RECORD OF DECISION

SITE 5 – PAINT STAIN AND SITE 12 – FORMER WIND TUNNEL

NASA Wallops Flight Facility

Wallops Island, Virginia

National Aeronautics and Space Administration
NASA Goddard Space Flight Center
Wallops Flight Facility

OCTOBER 2011

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

TABLES

NUMBER

FIGURES

NUMBER

ACRONYMS AND ABBREVIATIONS

µg/L	microgram per liter
ARAR	Applicable or Relevant and Appropriate Requirement
AST	above ground storage tank
BERA	baseline ecological risk assessment
bgs	below ground surface
CDI	chronic daily intake
CERCLA	Comprehensive Environmental, Response, Compensation, and Liability Act
CFR	code of federal regulations
COC	chemical of concern
COPC	chemical of potential concern
CSM	conceptual site model
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDTR	DDT and its constituents
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Differences
FS	Feasibility Study
GSFC	Goddard Space Flight Center
HI	hazard index
HQ	hazard quotient
ILCR	Incremental Lifetime Cancer Risk
LOEC	lowest observed effects concentration
LUC	land use control
mg/kg	milligram per kilogram
MSL	mean sea level
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No Observed Adverse Effects Level
NOEC	No Observed Effects Concentration
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	Operable Units

ACRONYMS AND ABBREVIATIONS (Continued)

PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyls
RAO	Remedial Action Objective
RBC	risk-based concentration
RfD	reference dose
RI	Remedial Investigation
ROD	Record of Decision
SCAR	Site Characterization Addendum Report
SF	Slope Factor
SI	Site Investigation
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbons
TSCA	Toxic Substance Control Act
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
WFF	Wallops Flight facility
µg/kg	microgram per kilogram
µg/L	microgram per liter

1.0 DECLARATION

1.1 SITE NAME AND LOCATION

Site 5- Paint Stain and Site 12- Former Wind Tunnel
NASA Wallops Flight Facility
Wallops Island, Virginia
CERCLIS ID No. VA8800010763

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the Record of Decision (ROD) for Site 5- Paint Stain and Site 12- Former Wind Tunnel (the Sites) at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Wallops Flight Facility (WFF) in Accomack County, Virginia. The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. Section 9601 et seq., and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 code of federal regulations (CFR) Part 300. This decision is based on the Administrative Record file for WFF.

NASA and the United States Environmental Protection Agency (USEPA) jointly selected the remedy, and the Virginia Department of Environmental Quality (VDEQ) concurs with the Selected Remedy.

1.3 ASSESSMENT OF SITE

Previous investigations have identified the presence of polynuclear aromatic hydrocarbon (PAH) and polychlorinated biphenyls (PCBs) in soils at concentrations that pose an unacceptable risk to human health and the environment. The greatest health risk was calculated for the lifetime resident exposure to soil (1.9×10^{-4}). The projected carcinogenic health risks for the industrial workers, construction workers and groundskeepers are within the United States Environmental Protection Agency (USEPA) acceptable risk range (10^{-4} to 10^{-6}). Based on the results of the baseline ecological risk assessment (BERA), low to moderate potential risks were identified in soil and sediment at the Sites for benthic communities, insectivorous, piscivorous, and carnivorous mammals, amphibians, soil invertebrates and microbial communities. The response action selected in this Record of Decision (ROD) is necessary to protect the public health and welfare and the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF SELECTED REMEDY

Sites 5 and 12 are two of the sites currently subject to the USEPA/NASA Administrative Agreement on Consent (AAOC) (EPA Docket No. RCRA-03-2004-0201TH). Separate investigations and assessments are being conducted for other sites in accordance with the AAOC and CERCLA. Therefore, this ROD only applies to Sites 5 and 12.

The Selected Remedy for contaminated soil/sediment at Sites 5 and 12 consists of the following major components:

- Excavation and Off-Site disposal of contaminated soil and sediment for protection of human health and ecological receptors.
- Regrading and revegetation of the Sites.
- No further action for groundwater was required as groundwater concentrations did not exceed MCLs and groundwater concentrations were similar to background concentrations. No unacceptable Site-related risks associated with potential exposure to groundwater were identified.

1.5 STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy for Sites 5 and 12 does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons: (1) principal threat materials are no longer present at the Sites; (2) these materials were addressed during previous removal actions at the site; and (3) remaining wastes are non-mobile contaminated source material of low to moderate toxicity.

Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD:

✓ Chemicals of concern (COCs) and their respective concentrations (See Table in Section 2.5.4: Nature and Extent of Contamination).

- ✓ Baseline risk represented by the COCs.
- ✓ Clean-up levels established for COCs and the basis for these levels (See Table 2-9 Cleanup Goals for Contaminated Soil at Sites 5 and12)
- ✓ How source materials constituting principal threats are addressed.

Current and reasonably anticipated future land use assumptions and current and beneficial uses of groundwater used in the baseline risk assessment and ROD (See Section 2.6 Current and Potential Future Land and Resource Uses).

- ✓ Potential land and groundwater use that will be available at the Sites as a result of the Selected Remedy.
- ✓ Estimated capital, annual operation and maintenance (O&M), and total present-worth costs, discount rate, and number of years over which the remedy cost estimates are projected (See Table 2-12 Table 2-12 Part 1 Capital Cost Estimate Summary fort he Selected Remedy).
- ✓ Key factor(s) that led to selecting the remedy (i.e., how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (See Section 2.12.1 Summary of Rationale for the Selected Remedy).

Additional information can be found in the Administrative Record file for this Site.

1.7 AUTHORIZING SIGNATURES

10/28/11

William A. Wrobel, Director
Wallops Flight Facility

Date

11/28/11

Abraham Ferdas, Director
Land and Chemicals Division
U.S. EPA Region 3

Date

12/2/11

Ronald J. Borsellino, Director
Hazardous Site Cleanup Division
U.S. EPA Region 3

Date

2.0 DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

WFF is located in Accomack County on the eastern shore of Virginia (Figure 2-1). The WFF is comprised of three separate areas: the Main Base, the Mainland, and Wallops Island. The Mainland and Wallops Island are located several miles south of, and are not contiguous with, the Main Base (Figure 2-2). The EPA identification number for the WFF is VA8800010763.

NASA is the lead agency for site activities at the WFF. USEPA is the lead regulatory agency, and VDEQ is the support agency. Funding is provided by NASA.

Sites 5 and 12 are being addressed by this Record of Decision (ROD). The Sites are located on the southeastern side of Wallops Island just west of the Atlantic coast on the western side of Seawall Road. (Figure 2-3). Sites 5 and 12 include several buildings, paved areas around the buildings, and lightly vegetated soils (Figure 2-3). Site 12 also includes contaminated sediment in the wetland adjacent to the boundary shown on Figure 2-3. Sites 5 and 12 are mostly level, at an approximate elevation of 5 feet to 7 feet above mean sea level (msl). To the southeast of Sites 5 and 12 are Seawall Road and then a field, at an approximate elevation of 8 feet to 9 feet above msl. Sites 5 and 12 are bounded to the southwest, west and north by wetlands, with an average elevation of approximately 3 feet to 4 feet above msl. The boundary to the northeast is part wetland and other facility buildings/paved areas. The majority of the boundary between Sites 5 and 12 and the wetland marsh area is a steep slope consisting of either a wall or a graded bank (Weiss, 2008).

2.2 SITE HISTORY AND ENFORCEMENT ACTIONS

2.2.1 Site History

Site 5 is located adjacent to Building X-30 and encompasses approximately 2 acres (Figure 2-3). A paint booth is located at this site and paint, paint thinner, and lacquers are currently used in the building. Contamination originating from the paint booth occurred in the past because of an inadequate exhaust venting from the building. The exhaust system has since been rebuilt to minimize emissions and undergoes annual inspections by VDEQ. Sandblasting is also conducted adjacent to the paint booth. Canvas barriers surround the sandblasting area; however, sandblasting grit is evident in soil in the surrounding area. This material has been sampled and is considered nonhazardous (Tetra Tech, 2008a).

Site 12 includes upland and marsh areas surrounding the Former Wind Tunnel Facility known as the Preflight Jet Facility and occupies an area of approximately 3.4 acres (Figure 2-3). Site 12 was one of the

first areas to be developed on Wallops Island by the National Advisory Committee on Aeronautics. The Preflight Jet Facility air compressors and support structures were installed by 1947 (NASA, 1978). The Preflight Jet Facility was built primarily to test ramjets at subsonic and supersonic speeds. The facility consisted of large air compressors and an activated alumina dryer system previously located in existing Building X-115, two 29-feet-diameter spherical air tanks, a heat exchanger that fed high-speed temperature-corrected air to the main (up to a 27-inch nozzle) and "B" (up to an 8-inch nozzle) jets. A large hangar-like structure with several bay doors housed the jets and the heat exchanger. Preliminary operations of the Preflight Jet Facility began in April 1948, and research operations continued until the facility was deactivated in October 1960 (NASA, 1978). Ramjet research at Wallops Island involved the use and testing of engines fueled by ethylene, jet fuel (JP-3 and JP-4), acetylene, pentaborane, solid fuels (aluminum/magnesium/boron-bearing) and slurry fuels (e.g., JP-4 and magnesium) (NASA, 1978).

Also included within the boundary of Site 12 is the Former Power Generating Plant, a diesel powered electrical generation facility for the island. The Former Power Generating Plant was present from 1947 through at least 1960 and was located approximately 100 feet northwest of Building X-15. Fuel for the generators was supplied from ASTs (Above Ground Storage Tanks) at the Former Island Liquid Refueling Station, located to the east of the Former Power Generating Plant. It is not known if any other ASTs or USTs (Underground Storage Tanks) were located at the Former Power Generating Plant. The Former Power Generating Plant structures, including the ASTs, were demolished in 1984 and Building X-105 was demolished in 2008. There is no evidence that USTs remain at the Site.

2.2.2 Previous Investigations, Removal Actions, and Enforcement Actions

A Site Inspection was performed in 1996 during which multi-media samples were collected for analyses (Metcalf & Eddy, 1996). Total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs), pesticides, and metals were detected in surface soil at Site 5, and PCBs, pesticides, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals were detected in both surface soil and sediment at Site 12.

A Site Characterization Report addressing fuel releases associated with the Former Power Generating Plant at Sites 5 and 12 (Versar, 2000) was submitted to VDEQ in November 2000. This report indicated that concentrations of TPH – diesel-range organics (TPH-DRO) in soils exceeded the VDEQ petroleum Soil Saturation Action Level of 11,000 milligrams per kilogram (mg/kg). This report concluded the petroleum should attenuate naturally and that further active remediation was not warranted.. The diesel release was regulated as a fuel site under Virginia regulations, and corrective actions addressing the diesel release were overseen by the VDEQ Tidewater Regional Office (VDEQ Tracking No. PC # 08-5052). A follow-up investigation was conducted in 2008 to evaluate the status of the site conditions. The 2008 supplemental investigation confirmed that petroleum contamination had decreased to less than the

Saturation Action Level in soil, confirmed that groundwater was not significantly impacted by the Former Power Generating Plant, and acknowledged that the soil and groundwater were being evaluated as part of the ongoing CERCLA actions at Sites 5 and 12. The Former Power Generating Plant Site was closed under the VDEQ Spills Program in 2008 (VDEQ, 2008). Data from the diesel release were included in the RI because the diesel release is co-located with other releases at the Sites.

A Draft Remedial Investigation/Feasibility Study (RI/FS) was completed for these Sites in December 2001 (Versar, 2001). This investigation identified concentrations of PAHs in surface soil that exceeded U.S. EPA Region 3 risk-based concentrations (RBCs) for industrial receptors and potential future residential receptors.

In 2002, a wetlands delineation study was performed to identify wetland boundaries prior to conducting a soil removal action so that they would be protected during excavation (Foster Wheeler, 2003).

In early 2003, a Removal Action was performed at the Sites to remove surface soil with PAHs concentrations exceeding the U.S. EPA Region 3 Risk-Based Concentrations (RBC)s for industrial receptors. Pre-Removal Action sampling was performed to determine the horizontal extent of the excavation areas, and post-Removal Action confirmation samples were collected to confirm that all objectives were met.

