Erosion and sediment control measures will be implemented during construction activities associated with the Selected Remedy.
Erosion and Sediment Control Law **[VA Code Ann. §§ 10.1-560 to 571 (2003)]**					
Erosion and deposits of soil/sediment caused by land disturbing activities	Regulations for the effective control of soil erosion, sediment deposition and nonagricultural runoff which must be met in any control program to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources.	If a local soil and erosion control program has been adopted in accordance with the *Erosion and Sediment Control Law* , and the *Erosion and Sediment Control Regulations* , and the response action is not exempt under the local program, the project must comply with the program. In the case of absence of a local program, or of an exemption to it, the standards and regulations should be followed.	*Erosion and Sediment Control Regulations* , 4 VAC 50-30-10 to 110	Applicable	Construction activities will disturb the land on and in the vicinity of the sites. Activities will be conducted in accordance with Virginia erosion control requirements.

Table 11f
Virginia Chemical-Specific ARARs
LF-01, LF-05, LF-18, LF-22, and FT-41
Langley Air Force Base

Media	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Air Pollution Control Board **[VA Code Ann. §§ 10.1-1300 to 1326 (1998)]**					
Air	Ensures that ambient concentrations of air pollutants are consistent with established criteria and serves as the basis for effective and reasonable management of the air resources of the Commonwealth. Primary ambient air quality standards define levels of air quality which, allowing an adequate margin of safety, are necessary to protect the public health. Secondary ambient air quality standards define more stringent levels of air quality which are necessary to protect the public welfare from any known or anticipated adverse effects associated with the presence of air pollutants in the ambient air.	Air emission from disturbance of soil, treatment of soil or water, or other pollutant management activities	*Ambient Air Quality Standards* , 9 VAC 5-30-10 to 80	Applicable	The Selected Remedy may generate fugitive dust during construction; however, mitigation measures, such as watering, will be undertaken.
State Water Control Law					
Surface water	Mandates the protection of existing high-quality state waters and provides for the restoration of all other state waters so they will permit reasonable public uses and will support the growth of aquatic life. Water quality standards consist of statements that describe water quality requirements. They also contain numeric limits for specific physical, chemical, biological or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming and other water-based recreation, public water supply, and the propagation and growth of aquatic life.	State surface waters designated for aquatic life or human uses.	*Water Quality Standards* , 9 VAC 25-260-5 to 550	Relevant and Appropriate	This ARAR is relevant and appropriate in the event ERP Sites LF-01, LF-05, LF-18, LF-22, and FT-41 in the event potential pollution enters State waters via runnoff from the sites during construction of the remedy.

Figures for this Record of Decision are available by placing a request using the Customized CERCLIS/RODS Report Order Form.

http://www.epa.gov/superfund/sites/phonefax/rods.htm