From 2003 to 2008, a Supplemental RI was conducted to address data gaps identified in the 2001 RI/FS. The data were used to determine potential impacts from remaining contaminated media in areas that were not included in the 2003 Removal Action.

In July 2004, wipe samples were collected from the concrete pad of the transformer station located on the northeastern side of Building X-115 to comply with the Toxic Substances Control Act (TSCA). Sampling results indicated that the pad was contaminated with PCBs at levels in excess of TSCA criterion for low-contact outdoor surfaces (both impervious and non-impervious) (Fields, 2004).

In 2005, an investigation was conducted to address data gaps associated with the release of PCBs at the Sites. This investigation characterized the lateral and vertical extent of PCBs that may have been associated with the Building X-115 transformer.

In 2007, a TSCA action was conducted northwest of Building X-115 to address PCB-contaminated soil and concrete associated with Building X-115 former transformer pad. This area is within Sites 5 and 12. PCB-contaminated soil in this area with concentrations greater than 10 mg/kg and concrete associated with the pad were excavated and disposed off-site (Tetra Tech, 2007). In addition, debris on the building

floor and in the building sump, as well as loose paint on the building interior walls were removed to reduce or eliminate potential future releases of PCBs to the environment.

In 2008, a MEC (Munitions and Explosives of Concern) sweep was conducted at Sites 5 and 12. This sweep resulted in the collection and disposal of 358 munitions items containing 20/30 millimeter fragments, projectiles, empty cartridges and 207 identified scrap metal items including pipe, rebar, nails, bolts, strapping, etc. The sweep addressed the visible surface area of the Sites and the top 2-feet of soil within the area of the Former Power Generating Plant (Tetra Tech, 2008b).

In 2008, a Site Characterization Addendum Report (SCAR) was completed for the Former Power Generating Plant. Monitoring wells were installed in the area of the Former Power Generating Plant and soil and groundwater samples were collected and analyzed for petroleum (TPH) and related constituents, and field testing was conducted to determine whether free product was present in the monitoring wells (Tetra Tech, 2008c). Based on the results of this investigation, free product and petroleum associated with this area was not found to be environmentally significant, and the Former Power Generating Plant Site was closed under the VDEQ Spills Program in August 2008 (DEQ Tracking Number: PC#08-5052) (VDEQ, 2008).

No other enforcement activities, removal actions, or remediation activities have been initiated at Sites 5 and 12.

2.3 COMMUNITY PARTICIPATION

The Feasibility Study and the Proposed Plan for Sites 5 and 12 were made available to the public on March 17, 2010. These documents can be found in the Administrative Record file and the Information Repositories maintained at the Eastern Shore Public Library (23610 Front Street, Accomack, Virginia 23301) and Island Library (4077 Main Street, Chincoteague, Virginia 23336). The notice of availability of these documents was placed in the Chincoteague Beacon and Eastern Shore News on March 17, 2010. A public comment period on the Proposed Plan was held from March 17, 2010 to April 19, 2010. In addition, a public meeting was held on March 24, 2010 to present the Proposed Plan to a broader community audience than those who had already been involved at the WFF. At this meeting, representatives from NASA, USEPA, and VDEQ were present to answer questions about the Sites and the remedial alternatives. No comments were received during the comment period as noted in the Responsiveness Summary section of this ROD.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

Sites 5 and 12 are one of the sites currently included in the NASA/USEPA AAOC. The Selected Remedy is the final remedial action for Sites 5 and 12 under CERCLA. The function of the remedy is to eliminate risks to human health and the environment associated with exposure to contaminated soil and sediment. There were no unacceptable risks to human health or the environment associated with exposure to groundwater.

Under current conditions, the RI concluded that there are no excessive carcinogenic and non-carcinogenic risks to workers at the Sites. These risks were addressed by two previous actions at the Sites. The soil at the Sites 5 and 12 poses unacceptable health risks to potential future residents. The cancer risks calculated for hypothetical future residential exposure to Sites 5 and 12 soils and sediments over a lifetime was 1.9×10^{-4}. The cancer risk was driven primarily by PAHs and PCBs. The non-cancer risk hazard index (HI) was 1.2 for a child, but organ specific HIs were all less than 1.0. A HI over 1.0 typically represents unacceptable non-cancer risk. There were no non-cancer risks identified for an adult resident.

Sites 5 and 12 are upland/palustrine habitat. Based on the results of the baseline ecological risk assessment (BERA), low to moderate potential risks were identified for benthic communities, insectivorous, piscivorous, and carnivorous mammals, amphibians, and soil invertebrate and microbial communities. Other ecological receptors in this habitat were found to be at no or low potential risk.

The estimated risk to representative receptors included a hazardous quotient (HQ) of: 2.58 for the short-tailed shrew (insectivorous mammal); 12.3 for the red fox and 1.79 for the red-tailed hawk (carnivorous mammals); and 2.82 for the mink (piscivorous mammals). Direct adverse effects on amphibians, soil invertebrate, and microbial communities were not identified, but these organisms can bioaccumulate/biomagnify contaminants and affect upper food chain receptors. The 2007 TSCA removal action at the Sites reduced, but did not eliminate these risks.

Although contaminated soil is present, the contamination is not affecting Sites 5 and 12 groundwater, public drinking water supplies, or nearby surface water.

Separate investigations and assessments are being conducted for the other sites at the WFF in accordance with CERCLA and the AAOC. Therefore, this ROD only applies to Sites 5 and 12. Separate RODs or other CERCLA decision documents have been or will be prepared for the other sites at the WFF subject to the AAOC.

2.5 SITE CHARACTERISTICS

2.5.1 Physical Setting

Sites 5 and 12 include several buildings, paved areas around the buildings, and vegetated soils (Figure 2-3). Sites 5 and 12 are mostly level, at an approximate elevation of 5 feet to 7 feet above msl. To the southeast of Sites 5 and 12 are Seawall Road and a field. Sites 5 and 12 are bounded to the southwest and north by wetlands, with an average elevation of approximately 3 feet to 4 feet above msl. The boundary to the northeast is comprised of wetlands, as well as other facility buildings/paved areas. The majority of the boundary between Sites 5 and 12 and the wetland marsh area is a steep slope consisting of either a retaining wall or a graded bank.

Soils at WFF are coastal plain soils that are typically level, very deep, and well drained. The soils present immediately below Sites 5 and 12 are designated as the Camocca fine sand. Camocca fine sand occurs on slopes ranging between 0- and 2-percent grade. These soils may contain 0 to 4% clay, and are frequently flooded throughout the year. The saturated hydraulic conductivity is 20 inches per hour (inches/hr) (USDA, 2006).

In late 2002, a wetlands delineation study was performed at the Sites to identify wetland boundaries prior to conducting the RA, so that they would be protected during excavation (Foster Wheeler, 2003a). Wetland boundaries were delineated in the field using the routine on-site United States Army Corps of Engineers (US ACE) methods (Environmental Laboratory, 1987). Two non-tidal palustrine wetlands were delineated on the Sites during the field investigations. Both wetlands exhibit hydric soils, a dominance of wetland vegetation and wetland hydrology. The Wetlands Delineation Report was submitted to US ACE. Based on a subsequent site visit, the US ACE determined that the potential wetland contained within the uplands area west of Building X-35 was a man-made feature that does not meet the functional characteristics of a wetland (US ACE, 2002).

The WFF is located in the Atlantic Coastal Plain Physiographic Province and is underlain by a thick sequence of approximately 7,000 feet of unconsolidated sediments that unconformably overlie crystalline bedrock. The sediments range in age from Recent to Cretaceous and generally consist of alternating series of sands, silts, clays, and gravels. The individual geologic units dip gently to the southeast at a rate of approximately 20 to 80 feet per mile (less than 1 degree) and also thicken in the down-dip direction, creating a wedge-shaped section of sediments that gradually thin westward to their up-dip limit of extent at the Fall Line.

The principal water-bearing units beneath the WFF are, in stratigraphically descending order, the Pleistocene-age Columbia Group and three hydraulically isolated aquifer units within the underlying Yorktown-age Yorktown Formation [United States Geologic Survey (USGS), 1968]. Collectively, these units form the four major aquifers on the Eastern Shore of Virginia (as identified by VDEQ) and locally are the primary source of water for public and domestic supplies and for agricultural and industrial uses. However there are no drinking water or production wells located on Wallops Island.

The Columbia Group extends to a subsurface depth of approximately 60 feet and consists of interbedded sands, gravels, and sandy clays deposited under fluvial and marine conditions. The Columbia Group is overlain by a variably thin (generally about 5 feet) veneer of recent deposits composed chiefly of wind-deposited or fluvial sands, silts, and gravels. The water table beneath the WFF typically occurs under unconfined conditions within the recent deposits and Columbia Group at depths of 0 to 30 feet (Occu-Health, 1999).

The Yorktown Formation is approximately 1,000 feet thick and consists of alternating sequences of fine- to coarse-grained glauconitic sands (that may be variably clayey, silty, or shelly) and finer-grained silts and clays (USGS, 1968; Occu-Health, 1999). The sands comprise the dominant aquifers, and the silts and clays form aquitards that create confining conditions and that separate the Yorktown Formation into three (upper, middle, and lower) aquifers. At the WFF, the upper Yorktown aquifer generally occurs at a depth of about 100 feet below ground surface (bgs) and is isolated from the overlying Columbia aquifer by a clay and silt aquitard that is approximately 20 to 40 feet thick. Aquifer tests conducted at the WFF indicate that there was no significant vertical leakage across the confining unit separating the upper Yorktown aquifer from the overlying Columbia Group.

Based on groundwater level data collected as a part of CERCLA investigations at Sites 5 and 12, the water table ranges from 2 to 4 feet bgs. Several rounds of groundwater monitoring conducted during 2007 CERCLA activities have shown that groundwater flow at Sites 5 and 12 is generally northeast towards the marsh area that separates Wallops Island from the Mainland.

There are no drinking water supply wells on the island and there are no known areas of archeological or historical importance at Sites 5 and 12.

2.5.2 Conceptual Site Model

Figures 2-4 and 2-5 are the Conceptual Site Models (CSMs) for human and ecological receptors, respectively. The CSM graphically integrates information regarding the physical characteristics of the Site, exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify potential exposure routes and receptors evaluated in the risk assessments. A well-defined CSM

allows for a better understanding of the risks at a site and aids in the identification of the potential need for remediation.

2.5.3 Sampling Strategy

From 1994 to 1996, NASA conducted a preliminary assessment (PA) and site inspection (SI) of Sites 5 and 12. Multi-media samples were collected for analyses. TPH, PCBs, pesticides, and metals were detected in surface soil at Site 5, and PCBs, pesticides, VOCs, SVOCs, and metals were detected in both surface soil and sediment at Site 12.

From 1997 to 2000, NASA conducted a RI at Sites 5 and 12 to determine the nature and extent of the contamination at these two sites. The Draft RI/FS was published for the Sites in December 2001. This investigation identified concentrations of PAHs in surface soil that exceeded human health criteria for commercial/industrial-scenario receptors.

A Site Characterization Report addressing fuel releases associated with the Former Power Generating Plant at Site12 (Versar, 2000) was submitted to the VDEQ in November 2000. This report indicated that concentrations of TPH-DRO in soils exceeded the VDEQ petroleum Soil Saturation Action Level of 11,000 mg/kg..This report concluded that the petroleum should attenuate naturally and recommended that further active remediation was not warranted. The diesel release was regulated as a fuel site under Virginia regulations, and corrective actions addressing the diesel release were overseen by the VDEQ Tidewater Regional Office (VDEQ Tracking No. PC#08-5052). A follow-up investigation was conducted in 2008 to evaluate the status of the site conditions. The 2008 supplemental investigation confirmed that petroleum contamination had decreased to less than the Saturation Action Level in soil, confirmed that groundwater was not significantly impacted by the Former Power Generating Plant, and acknowledged that soil and groundwater were being evaluated as part of the ongoing CERCLA actions at Sites 5 and 12. The Former Power Generating Plant Site was closed under the VDEQ Spills Program in 2008 (VDEQ, 2008). Data from the diesel release were included in the RI because the diesel release is co-located with other releases at the Sites.

A Draft Remedial Investigation/Feasibility Study (RI/FS) was completed for the Sites in December 2001 (Versar, 2001). As part of the RI/FS, NASA installed monitoring wells and collected ground water, surface soil, subsurface soil, sediment, surface water and fauna tissue samples were collected.

From 2000 to 2003, NASA conducted a Removal Action at the Sites to remove surface soil with PAH concentrations exceeding human health criteria for commercial/industrial-scenario receptors. Soil that exceeded benzo(a)anthracene at 7,800 micrograms per kilogram (µg/kg), benzo(a)pyrene at 780 µg/kg,

benzo(b)fluoranthene at 7,800 µg/kg, dibenzo(a,h)anthracene at 780 µg/kg, and indeno(1,2,3-cd)pyrene at 7,800 µg/kg were excavated and disposed off site. A total of 2,936 tons was excavated to a depth of approximately 2 feet and disposed at an off-site facility. Pre-Removal Action sampling was performed to determine the horizontal extent of the excavation areas, and post-Removal Action confirmation samples were collected to confirm that all objectives were met.

From 2003 to 2008, a Supplemental RI was conducted to address data gaps identified in the 2001 RI/FS. The data were used to determine potential impacts from remaining contaminated media in areas that were not included in the 2003 Removal Action.

In 2007, A TSCA removal action was conducted northwest of Building X-115 to address PCB-contaminated soil and concrete associated with a former transformer pad. PCB-contaminated soil in this area with concentrations greater than 10 milligram per kilogram (mg/kg) and concrete associated with the pad were excavated and disposed off-site. In addition, debris on the building floor and in the building sump and loose paint on the building interior walls were removed to reduce or eliminate potential future releases of PCBs to the environment. A total of 68 tons of soil and concrete were excavated to a maximum depth of approximately 3 feet and disposed at an off-site facility.

In 2008, an MEC sweep was conducted at Sites 5 and 12. This sweep resulted in the collection and disposal of 358 munitions items containing 20/30 millimeter fragments, projectiles, empty cartridges and 207 identified scrap metal items including pipe, rebar, nails, bolts, strapping, etc. The sweep addressed the visible surface area of the Sites and the top 2-feet of soil within the area of the Former Power Generating Plant (Tetra Tech, 2008b).

In 2008, a Site Characterization Addendum Report (SCAR) was completed for the Former Power Generating Plant. Monitoring wells were installed in the area of the Former Power Generating Plant and soil and groundwater samples were collected and analyzed for petroleum (TPH) and related constituents, and field testing was conducted to determine whether free product was present in the monitoring wells (Tetra Tech, 2008c). Based on the results of this investigation, free product and petroleum associated with this area was not found to be environmentally significant, and the Former Power Generating Plant Site was closed under the VDEQ Spills Program in August 2008 (DEQ Tracking Number: PC#08-5052) (VDEQ, 2008).

2.5.4 Nature and Extent of Contamination

Based on the findings in the RI and evaluation of potential risks to human health and the environment, upland soil, hydric soil, and sediment are the media of concern at Sites 5 and 12. Groundwater was not identified as a medium of concern in the RI. For human health, because of proximity, upland soil and

hydric soil will be considered as one medium (soil). For ecological receptors, because of potential erosion and proximity, upland soil, hydric soil, and sediment will be considered one medium (soil/sediment). Although contamination is not anticipated, analytical data for solids under paved areas are not available. The COCs associated with potential human and ecological exposure to soil and sediment at Sites 5 and 12 under current conditions are summarized below (Tetra Tech, 2008a).

Chemical of Concern	Maximum Site Concentration (mg/kg)	Human Health (Potential Future Use Residential) Soil	Ecological Risk Soil/Sediment
Chromium	248	No	Yes
Copper	367	No	Yes
Lead	1,520	No	Yes
Zinc	19,500	No	Yes
PCBs		Yes	Yes
Aroclor-1248	36		
Aroclor-1254	6.6		
Aroclor-1260	610		
PAHs		Yes	No
Benzo(a)anthracene	12		
Benzo(a)pyrene	10		
Benzo(b)fluoranthene	13		
Dibenz(a,h)anthracene	6		
Indeno(1,2,3-cd)pyrene			
DDTR		No	Yes [1]
DDT	0.39		
DDE	0.84		
DDD	0.495		

1. Although DDTR was identified as a potential risk to ecological receptors, its presence is widespread and does not appear to be associated with historical site activities. Implementation of remedial alternatives will result in a reduction of DDTR at the Sites.

Analytical data and COC-specific figures representing the extent of contamination at Sites 5 and 12 can be found in Appendix A of the 2009 Feasibility Study (Tetra Tech, 2009). For more details on the data for Sites 5 and 12, refer to the RI (Weiss, 2008)

2.5.5 Fate and Transport

Chromium, copper, lead, zinc, PCBs, PAHs, and DDTR have been identified as the COCs in soil and sediment at Sites 5 and 12. Fate and transport mechanisms operating on surface media appear to be the dominant migration paths for site COCs.

The migration of contaminants into air via the entrainment of contaminated soil particles by the wind (i.e., fugitive dust emissions) and volatilization, primarily of organic compounds, is a viable environmental fate and transport mechanism at Sites 5 and 12. However, it is of minimal importance due to the contaminant

concentrations and physical site characteristics (i.e., extensive vegetative and/or concrete cover, hydric soils, etc.).

The migration of contaminants from source areas to and within transitory impounded surface water and surface runoff, either directly or via storm water drainage, or eventually to the adjacent marshland/estuary is an important environmental fate and transport mechanism at Sites 5 and 12. This mechanism has resulted in site contaminants migrating to the sediments and/or marsh soil (e.g., PCBs, PAHs and metals), site soil and the palustrine marsh serve as sinks for contaminants due to the abundance of organic matter and fine-grained sediment present in the marsh. Based on the data from the estuarine study area, site contaminants have not migrated to downgradient receiving waters (e.g., Little Cat and Hog Creeks and the Main Channel) via this fate and transport mechanism. The migration of contaminants from soil to ground water by the percolation of surface water through contaminated soils is a principal environmental fate and transport mechanism at Sites 5 and 12.

Contaminants in soil, surface water and/or sediments may accumulate in terrestrial plants or organisms directly through bioconcentration or indirectly by bioaccumulation through the food chain. This contaminant migration into terrestrial biota is an extremely important environmental transport mechanism potentially affecting various plants and animals. This transport mechanism will be especially important for pesticides, PCBs, mercury, thallium, silver, zinc and barium, and of lesser importance for PAHs, copper, lead, nickel, cadmium and arsenic.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

Site 5 is located adjacent to Building X-30 and encompasses approximately 2 acres (Figure 2-3). A paint booth is located at this site and paint, paint thinner, and lacquers are currently used in the building. Contamination originating from the paint booth occurred in the past because of an inadequate exhaust venting from the building. The exhaust system has since been rebuilt to minimize emissions and undergoes annual inspections by VDEQ. Sandblasting is also conducted adjacent to the paint booth. Canvas barriers surround the sandblasting area; however, sandblasting grit is evident in soil in the surrounding area. This material has been sampled and is considered nonhazardous (Tetra Tech, 2008a).

Site 12 includes upland and marsh areas surrounding the Former Wind Tunnel Facility known as the Preflight Jet Facility and occupies an area of approximately 3.4 acres (Figure 2-3). Also included within this area is the Former Power Generating Plant, a diesel powered electrical generation facility for the island. The Former Power Generating Plant was present from 1947 through at least 1960 and located approximately 100 feet northwest of Building X-15. Two 30,000 gallon ASTs were associated with the power plant and at least one of the five 3,000 gallon USTs were known to exist on the island, but exact

locations are not known. The Former Power Generating Plant structure was demolished in 1984 and Building X-105 was demolished in 2008. Site 12 is currently not in use.

Sites 5 and 12 are not located close to residential areas and WFF plans to retain the Sites for future (non-residential) test facilities. Other active facilities currently located within 500 feet of Sites 5 and 12 are a fire department and an experimental model aircraft laboratory. Future activities in the area are anticipated to continue with current or similar applications. In addition, there are no current or future plans for groundwater use at Sites 5 and 12. Sites 5 and 12 are provided with potable water from off-site sources of groundwater.

2.7 SUMMARY OF SITE RISKS

2.7.1 Summary of Human Health Risk Assessment

The human health risk assessment evaluated potential risks from contaminants in soil to current/future commercial/industrial workers, current/future groundskeepers, current/future construction workers, and adult and child future residents. The projected carcinogenic health risks for the industrial workers, construction workers, and groundskeepers are within the United States Environmental Protection Agency (USEPA) acceptable risk range (10^{-4} to 10^{-6}). The soil at Sites 5 and 12 poses unacceptable health risks to potential future residents. The greatest health risk was calculated for the lifetime resident exposure to soil (1.9×10^{-4}). The risk to the lifetime resident is equivalent to the sum of the risks for the child and adult residents. The non cancer risk HI was 1.2 for a child, but organ specific HIs were all less than 1.0. The chemicals of potential concern (COPCs) contributing most to these risks were two PAHs (benzo(a)pyrene and dibenz(a,h)anthracene), two PCBs (Aroclor-1248 and -1260), and chromium in soil. The non carcinogenic risk estimate hazard quotient for site workers was less than 1.0, indicating that non carcinogenic risks would not be anticipated. The risk assessment in the Supplemental RI Report contains an evaluation of all COPCs and exposure pathways, including those that do not pose unacceptable risks to human health. COPCs are those chemicals that are identified as potential threats to human health and are evaluated further in the baseline risk assessment. COCs are a subset of COPCs that are identified in the RI/FS as needing to be addressed by the response action selected in this ROD.

Groundwater data were compared to human health risk criteria maximum contaminant levels (MCLs), established for drinking water pursuant to the Safe Drinking Water Act and background levels. Groundwater concentrations did not exceed MCLs and groundwater concentrations were similar to background concentrations. No unacceptable Site-related risks associated with potential exposure to groundwater were identified. Therefore, no action for groundwater is required.

2.7.1.1 Identification of Chemicals of Concern

Table 2-1 presents the COCs and exposure point concentrations for each of the COCs detected in soil based on the risk assessment in the RI Report. There are no COCs for groundwater, surface water or sediment. COCs in soil either result in an unacceptable risk or exceed a regulatory standard. The exposure point concentration is the concentration that was used to estimate the exposure and risk from each COC. Table 2-1 contains the concentration range of each COC in soil, the frequency of detection, the exposure point concentration, and how the exposure point concentration was derived.

The soil COCs that were evaluated because they could pose unacceptable risks to human health include chromium, copper, lead, zinc, Aroclor-1248, Aroclor-1254, Arolclor-1260, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]-anthracene, and indeno-[1,2,3-cd]pyrene. The contaminant contributing the majority of the risk is Aroclor-1260.

2.7.1.2 Exposure Assessment

This section presents a summary of the exposure assessment detailed in the RI Report (Weiss, 2008). The exposure assessment defines and evaluates the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, to identify potentially exposed populations, and to estimate chemical intakes under the identified exposure scenarios. Actual or potential exposures are based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has the following three components: a source of chemicals that can be released into the environment, a route of contaminant transport through an environmental medium, and an exposure or contact point for a human receptor. No unacceptable Site-related risks associated with potential exposure to groundwater were identified. Therefore, no action for groundwater is required.

The compilation of contaminant sources, likely exposure pathways, and receptors at Sites 5 and 12 is depicted in the CSM (Figures 2-4 and 2-5). Potential receptors include current and future industrial workers, future construction workers, and hypothetical future residents. Examples of activities for the industrial worker include groundskeeping, and utility or road work. Construction workers can be involved in any type of excavation activity. Future residential use is not a reasonably anticipated land use but was evaluated to determine whether unrestricted land use could be permitted. Potential exposure pathways evaluated in the risk assessment include direct contact with and ingestion of soils and inhalation of soil vapors.

Major assumptions about exposure frequency (days per year), exposure duration (years), and other exposure factors (e.g., body surface area for dermal exposure, ingestion rates) that were included in the exposure assessment can be found in the RI Report (Weiss, 2008).

2.7.1.3 Toxicity Assessment

Table 2-2 provides carcinogenic risk information for COCs in soil. All of the COCs have toxicity data indicating their potential for carcinogenic effects in humans.

Table 2-3 provides noncarcinogenic risk information for COCs in soil. All of the COCs have toxicity data indicating their potential for adverse noncarcinogenic effects in humans. At this time inhalation reference concentrations are only available for chromium.

2.7.1.4 Human Health Risk Characterization

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

$$Risk = CDI \times SF$$

Where: Risk = a probability (e.g., 2.0E-05) of an individual developing cancer (unit less)
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$

These risks are probabilities that are usually expressed in scientific notation (e.g., 1.0E-06). An excess lifetime cancer risk of 1.0E-06 indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This risk is referred to as an “excess lifetime cancer risk” because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. The EPA’s generally acceptable risk range for site-related exposure is 10^{-4} to 10^{-6}, or an excess lifetime cancer risk of 1 in 10,000 to 1 in 1,000,000.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An 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 of less than one indicates that a receptor's dose of a single contaminant is less than the RfD and that toxic noncarcinogenic effects from that chemical are unlikely. The hazard index (HI) is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver). An HI of less than one indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI greater than one indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$\text{Noncancer HQ} = \text{CDI}/\text{RfD}$$

Where: CDI = chronic daily intake
RfD = reference dose

CDI and RfD are expressed in the same units (e.g., mg-kg/day) and represent the same exposure period (i.e., chronic, subchronic, or short-term).

Carcinogenic Risks

The only unacceptable carcinogenic risk at Sites 5 and 12 was for the future lifetime resident. The total lifetime risk for a hypothetical resident exposed to contaminated soil is estimated to be 1.9E-04. Carcinogenic effects for all other evaluated receptors were within or less than the EPA acceptable risk range of 10^{-4} to 10^{-6}. The major contributing factors to the estimated lifetime carcinogenic risk are presented in Table 2-4 and summarized below.

Table 2-4 provides risk estimates for the hypothetical future child and adult resident for exposure to soil. The total risk from direct exposure to soil at Sites 5 and 12 for a future child resident is estimated to be 1.1E-04. The COC contributing most to this risk level is Aroclor-1260. This risk level indicates that, if no clean-up action is taken, an individual child resident would have an increased probability of about 1 in 10,000 of developing cancer as a result of Site-related exposure to the COCs in soil. The total risk from direct exposure to soil at Sites 5 and 12 for a future adult resident is estimated to be 8.4E-05. No unacceptable Site-related risks associated with potential exposure to groundwater were identified. Therefore, no action for groundwater is required.

These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's or adult's exposure to soil. The risk estimates were based on the toxicity of the COCs (chromium, copper, lead, zinc, Aroclor-1248, Aroclor-1254, Arolclor-1260, benzo[a]anthracene, benzo[a]pyrene, benzo[b]-

fluoranthene, dibenzo[a,h]-anthracene, and indeno-[1,2,3-cd]pyrene). No carcinogenic risks were associated with exposure to groundwater.

Noncarcinogenic Risks

Table 2-5 provides the HQs for the hypothetical future child resident for exposure to soil and the HI for all COCs. The only potential unacceptable non carcinogenic risk was for the future child resident. Non carcinogenic risks for all other evaluated receptors have an HI of less than one. The non cancer risk HI was 1.2 for a child, but organ specific HIs were all less than 1.0, indicating that non carcinogenic health effects are not anticipated.

Table 2-6 provides the HQs for the hypothetical future adult resident for exposure to soil and the HI for all COCs. The estimated HI of 0.2 indicates that there was no unacceptable non-cancer risk identified for an adult resident. The COC contributing most to the soil HI is chromium.

Uncertainty Analysis

At Sites 5 and 12, Aroclor-1260 is the major contributor to the carcinogenic risks for the soil pathway for the hypothetical future resident. Although the accepted basis for evaluating risk associated with exposure to Aroclor-1260 is to assume it is a carcinogen, there is uncertainty whether carcinogenic effects are the primary health effects expected to be manifested upon exposure to Arcolor-1260.

2.7.2 Summary of Ecological Risk Assessment

The ecological risk assessment (ERA) was performed to characterize potential risks to ecological receptors from Site-related contaminants. Details may be found in the RI Report (Weiss, 2008). The ERA for Sites 5 and 12 included the following steps of the eight-step ERA process:

- Step 1 – Preliminary Problem Formulation and Ecological Effects Evaluation
- Step 2 – Preliminary Exposure Assessment and Risk Calculation
- Step 3A – Refinement of COPCs
- Step 8 – Risk Management

2.7.2.1 Identification of Chemicals of Concern

Table 2-7 presents the COCs and HQs for each of the COCs detected in soil and sediment based on the risk assessment in the RI Report. Because the TSCA removal action conducted in 2007 significantly reduced PCB contamination at the Site, Site data for both the Pre- and Post-Removals are presented. Based on the ERA screening step, COCs for groundwater and surface water were not identified.

The soil and sediments posing unacceptable risks to ecological receptors consist of chromium, copper, lead, zinc, PCBs, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and DDTR.

2.7.2.2 Exposure Assessment

This section presents a summary of the exposure assessment detailed in the RI Report (Weiss, 2008). The habitat, contaminants present, migration pathways, and the routes by which receptors may be exposed to chemicals were defined and evaluated as part of the ERA. Sites 5 and 12 are upland/palustrine habitat, and the receptors evaluated in the ecological risk assessment were sediment dwelling insects and animals, terrestrial/wetland plants, aquatic life, soil invertebrates, birds, mammals, amphibians, and reptiles. The contaminant concentrations, occurrence, distribution, and potential effects data were evaluated to determine whether adverse risks to these receptors were likely from exposure to contaminants identified at Sites 5 and 12. The soil/sediment samples and data were collected prior to the 2007 TSCA removal action, during which the majority of the PCB-contaminated soil was removed from the Site.

Results of a qualitative ecological characterization for Sites 5 and 12 revealed that the Site includes an assemblage of upland terrestrial areas, marshes, and numerous unnamed tidal creeks. The Site's fauna included aquatic and terrestrial invertebrates, birds, mammals, and amphibians, which use the on-site habitats for cover, feeding, nesting, and as a migratory stopover point. The tidal marshes serve as a nursery for many fish species and aquatic invertebrates. Invertebrates such as calico crabs (*Ovalipes ocellatus)*, fiddler crabs (*Uca* spp.), sand shrimp (*Crangon septemspinosa*), and moon jelly (*Aurelia aurita*) are common. Fish commonly found in the main tidal creeks at Wallops Island include spot (*Leiostomas xanthurus*), bay anchovy (*Anchoa mitchilli*), northern pipefish (*Syngnathus fuscus*), dusky pipefish (*Syngnathus floridae*), bluefish (*Pomatomidae saltarix)*, and flounder (*Paralichthys dentatus*).

Birds such as the great blue heron (*Ardea herodias*), herring gull (*Larus argentatus*), laughing gull (*Larus atricilla*), and willet (*Catoptrophorus semipalmatus*) are commonly observed in the tidal wetlands and estuaries of Wallops Island and likely occur on Sites 5 and 12. Mammals also observed included masked shrew (*Sorex cinereus*), short-tail shrew (*Blarina brevicauda*), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), marsh rice rat (*Oryzomys palustris*), eastern cottontail (*Sylvilagus floridanus*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), and white-tailed deer (*Odocoileus virginianus*).

The US EPA recommends that receptor species be selected to represent a specific trophic level or feeding guild for assessing local food chain effects. This selection process was used to develop and

refine a simple conceptual food chain model which incorporates a variety of ecological receptors deemed representative of plant and animal communities associated with WFF Sites 5 and 12. Figure 2-5 presents the Ecological Conceptual Site Model for WFF Sites 5 and 12. The conceptual food chain model considered the following:

- Ecological receptors common to or expected to occur on-site;
- A simple food web applicable to the habitats observed on-site;
- Key endpoint receptors in the food web that may have the potential to bioaccumulate/ bioconcentrate contaminants through contact with a biotic media or consumption of contaminated biota;
- Selection of species whose life history and ecology are documented in the scientific literature; and
- A basis for empirically determining potential threats to key trophic level receptors based upon the scientific literature, and fate and transport characteristics for the contaminants of concern.

2.7.2.3 Ecological Effects Assessment

The characterization of ecological effects on the environment from VOCs, SVOCs, pesticides, metals, and PCBs was based on the following tests;

- Biota Tissue Samples
- Earthworm Toxicity Tests
- Amphipod Toxicity Test

Biota Tissue Samples

Fifteen stations and one reference station were designated for the collection of biota tissue samples, blue crab, killifish, mud crab, ribbed mussel and rodents. It was intended that all species, if present, were to be collected at each station. Analytical results of tissue samples indicated the following.

- Crabs: one VOC, one SVOC, one pesticide and ten metals were detected at six blue crab and mud crab sampling stations located throughout Hog Creek, Little Cat Creek, and their tributaries. None of these compounds were detected in the reference sample. However, due to the distance from the Site, it is uncertain if contaminants detected in the tissue are a direct result of site-related contaminants.

- Killifish: one VOC, one SVOC, one pesticide and sixteen metals were detected in the killifish tissue sampled collected from 5 of the 15 stations. No reference was collected as a means of comparison.

- Mussel: five VOCs, two SVOCs and fourteen metals were detected with concentrations exceeding reference concentrations. Mussels were collected from 5 sampling locations and 1 reference location.

- Rodents: one VOC, one SVOC, one pesticide, one PCB and eleven metals were detected at concentrations exceeding reference concentrations. Rodents were collected at 5 of the 15 sampling stations and the reference location.

Detected chemicals included 2-butanone, acetone, benzene, ethylbenzene, methylene chloride, toluene, xylenes, bis(2-ethylhexyl)phthalate, aroclor-1260, 4,4'-DDE and 21 metals.

Earthworm Toxicity Test

Toxicity tests are laboratory-controlled evaluations in which the largest number of variables may be maintained for evaluating contaminant effects as a product of concentration on a discrete toxicological endpoint. Such tests are performed under strict laboratory conditions and rarely reflect a natural state of exposure. Determination of toxicity is established by comparing cultured organisms in the evaluation versus the laboratory controls and reference conditions. Earthworm toxicity tests were conducted concurrently with the bioaccumulation tests due to low levels of detected PCBs and metals in the soil at Site 12. This test is specifically used to assess the bioaccumulation potential of earthworms and insectivorous receptors via earthworm consumption. The remaining toxicity tests for sediment and surface water were designed to provide site-specific risk estimates to potential ecological receptors.

A 14-day earthworm toxicity test was used as a line of evidence to support assessment endpoints. Test methods followed American Society for Testing Materials (ASTM) methods (ASTM, 1999) and the preferred test species was the red worm, *Eisenia fetida*. The primary endpoints for this test were earthworm survival and growth. Additionally, a background 14-day survival and growth assay and a 28-day earthworm bioaccumulation study were conducted at location kb-5.

Amphipod Toxicity Test

A 10-day toxicity test using a representative amphipod was performed for use as one line of evidence in assessing risks to benthic communities as part of an assessment endpoint. Endpoints for the 10-day evaluation were survival and growth. Based on the estuarine conditions observed out in the field, a 7-day

surface water chronic toxicity test (USEPA, 1996) was performed with the sheepshead minnow. Endpoints for this test were survival and growth.

Assessment Endpoints

Assessment endpoints for Sites 5 and 12 are discussed below:

- Benthic Macroinvertebrate Community Assessment (Assessment Endpoint No. 1) used two measurement endpoints as lines of evidence for the exposure characterization for the benthic community assessment endpoint: (1) Comparison of COPEC concentrations in the sediments of the unnamed tidal creeks and channels that directly flow into Little Cat and Hog Creeks and sediments from aquatic and wetland habitats present adjacent to the Site to sediment benchmarks in (Long, 1995) if estuarine in nature or (MacDonald, 2000) if palustrine, and (2) Evaluation of potential toxicity of COPECs in sediments to benthic organisms through whole sediment 10-day toxicity testing using a representative infaunal amphipod.

- Aquatic Life Communities Assessment (Assessment Endpoint No. 2) used three measurement endpoints as lines of evidence for the exposure and effects characterization for this assessment endpoint: 1) Comparison of contaminants concentrations in the on-site and off- site surface waters of the aquatic habitats present to ambient water quality criteria for estuarine environments; 2) Evaluation of potential toxicity of on-site surface waters using a 7-day toxicity and growth test with a representative salt water organism; and 3) comparison of ambient levels of contaminants in indigenous aquatic species to reference concentrations to determine if site related contaminants are being bioaccumulated.

- Terrestrial Plants and Invertebrates Assessment (Assessment Endpoints Nos. 3 and 4) used two or three lines of evidence to characterize risks to terrestrial plants and invertebrates: 1) A qualitative survey of the habitats was conducted by an ecologist as the first line of evidence; 2) Concentrations of all COPCs identified in the initial screening evaluation were compared with screening criteria protective of terrestrial plants, earthworms and microbial processes; and 3) Performance of 14-day earthworm toxicity and 28-day earthworm bioaccumulation tests were conducted and used as a third line of evidence.

- Terrestrial Wildlife Exposure Assessment (Assessment Endpoints Nos. 5, 6, 7, 8, 9, 10, 11, and 12) was part of the Supplemental BERA, risks to candidate wildlife assessment endpoints were assessed to determine if identified contaminants pose a risk to higher trophic level species using the habitats present. Species evaluated included the short tailed shrew (*Blarina brevicauda*), American robin (*Turdus migratorius*), raccoon (*Procyon lotor*), mink (*Mustela vison*), belted

kingfisher (*Ceryle alcyon*), red fox (*Vulpes vulpes*), red-tailed hawk (*Buteo jamaicensis*), and the eastern cottontail (*Sylvilagus floridanus*).

- Assessment Endpoint No. 13: Protection and Sustainability of Resident Reptile and Amphibian Populations, Three measurement endpoints were used as lines of evidence for this assessment endpoint: 1) Qualitative observations related to amphibian abundance observed in and around Sites 5 and 12 to those observed in a reference area; 2) Comparison of body burden levels in a reference population of amphibian species to the same species at Sites 5 and 12; and 3) Comparison of contaminant specific effects threshold concentrations to collected body burden data.

2.7.2.4 Ecological Risk Characterization

Based on the results of the baseline ecological risk assessment (BERA), low to moderate potential risks were identified in soil and sediment for the following receptor groups:

- Benthic communities
- Insectivorous, piscivorous, and carnivorous mammals
- Amphibians
- Soil invertebrate and microbial communities

The remaining receptors were found to be at no or low potential risk. Groundwater data were compared to ecological risk criteria and background levels. Groundwater concentrations were similar to background and/or screening criteria. No actionable or unacceptable risks associated with potential exposure to groundwater were identified. Therefore, no action for groundwater is required.

For benthic communities, the primary COCs were chromium, copper, lead, and zinc because these metals were detected at elevated concentrations in a sediment sample that was toxic to sediment invertebrates.

Risks to insectivorous mammals were based on elevated concentrations of Aroclor-1260 in small mammal tissue samples from the Site and HQs greater than 1.0 based on the No Observed Adverse Effects Level (NOAEL). DDT and its metabolites were also elevated in mammal tissue samples compared to samples collected from their reference locations. For piscivorous and carnivorous mammals, HQs were greater than 1.0 for Aroclor-1260 based on the NOAEL (assuming dietary exposure to amphibians only for piscivorous mammals). The estimated risk to representative receptors included a HQ of: 2.58 for the short-tailed shrew (insectivorous mammal); 12.3 for the red fox and 1.79 for the red-

tailed hawk (carnivorous mammals); and 2.82 for the mink (piscivorous mammals). However, if the home ranges for piscivorous and carnivorous mammals were accounted for in the food chain model, potential risks would likely be low. In addition, most of the Aroclor-1260 was removed from the Site as part of the 2007 TSCA removal action and residual risks associated with Aroclor-1260 should be significantly reduced.

Risks to amphibians were based on concentrations of Aroclor-1260 and DDTR in toad tissue samples that exceeded residue-based toxicity reference values. Direct adverse effects on amphibians were observed in two of eight samples at the Sites. One of the samples contained elevated concentrations of several metals (e.g. chromium, copper, lead and zinc at concentrations greater than proposed cleanup levels). The second sample did not contain elevated metal concentrations, but as discussed in the Remedial Investigation Report, the survival rates may have been affected by salinity and hydrogen sulfide variances in that location. In addition, contaminants in these organisms can bioaccumulate/ biomagnify and affect upper food chain receptors. There is no evidence that DDTR is site-related and there are no reports of storage or disposal of it at the Sites. In addition, the wide spread distribution and range of concentrations detected are characteristic of commercial application of DDT in the area for control of insect populations.

For soil invertebrate and microbial communities, site-specific toxicity testing did not reveal any toxic effects to the earthworm test species. Survival and growth rates were similar to reference locations. However, these tests did not include soil samples from areas where the greatest concentrations of metals (in particular lead and zinc) were detected. Therefore, the maximum detected concentrations of lead and zinc in the tested soil samples are considered No Observed Effects Concentrations (NOECs). Table 2-8 presents COC concentrations expected to provide adequate protection of ecological receptors at Sites 5 and 12 based on NOEC and LOEC protective level values.

2.7.3 Risk Assessment Conclusions

The only unacceptable risks to human health are for the hypothetical child and adult residents who come in contact with soil. There are no unacceptable risks to other human receptors under current land use and the expected future use of the Sites for commercial/industrial purposes. The groundwater, surface water, sediment and vapor exposure pathways were considered. Surface water is not present on site and no COCs were identified for groundwater. The main risk driver for soil is Aroclor-1260.

Chromium, copper, lead, zinc, PCBs, and DDTR in soil/sediment represent a potential threat to ecological receptors, including benthic communities, insectivorous, piscivorous, and carnivorous mammals, amphibians, and soil invertebrate and microbial communities.

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The response action selected in this ROD is necessary to protect human health and the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment.

2.8 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) provide a general description of what the cleanup will accomplish. These levels typically serve as the design basis for many of the remedial alternatives that are discussed in Section 2.9. The RAOs provide the basis for evaluation of clean-up options for the Sites and an understanding of how the risks identified in the previous section will be addressed by the response action. Based on the recommendations in the FS, the only medium of concern at Sites 5 and 12 is shallow soil.

The RAOs for remedial action at Sites 5 and 12 are summarized as follows:

- Protection of human health by preventing residential exposure to contaminated soil
- Protection of ecological receptors from exposure to contaminated soil and sediment

The Site 5 and 12 chemicals of concern and associated cleanup goals for these RAOs are presented in Table 2-9. The cleanup goals presented in Table 2-9 are the more stringent of the human health- and ecological-based values. Also presented in Table 2-9 is the basis for establishing the cleanup goals. In addition to these RAOs, remedial actions should not interfere with NASA's ability to perform its mission at WFF. Based on the widespread distribution of low-concentration PAHs and the potential for non site related sources, 1×10^{-5} ILCR was determined to be protective for PAHs at these Sites.

RAOs were not developed for groundwater. There are no unacceptable risks to human health under a residential land use scenario or to ecological receptors from exposure to groundwater.

DDTR was determined to not be site-related and is present throughout the area. Risks associated with DDTR will be reduced during remedial actions to address PCB and metal contamination.

2.9 DESCRIPTION OF ALTERNATIVES

Remedial alternatives evaluated for Sites 5 and 12 soil/sediments are presented below. More detailed descriptions of the alternatives can be found in the FS Report (Tetra Tech, 2009).

2.9.1 Description of Remedy Components

This section provides a list of the major components of each alternative as they occur in the remediation process. Each list includes treatment components and the materials they will address, institutional controls, O&M activities requirements to maintain the integrity of the remedy, and monitoring requirements. In addition, the Applicable or Relevant and Appropriate Requirements (ARARs) are listed and summarized in Table 2-10 of this ROD.

Four alternatives were ultimately developed and retained for consideration during the FS; these alternatives are presented as Site Wide alternatives in the FS and are described in the following sections.

- Alternative 1: No Action
- Alternative 2: Excavation and Off-Site Disposal of Contaminated Soil/Sediment Exceeding Ecological Risk Based Gleanup Goals and Land Use Controls to Protect Human Health and Environment
- Alternative 3: Excavation and Off-Site Disposal of Contaminated Soil/Sediment Exceeding Human Health and Ecological Risk Based Cleanup Goals
- Alternative 4: Excavation and On-Site Consolidation of Contaminated Soil/Sediment Exceeding Human Health and Ecological Risk Based Cleanup Goals Under a Soil Cover for the Protection of Human Health and the Environment

2.9.1.1 Alternative 1: No Action

CERCLA requires evaluation of a No Action alternative. Under this alternative, no action would be taken to reduce the potential risks at Sites 5 and 12. The No Action alternative would not meet any of the RAOs for the Sites. Alternative 1 is retained as required by CERCLA for comparison with other alternatives. There is no cost for this alternative with the exception of $36,000 for recurring 5 year reviews as waste will be left in place above unrestricted use.

2.9.1.2 Alternative 2: Excavation and Off-Site Disposal of Contaminated Soil/Sediment Exceeding Ecological Risk Based Cleanup Goals and Land Use Controls to Protect Human Health-

This alternative includes the removal of approximately 760 cubic yards (CY) of contaminated soil over an area of 10,260 square feet (SF) to a depth of 2 feet. The excavation limits would be defined by soil with concentrations that exceed ecological risk based cleanup goals as described in Section 2 [Remedial Action Objectives and General Response Actions] and Table 2-7 [Preliminary Remediation Goal Development] of the FS. The ecological clean up goals were based on the lowest contaminant

concentration where certain plants or animals showed adverse effects to growth, development, reproduction, and survival. This alternative would also include the collection of verification samples, including under demolished Site features, to confirm the removal of soil contamination at concentrations that cause unacceptable ecological risk. Verification samples would be analyzed for PAHs, pesticides, PCBs and metals. This alternative would also include the demolition of Site features including concrete slabs, pads, cradles, roadways, and Building X-115. Upland excavated areas would be backfilled with clean soil and planted with native vegetation. This alternative will involve the removal of contaminated sediments from 0.25 acre of wetland. Following excavation, the area will be returned to equivalent or improved ecological conditions.

Additionally, this alternative would include the implementation of land use controls (LUCs) over 12,200 square feet of Sites 5 and 12. The LUC limits for Alternative 2 would be defined by soil with PAHs and PCBs concentrations that cause unacceptable human health risks. The LUCs associated with this alternative would include institutional controls to prohibit potential future residential development within the identified areas and annual inspections of the Site to assure the continued use of LUCs, and to evaluate Site conditions. Because contaminants would remain On-Site, Site reviews would be performed every 5 years to evaluate Site status to assess the continued adequacy of these remedial activities, and to determine whether further action is necessary. For this alternative, the estimated present-worth cost is $1,043,000. The estimated present-worth cost estimate is based on a capital cost of $971,000, annual LUC site inspections of $2,900 per year, and Five-Year Reviews of $16,500 per event for a period of 30 years. For a breakdown of cost, see Section 2.10.7. It would take an estimated 2 months of construction to implement this alternative.

2.9.1.3 Alternative 3: Excavation and Off-Site Disposal of Contaminated Soil/Sediment Exceeding Human Health and Ecological Risk Based Cleanup Goals -

This alternative would include the removal of approximately 1,400 cubic yards of soil over an area of 18,900 square feet to a depth of 2 feet. The excavation limits for Alternative 3 would be defined by soil with COC concentrations that exceed the Cleanup Goals (NOEC-based) presented in Table 2-7 and Section 2 [Remedial Action Objectives and General Response Actions] and Table 2-7 [Preliminary Remediation Goal Development] of the FS. The ecological clean up goals were based on the concentration of contaminants where certain plants or animals show no adverse effects to growth, development, reproduction, and survival. The human health clean up goals were based on the concentration of contaminants which do not pose unacceptable Human Health risk below a 1×10^{-5} lifetime cancer risk. Based on the widespread distribution of low-concentration PAHs and the potential for non site related sources, 1×10^{-5} ILCR was determined to be protective for PAHs at these Sites. This alternative would also include the collection of verification samples, including under demolished Site features, to confirm the removal of soil contamination at concentrations that cause unacceptable

ecological risk. Verification samples would be analyzed for PCBs, DDT, and metals. This alternative would also include the demolition of Site features including concrete slabs, pads, cradles, roadways, and Building X-115. Upland excavated areas would be backfilled with clean soil and planted with native vegetation. This alternative will involve the removal of contaminated sediments from 0.40 acre of wetland. Following excavation, the area will be returned to equivalent or improved ecological conditions.

Additionally, this alternative would include the removal of approximately 920 cubic yards of soil over an area of 12,200 square feet to a depth of 2 feet. The excavation limits would be defined by soil with COC concentrations that cause unacceptable human health risks under a potential future residential use scenario (PAHs and PCBs, as defined in Section 2 [Remedial Action Objectives and General Response Actions] and Table 2-7 [Preliminary Remediation Goal Development] of the FS). This additional excavation area is adjacent to areas that are being excavated to achieve ecological clean up goals (See Figure 2-6). The alternative would also include collection of verification samples to confirm the removal of soil contamination at concentrations that cause unacceptable human health risk. Verification samples would be analyzed for PAHs and PCBs. For this alternative, the estimated present-worth cost and capital cost are $1,383,000. There are no O&M costs associated with this alternative. It would take an estimated 2 months of construction to implement this alternative.

2.9.1.4 Alternative 4: Excavation and On-Site Consolidation of Contaminated Soil/Sediment Exceeding Human Health and Ecological Risk Based Cleanup Goals Under a Soil Cover for the Protection of Human Health and the Environment -

This alternative would include the On-Site consolidation of contaminated soil and sediment at Site 12 under a vegetated cover. The contaminated soil and sediment consists of material that exceeded Cleanup Goals for humans and ecological receptors. The ecological clean up goals were based on the concentration of contaminants where certain plants or animals show no adverse effects to growth, development, reproduction, and survival. The human health cleanup goals were based on concentration of contaminants which do not pose unacceptable Human Health risk below a 1×10^{-5} lifetime cancer risk. After excavation and consolidation, the contaminated soil and sediments would be covered by a bio-engineered soil cover using clean fill, soil, and native vegetation. This alternative would include verification sampling, including under demolished Site features, to confirm the removal limits. In addition, this alternative would include the demolition and off-site disposal of Site features including concrete slabs, pads, cradles, roadways, and Building X-115. This alternative will involve the removal of contaminated sediments from 0.40 acre of wetland. Following excavation, the area will be returned to equivalent or improved ecological conditions. If during excavation, soil or sediment is encountered with PCB concentrations exceeding 50 mg/kg, the material will be managed and disposed off site as a TSCA waste.

This alternative would include LUCs to prohibit residential use (1×10^{-5} ILCR) and limit construction activities at Site 12 in the vicinity of the soil cover. Also, the PAH-contaminated soil at Site 5 would remain in place with a vegetated soil cover. This option would also include periodic inspections to confirm soil cover integrity, and protectiveness of the LUCs. The cover would be maintained and repaired as needed in the event that erosion or animal burrows cause damage to the cover. Because contaminants would remain On-Site after the implementation of the alternative, Five-Year Reviews would be conducted to evaluate the protectiveness of the cover and the LUCs. For this alternative, the estimated present worth cost is $1,389,000. The present-worth cost estimate is based on a capital cost of $1,141,000, quarterly LUC site and cover inspections and semiannual mowing of the cover of $14,300 per year, assumed cap repairs every 5 years of $13,000 per event, and Five-Year Reviews of $19,500 per event for a period of 30 years. For a breakdown of cost, see Section 2.10.7. It would take an estimated 3 months of construction to implement this alternative.

2.9.2 Common Elements and Distinguishing Features of Each Alternative

No response actions would be implemented under Alternative 1, the no-action alternative.

Alternatives 2 and 3 include excavation and off-site disposal to reduce COC concentrations in soil. Alternative 4 includes excavation and on-site consolidation under a soil cover. Alternatives 2 and 4 would require LUCs and Alternative 3 would use excavation and off site disposal in order to meet ecological and human health Cleanup Goals.

LUCs are a component of Alternatives 2 and 4 to prohibit residential use (1×10^{-5} ILCR) and limit construction activities at the Site. Because contaminants would remain On-Site, Site reviews would be performed every 5 years to evaluate Site status to assess the continued adequacy of these remedial activities, and to determine whether further action is necessary.

Alternatives 2, 3, and 4 include collection of verification samples to confirm the removal of soil/sediment contamination at concentrations that cause unacceptable ecological or human health risk. Verification samples would be analyzed for PCBs, PAHs, DDT and metals.

Five-Year Reviews would be required for Alternatives 1, 2, and 4. Alternative 3 will not result in hazardous substances, pollutants, or contaminant remaining on site above levels and allow for unlimited use and unrestricted exposure.

Alternatives 2, 3, or 4 would each require approximately 2 to 3 months in the field. The RAOs would be achieved once the field activities are complete (for Alternative 3) and LUCs are implemented (for Alternatives 2 and 4).

The present-worth costs of Alternatives 2, 3, and 4 are assessed based on capital costs (initial cost to implement) and annual O&M costs. The estimated present-worth costs are as follows:

- Alternative 1: $36,000
- Alternative 2: $1,043,000
- Alternative 3: $1,383,000
- Alternative 4: $1,389,000

2.9.3 Expected Outcome of Each Alternative

For Alternative 1, no LUCs would be implemented, thereby resulting in unacceptable risks to human health and the environment from exposure to contaminated soil and sediment.

For Alternative 3, the Site would allow for unrestricted future use and risks to ecological receptors would be eliminated. For Alternatives 2 and 4, risk to ecological receptors would be minimal and potential risk to human heath would be controlled. LUCs would be in place to restrict soil exposure to potential future residents. Site activities would be controlled through restrictions documented in the Facility Master Plan. The LUCs would be required for an extended period of time.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The objective of the comparative analysis of alternatives is to evaluate the relative performance of the alternatives with respect to the nine evaluation criteria established in the NCP so that the advantages and disadvantages of each are clearly understood. The first two evaluation criteria, Overall Protection of Human Health and the Environment and Compliance with ARARs, are threshold criteria that must be satisfied by a remedial alternative chosen for a site. Table 2-11 contains a summary of the comparative analysis of alternatives.

2.10.1 Overall Protection of Human Health and the Environment

Alternative 1 would not provide protection of human health and the environment because contaminants would remain in soil at the Sites. Adverse affects on ecological receptors would continue, and future potential residential receptors could be exposed to site contaminants at concentrations greater than the Cleanup Goals.

The implementation of Alternatives 2, 3, and 4 would be protective of human health and the environment. Under Alternative 2, contaminated soil and sediment that is affecting ecological receptors would be removed from the Site and land use controls would be used to protect human health from residual Site contamination. Contaminated soil and sediment that may affect ecological receptors would remain (i.e., those soils with contaminant concentrations between greater than NOECs but less than LOECs). The soil and sediment that would remain at Sites 5 and 12 under Alternative 2 would contain greater chemical concentrations than would remain under Alternative 3, which is based on NOECs. The land use controls would prohibit residential development at the Sites. Under Alternatives 3 and 4, exposure to all of the contaminated soil and sediment that is affecting ecological receptors and potential future human receptors would be addressed. Under Alternative 3, contaminated soil and sediment would be excavated and disposed off-site, whereas under Alternative 4, most of the contaminated soil and sediment would be consolidated On-Site under a bio-engineered soil cover at Site 12. At Site 5, the PAH-contaminated soil would remain in place and a vegetated cover would be constructed over it. LUCs would be implemented to prohibit future residential development.

Alternative 3 would provide more protection to ecological receptors than Alternative 2, because Alternative 3 would remove all of the soil with contaminant concentrations that exceed ecological criteria, whereas Alternative 2 would leave some contaminated soil and sediment that has the potential to affect some ecological receptors. Alternative 3 would also provide more protection of human health than Alternative 2, because Alternative 3 would remove contaminants and Alternative 2 would only include access restrictions. Alternative 3 also would provide more protection to human health and the environment than Alternative 4, because under Alternative 4, contaminated soil and sediment would remain On-Site under a cover, but would require long-term maintenance and LUCs to assure long term protectiveness.

Under Alternatives 2, 3 and 4, excavations would be conducted in wetlands. Implementation of any of these remedies will require returning the impacted wetlands to equivalent or improved ecological conditions.

2.10.2 Compliance with ARARs

Federal TSCA regulations (40 CFR 761.61) governing the management, transportation and disposal of PCB contaminated media has been identified as a potential chemical specific ARAR. If during excavation, soil or sediment is encountered with PCB concentrations exceeding 50 mg/kg, the material will be managed and disposed off site as a TSCA waste under Alternatives 2, 3 and 4 to comply with this ARAR. Location- and action-specific ARARs have not been identified for Alternative 1. Alternatives 2, 3, and 4 would involve excavation in a wetland area to remove contaminated sediments. Alternative 2 and 3

also would include transportation and disposal of contaminated soil and sediment off-site. Wetland ARARs include federal Clean Water Act Section 404 requirements and similar state requirements (Wetlands Policy 9 VAC 25-380 and Water Resources Policy 9 VAC 25-390). Since the actions would involve the removal of contamination from Site wetlands and the wetlands would be restored, Alternatives 2, 3, and 4 alternatives would comply. Off-site transportation of waste also would comply with applicable sections of Virginia Solid Waste and Hazardous Waste Regulations. Off-site disposal would comply with applicable requirements of the state receiving the waste. In addition, although not an ARAR, Federal Executive Order 11989 requires that Federal activities in floodplains must reduce the risk of flood loss, minimize impact of floods on human safety, health, and welfare, and preserve the natural and beneficial values served by floodplains. Sites 5 and 12 are located in the 100-year floodplain. Federal agencies must follow executive orders.

2.10.3 Long-Term Effectiveness and Permanence

Alternative 1 would have very limited long-term effectiveness and permanence because no contaminant removal or reduction would occur through treatment. Although over time some reduction in PAHs would occur through natural attenuation, PCB and metals contamination would remain for an extended period of time. Because there would be no LUCs to restrict residential development, unacceptable risk to human and ecological receptors to contamination would remain. There are no current plans for residential development in this area.

Alternatives 2, 3, and 4 would provide long-term effectiveness and permanence for the portions of Sites 5 and 12 that are affected by the associated excavations. Alternative 3 would remove all the contaminated media from the Sites. Alternative 4 would eliminate the exposure route to the contaminated media, but the contaminated media would remain on-site, requiring long-term O&M and LUCs to assure protectiveness. Alternative 2 would leave residual contamination on site that may continue to have some adverse effects on ecological receptors. The long-term effectiveness of LUCs for 2 and 4 would depend on controls of future development at the Sites. As long as the property remains under control of the government, the LUCs would be very effective. In the event the property is transferred, the LUCs may not be as effective. For Alternative 3, the contaminated soil/sediment that presents a potential risk to human health and environment would be removed and encapsulated in an off-site landfill.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the alternatives being considered achieve any reduction of toxicity, mobility, or volume of COCs through active treatment. All of the alternatives have the potential to achieve irreversible reduction of

PAH toxicity and volume through natural attenuation. PCB and metals contamination would remain for an extended period of time.

2.10.5 Short-Term Effectiveness

The implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment, because no remedial activities would be performed.

Implementation of Alternatives 2, 3, and 4 would include excavation and handling of contaminated soil and sediment, so associated risks to construction workers and the environment are possible. However, these risks of exposure could be effectively controlled using personal protection equipment, compliance with proper site-specific health and safety procedures, and utilizing proper best management practices to prevent the migration of contamination through sediment transport and dust. Short-term impacts to wetlands under Alternatives 2, 3, and 4 would occur during excavation of contaminated sediment. After the removal is complete, equivalent or better quality wetlands should develop.

Alternatives 2, 3, or 4 would each require approximately 2 to 3 months in the field. The RAOs would be achieved once the field activities are complete (for Alternative 3) and LUCs are implemented (for Alternatives 2 and 4).

2.10.6 Implementability

Alternative 1 would be easiest to implement because there would be no activities to implement. Both Alternatives 2 and 3 would involve excavation and off-site disposal of contaminated soils and debris. Alternative 4 would involve the same excavation as 3, but would consolidate the materials on-site under a bio-engineered soil cover. The construction activities associated with these alternatives would include conventional construction activities that could be easily implemented. Excavation in the wetland areas may require that substantive portions of a wetland permit be complied with. NASA WFF plans to construct new facilities at Sites 5 and 12, which may preclude the on-site consolidation / long-term soil cover Alternative 4.

2.10.7 Cost

The estimated present-worth costs for Alternatives 1, 2, 3, and 4, range from $36,000 for Alternative 1 to $1,389,000 for Alternative 4. Capital, annual O&M, and present-worth costs for each of the alternatives are summarized in the table below. A detailed cost estimate for the selected Alternative, Alternative 3, is provided in Table 2-12 of this document. The O&M cost and 5-year cost in the table below are summed

as Net Present Worth utilizing compounding interest over a 30-year period for each alternative. For example, the cost for the five-year review for Alternative 1 is budgeted over a 30-year period. To fund the first five-year review, $11,765 will need to be put in an escrow account at present time. Funding for the second ($8,382), third ($5,973), fourth ($4,257), fifth ($3,036) and sixth ($2,162) five-year reviews are also put in the escrow account at this time. Therefore, total amount of money needed at present time for Alternative 1 is $35,574, which is rounded to $36,000. The present worth cost utilizes a 7% annual discount rate (see the Appendix C in the Feasibility Study for additional details).

Alternative	Capital Cost ($)	O&M Costs		Net Present Worth Cost ($)
		Annual ($/Year)	Five-Year Activities ($ per event)	
1	0	0	16,500	36,000
2	971,000	2,900	16,500	1,043,000
3	1,383,000	0	0	1,383,000
4	1,141,000	14,300	32,500	1,389,000

2.10.8 State Acceptance

The Commonwealth of Virginia has expressed its support of Alternative 3 and agrees with the Selected Remedy described in Section 2.12 below.

2.10.9 Community Acceptance

Because no comments were expressed at the public meeting, and no written comments were received during the public comment period, it appears that the community generally agrees with the Selected Remedy. Specific details regarding the public comment period can be found in the Responsiveness Summary section of this ROD.

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 CFR 300.430(a)(1)(iii)(A)]. Based on the results of the investigations, studies, and sampling conducted, the contaminated soil at Sites 5 and 12 does not constitute a principal threat waste as defined by the NCP. 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. Contaminated soil is generally not considered to be a source material.

2.12 SELECTED REMEDY

2.12.1 Summary of Rationale for the Selected Remedy

The Selected Remedy for Sites 5 and 12 is Alternative 3. This alternative meets the RAOs, provides adequate protection of human health and the environment, attains ARARs, and provides the best balance of tradeoffs with respect to the balancing and modifying criteria. Alternative 3 excavation and off-site disposal and is expected to attain all RAOs in a similar time as Alternatives 2 and 4. Although Alternatives 2 and 4 also include excavation, Alternative 3 is equally as effective as these alternatives and will not require the additional costs of LUCs and five-year reviews. Alternative 3 would be easier to implement than Alternative 4. For groundwater, because site-related risks or ARAR exceedences were not identified, no action will be required for that medium.

2.12.2 Description of Selected Remedy

The Selected Remedy was formulated and analyzed to evaluate a remedial action that removes all known and potential risks to ecological and human receptors under the future residential scenario. This alternative would include the removal of approximately 2,320 CY of soil over an area of 31,200 SF to a depth of 2 feet (see Figure 2-6). The excavation limits for the Selected Remedy would be defined by soil with COC concentrations that exceed the Cleanup Goals (NOECs described in Section 2.0 of the FS and soil with COC concentrations that cause unacceptable human health risk at the 1×10^{-5} ILCR). The alternative would also include the collection of verification samples to confirm the removal of soil contamination causing unacceptable ecological and human health risk. Verification samples would be analyzed for PAHs, PCBs, and site-specific metals. If necessary, additional soils and sediments would be removed.

Following excavation in the identified wetlands, the area will be returned to equivalent or improved ecological conditions. The upland area excavations would be backfilled with two feet of vegetative soil material and revegetated. The area between the upland and wetland areas would be graded and vegetated to establish a more natural transition zone than the current abrupt drop off. A Remedial Design (RD) will be prepared to provide grading and vegetation requirements.

Although the remedial action portion of this alternative is limited to the removal of soil identified in Figure 2-6 to a depth of 2 feet, collection of verification samples, and restoration of Site 12, supplemental activities would be conducted under the Selected Remedy to establish a more beneficial (less-invasive plant species and gently sloped transition zone) ecological habitat in the area. All construction/ excavation-derived material and investigation-derived waste would be characterized prior to disposal.

2.12.3 Summary of Estimated Remedy Costs

Cost estimate summaries for the Selected Remedy are provided in Table 2-12 (capital cost), the information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. The estimated present-worth of the selected remedy is $1,383,000. Changes in the cost elements may occur because of new information or data collected during the engineering design of the selected remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences (ESD), or a ROD amendment depending on the scope of the change. This is an order-of-magnitude engineering cost estimate that is expected to be within plus 50 to minus 30 percent of the actual project cost. These estimates are refined as the remedy is designed and implemented.

2.12.4 Expected Outcomes of the Selected Remedy

After the Selected Remedy has been implemented, soil/sediment will no longer pose a risk to human health or the environment. There will be unrestricted use for soil. Exposure to all of the contaminated soil/sediment that is affecting ecological receptors (actual and potential) and potential future human receptors would be removed from the Sites. The estimated time to achieve RAOs is 3 months in the field.

2.12.5 Performance Standards

Clean-up levels for the COCs are as follows (See Table 2-9):

- Chromium – 80.3 mg/kg
- Copper – 48.6 mg/kg
- Lead – 131 mg/kg
- Zinc – 378 mg/kg
- PCBs (total) – 1.0 mg/kg
- Benzo(a)anthracene – 6.2 mg/kg
- Benzo(a)pyrene – 0.62 mg/kg
- Benzo(b)fluoranthene – 6.2 mg/kg
- Dibenzo(a,h)anthracene – 0.62 mg/kg
- Indeno(1,2,3-cd)pyrene – 6.2 mg/kg

NASA will prepare a Remedial Design and Remedial Action Work Plan and Reports for EPA and DEQ review and EPA approval. These documents will detail the excavation, sampling and analysis, backfill, regrading, revegetation, and site restoration requirements to be implemented as part of the Selected Remedy.

2.13 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the toxicity, mobility, or volume of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The Selected Remedy, Alternative 3, will protect human health and the environment by excavating the contaminated soil and sediment with off-site disposal. After implementation, contaminated media will not remain at the Site.

There are no short-term threats associated with the Selected Remedy that cannot be readily controlled. In addition, proper controls such as silt fencing or biobarriers will be used to control cross-media impacts during implementation of the Selected Remedy.

2.13.2 Compliance with ARARs

The Selected Remedy will meet all identified ARARs. Federal and State ARARs for the Selected Remedy are identified and summarized by classification in Table 2-10.

2.13.3 Cost-Effectiveness

In NASA's and EPA's judgment, the Selected Remedy is cost effective. In making this determination, the following definition was used [40 C.F.R. 300.430(f)(1)(ii)(D)]: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." NASA first evaluated the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and in 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). The overall effectiveness of all the alternatives was considered and then compared to each of their costs.

The estimated present-worth cost of the Selected Remedy (Alternative 3) is $1,383,000. Although Alternative 2 is approximately $430,000 less expensive than the Selected Remedy, it requires long term LUCs and O&M, provides less protection of ecological receptor, and would interfere with planned future uses of the area. Present-worth costs for Alternative 4 is approximately $6,000 more expensive than for the Selected Remedy, and is generally equally effective at attaining the clean-up levels in the same time frame; however, it would result in the contamination remaining on site under a soil cover, it requires long term LUCs and O&M, and would interfere with planned future uses of the area.

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

NASA and EPA, with DEQ concurrence, have determined that the Selected Remedy Alternative 3: Excavation and Off-Site Disposal of Contaminated Soil/Sediment Exceeding Human Health and Ecological Risk Based Cleanup Goals represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, NASA and EPA have determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria. NASA and EPA also considered the statutory preference for treatment as a principal element and state and community acceptance.

The Selected Remedy would remove all the contaminated soil and sediment from the Sites. The contaminated soil and sediment that presents a potential risk to human health and environment would be removed and encapsulated in an off-site landfill. The Selected Remedy could be completed within 2 to 3 months. At the time of completion RAOs would be achieved with no risk remaining to human health or the environment. The Selected Remedy does not present short-term risks different than the other alternatives. There are no special implementability issues that set the Selected Remedy apart from any of the other alternatives evaluated.

2.13.5 Treatment as a Principal Element

Based on the results of the investigations, studies, and sampling conducted, the contaminated soil and sediment at Sites 5 and 12 does not constitute a principal threat waste as defined by the NCP. 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 Site COCs are present at relatively low concentrations and are not mobile.

2.13.6 Five-Year Review Requirement

Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for Sites 5 and 12 at NASA WFF, Wallops Island, Virginia was released for public comments March 17, 2010. The Proposed Plan identified Alternative 3, Excavation and Off-Site Disposal of Ecological NOEC-Contaminated Soil/Sediment and Excavation and Off-Site Disposal of PAH-Contaminated Soil for Protection of Human Health (Residential Use – 1×10^{-5} ILCR), as the preferred alternative. No written or verbal comments were submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

3.0 RESPONSIVENESS SUMMARY

In accordance with Sections 113 and 117 of CERCLA, NASA provided a public comment period from March 17, 2010 to April 19, 2010 for the proposed remedial action described in the Proposed Plan for Sites 5 and 12. Public input is a key element in the decision-making process.

The Proposed Plan is available to the public in the Administrative Record. The RI and FS Reports are also available in the Administrative Record. The Information Repositories for the Administrative Record are maintained by the Eastern Shore Public Library (23610 Front Street, Accomack, Virginia 23301) and the Island Library (4077 Main Street, Chincoteague, Virginia 23336). The Proposed Plan was made available on March 17, 2010.

A public meeting to present the Proposed Plan for Sites 5 and 12 was held at the NASA WFF Visitor Center on March 24, 2010. Public notice of the meeting and availability of documents was placed in the Chincoteague Beacon and Eastern Shore News on March 17, 2010.

No comments were received by NASA, EPA, or DEQ during the public comment period. Representatives of NASA, EPA, and DEQ were available at the public meeting to present the Proposed Plan for Sites 5 and 12 and to answer questions on the proposed remedy.

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TABLES

TABLE 2-1

SUMMARY OF CHEMICALS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Exposure Point	Chemical of Concern	Maximum Concentration Detected (mg/kg)	Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
Soil – ingestion, dermal contact, inhalation	Chromium	248	90/90	62	95% UCL
	Copper	369	83/87	73	95% UCL
	Lead	1,520	89/90	110(1)	Ave
	Zinc	19,500	90/90	1,105(2)	95% UCL
	Aroclor-1248	36	5/326	0.87	95% UCL
	Aroclor-1254	6.6	24/326	0.31	95% UCL
	Aroclor-1260	610	131/326	14.5	95% UCL
	Benzo(a)anthracene	12	153/245	1.21	95% UCL
	Benzo(a)pyrene	10	147/245	1.17	95% UCL
	Benzo(b)fluoranthene	13	163/245	1.35	95% UCL
	Dibenz(a,h)anthracene	1.4	22/245	1.16	95% UCL
	Indeno(1,2,3-cd)pyrene	6	135/245	1.01	95% UCL

UCL: Upper confidence limit.
mg/kg: milligrams per kilogram

This table presents the chemicals of concern (COCs) and exposure point concentrations (i.e., the concentration that will be used to estimate the exposure and risk) for each of the COCs detected in soil.

Notes:
Arithmetic mean calculated using detected concentrations
Average concentration calculated using detected concentrations and the ½ the SQL for non-detected concentrations.
Average Concentration (Ave)

(1) Based on USEPA Technical Review Workgroup for Lead, the EPC is the average concentration.
(2) 95% UCL based on lognormal distribution.

TABLE 2-2

CANCER TOXICITY DATA SUMMARY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Pathway: Ingestion, Dermal

Chemical of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence	Source	Date
Chromium	-	-	1/(mg/kg-day)	D	IRIS	January 2004
Copper	-	-	1/(mg/kg-day)	A	IRIS	January 2004
Lead	-	-	1/(mg/kg-day)	B2	IRIS	January 2004
Zinc	-	-	1/(mg/kg-day)	D	IRIS	January 2004
Aroclor-1248	2.00E+00	2.00E+00	1/(mg/kg-day)	B2	VDEQ	December 2003
Aroclor-1254	2.00E+00	2.00E+00	1/(mg/kg-day)	B2	IRIS	January 2004
Aroclor-1260	2.00E+00	2.00E+00	1/(mg/kg-day)	B2	VDEQ	December 2003
Benzo(a)anthracene	7.30E-01	7.30E-01	1/(mg/kg-day)	B2	IRIS/NCEA	January 2004/October 2003
Benzo(a)pyrene	7.30E+00	7.30E+00	1/(mg/kg-day)	B2	IRIS	January 2004
Benzo(b)fluoranthene	7.30E-01	7.30E-01	1/(mg/kg-day)	B2	IRIS	January 2004
Dibenz(a,h)anthracene	7.30E+00	7.30E+00	1/(mg/kg-day)	B2	IRIS	January 2004
Indeno(1,2,3-cd)pyrene	7.30E-01	7.30E-01	1/(mg/kg-day)	B2	IRIS	January 2004

TABLE 2-2

CANCER TOXICITY DATA SUMMARY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Pathway: Inhalation

Chemical of Concern	Unit Risk	Units	Inhalation Cancer Slope Factor	Units	Weight of Evidence	Source	Date
Chromium	1.20E+01	1(mg/m^3)	4.20E+01	1/(mg/kg-day)	A	IRIS	January 2004
Copper	4.3E+00	1(mg/m^3)	1.51E+01	(mg/kg/day)$^{-1}$	A	IRIS	January 2004
Zinc	--	--	--	--	D	IRIS	January 2004
Aroclor-1248	5.71E-01	1(mg/m^3)	2.00E+00	(mg/kg/day)$^{-1}$	B2	VDEQ	December 2003
Aroclor-1254	5.71E-01	1(mg/m^3)	2.00E+00	(mg/kg/day)$^{-1}$	B2	IRIS	January 2004
Aroclor-1260	5.71E-01	1(mg/m^3)	2.00E+00	(mg/kg/day)$^{-1}$	B2	VDEQ	December 2003
Benzo(a)pyrene	8.86E-01	1(mg/m^3)	3.10E+00	(mg/kg/day)$^{-1}$	B2	NCEA	October 2003

--: No information available.
IRIS: Integrated Risk Information System.
VDEQ: Virginia Department of Environmental Quality
NCEA: National Center for Environmental Assessment
mg/m^3: milligram per cubic meter
mg/kg/day: milligram per kilogram per day

Weight of Evidence
Known/Likely
Cannot be Determined
Not Likely

EPA Group
A: Human carcinogen
B2: Probable human carcinogen - Indicates sufficient evidence in animals and inadequate or no evidence in humans.
D: Not classifiable as a human carcinogen

Cancer slope factors are not available for the dermal route of exposure; the dermal slope factors used in the assessment have been extrapolated from oral values. An adjustment factor is applied and is dependent on how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent absorption via the ingestion route. However, no adjustments were necessary. Benzene and arsenic are also considered carcinogenic via the inhalation route of exposure.

TABLE 2-3

NONCANCER TOXICITY DATA SUMMARY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Pathway: Ingestion, Dermal

Chemical of Concern	Chronic/ Subchronic	Oral RfD	Dermal RfD	Units	Target Organ(s)	Uncertainty Factor	Source	Date
Chromium	Chronic	3.00E-03	7.50E-05	mg/kg-day	none reported	--	IRIS	January 2004
Copper	Chronic	4.00E-02	4.00E-02	mg/kg-day	GI tract	--	HEAST	July 1997
Zinc	Chronic	3.00E-01	3.00E-01	mg/kg-day	blood	--	IRIS	January 2004
Aroclor-1254	Chronic	2.00E-05	2.00E-05	mg/kg-day	eyes	--	IRIS	January 2004

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC	Units	Inhalation RfD	Units	Primary Target Organ	Uncertainty Factor	Source	Date
Chromium	Chronic	1.00E-04	mg/m^3	2.90E-05	mg/kg-day	respiratory	1,000	IRIS	January 2004

--: No information available.
IRIS: Integrated Risk Information System.
RfC: Reference concentration.
RfD: Reference dose.
mg/kg-day: milligram per kilogram per day

IRIS: Integrated Risk Information System.
VDEQ: Virginia Department of Environmental Quality
NCEA: National Center for Environmental Assessment
HEAST: Health effects Assessment Summary Tables

The chronic toxicity data available for oral exposures have been used to develop oral RfDs. As was the case with carcinogenic data, dermal RfDs can be extrapolated from oral values by applying an adjustment factor as appropriate. However, no adjustments were necessary, and the oral values were used as the dermal RfDs. The uncertainty factor is used to account for uncertainty when deriving the RfD from experimental data.

TABLE 2-4

FUTURE LIFETIME RESIDENT RISK CHARACTERIZATION SUMMARY – CARCINOGENS
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

CHILD RESIDENT

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Route Total
Soil	Soil	Soil	Chromium	NA	NA	3.22E-05	3.22E-05
			Copper	NA	NA	NA	NA
			Lead	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA
			Aroclor-1248	1.91E-06	7.47E-07	2.30E-07	2.88E-06
			Aroclor-1254	6.79E-07	2.66E-07	1.78E-08	9.64E-07
			Aroclor-1260	3.18E-05	1.24E-05	6.08E-07	4.48E-05
			Benzo(a)anthracene	9.71E-07	3.53E-07	NA	1.32E-06
			Benzo(a)pyrene	9.33E-06	3.40E-06	3.30E-08	1.28E-05
			Benzo(b)fluoranthene	1.08E-06	3.92E-07	NA	1.47E-06
			Dibenz(a,h)anthracene	9.28E-06	2.94E-07	NA	1.27E-05
			Indeno(1,2,3-cd)pyrene	8.07E-07	2.94E-07	NA	1.10E-06
						Soil risk total =	**1.1E-04**

TABLE 2-4

FUTURE LIFETIME RESIDENT RISK CHARACTERIZATION SUMMARY – CARCINOGENS
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

ADULT RESIDENT

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Route Total
Soil	Soil	Soil	Chromium	NA	NA	4.59E-05	4.59E-05
			Copper	NA	NA	NA	NA
			Lead	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA
			Aroclor-1248	8.17E-07	4.56E-07	2.30E-07	1.50E-06
			Aroclor-1254	2.91E-07	1.63E-07	1.78E-08	4.72E-07
			Aroclor-1260	1.36E-05	7.60E-06	6.08E-07	2.18E-05
			Benzo(a)anthracene	4.16E-07	2.16E-07	NA	6.32E-07
			Benzo(a)pyrene	4.00E-06	2.07E-06	3.30E-08	6.10E-06
			Benzo(b)fluoranthene	4.26E-07	2.40E-07	NA	7.02E-07
			Dibenz(a,h)anthracene	3.98E-06	2.06E-06	NA	6.04E-06
			Indeno(1,2,3-cd)pyrene	3.46E-07	1.79E-07	NA	5.26E-07
						Soil risk total =	**8.37E-05**

LIFETIME RESIDENT INCREMENTAL CARCINOGENIC RISK	**1.94E-04**

NA: Route of exposure is not applicable to this medium.
NT: Toxicity criteria are not available to quantitatively address this route of exposure.

TABLE 2-5

FUTURE CHILD RESIDENT RISK CHARACTERIZATION SUMMARY – NONCARCINOGENS
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Noncarcinogenic Hazard Quotient			
					Ingestion	Dermal	Inhalation	Exposure Route Total
soil	soil	soil	Chromium	None reported	2.65E-01	2.96E-01	3.09E-01	8.70E-01
			Copper	GI tract	2.34E-01	6.55E-04	NA	2.41E-02
			Lead	NA	NA	NA	NA	NA
			Zinc	blood	4.71E-02	1.32E-03	NA	4.48E-02
			Aroclor-1248	NA	NA	NA	NA	NA
			Aroclor-1254	eyes	1.98E-01	7.77E-02	NA	2.76E-01
			Aroclor-1260	NA	NA	NA	NA	NA
			Benzo(a)anthracene	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	NA
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA
			Dibenz(a,h)anthracene	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
							Soil Hazard Index Total =	**1.2**
							Blood Hazard Index =	**0.04**
							GI tract =	**0.02**
							Eyes =	**0.28**

NA: Route of exposure is not applicable to this medium.

TABLE 2-6

FUTURE ADULT RESIDENT RISK CHARACTERIZATION SUMMARY – NONCARCINOGENS
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Noncarcinogenic Hazard Quotient			
					Ingestion	Dermal	Inhalation	Exposure Route Total
Soil	Soil	Soil	Chromium	none reported	2.83E-02	4.52E-02	1.10E-01	1.83E-01
			Copper	GI tract	2.51E-03	1.00E-04	NA	2.61E-03
			Lead	NA	NA	NA	NA	NA
			Zinc	blood	5.05E-03	2.01E-04	NA	5.25E-03
			Aroclor-1248	NA	NA	NA	NA	NA
			Aroclor-1254	eyes	2.12E-02	1.19E-02	NA	3.31E-02
			Aroclor-1260	NA	NA	NA	NA	NA
			Benzo(a)anthracene	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	NA
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA
			Dibenz(a,h)anthracene	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
							Soil Hazard Index Total =	**0.2**
							Blood Hazard Index =	**0.005**
							GI tract =	**0.003**
							Eyes =	**0.03**

NA: Route of exposure is not applicable to this medium.
NT: Toxicity criteria are not available to quantitatively address this route of exposure.

TABLE 2-7
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN (COC)
SITES 5 AND 12
WALLOPS FLIGHT FACILITY, WALLOPS ISLAND VIRGINIA

Exposure Medium: Soil/Sediment – Ecological Receptors

Chemical of Potential Concern	Post X-115 Removal (Current Conditions)		2007 Pre X-115 Removal (Basis of Risk Estimates)		95% UCL of the Mean [2] (mg/kg)	Background Concentration (mg/kg)	Screening Toxicity Value [3] (mg/kg)	HQ Value [4]	COC Flag
	Max Concentration [(1)] (mg/kg)	Arithmetic Mean Concentration (mg/kg)	Soil Maximum Concentration (mg/kg)	Soil Mean Concentration (mg/kg)					
Chromium	221	38	221	34.8	62	11.1	26	8.5	Yes
Copper	367	33	367	29.4	73	4.4	15	24.5	Yes
Lead	1,520	150	1,520	143	110	19	11	138	Yes
Zinc	19,500	770	19,500	867	1,105	24.6	10	1,950	Yes
PCBs	36	1.00	610 [(2)]	3.49 [(2)]	15.67	NC	0.1	360	Yes
Benzo(a)anthracene	12	0.27	12	0.21	1.21	NC	0.1	120	Yes
Benzo(a)pyrene	10	0.80	22	0.563	1.17	NC	0.1	100	Yes
Benzo(b)fluoranthene	13	0.27	13	0.22	1.35	NC	0.1	130	Yes
Dibenzo(a,h)anthracene	3.2	0.35	1.4	0.26	1.16	NC	0.1	32	Yes
Indeno(1,2,3-cd)pyrene	6	0.13	6	0.10	1.01	NC	0.1	60	Yes
DDTR	0.67	0.07	0.84	0.0328	NC	NC	0.1	6.7	Yes

Notes
[1] Maximum detected concentration above the sample quantitation limit (SQL).
[2] The 95 Upper Confidence Limit (UCL) represents the RME concentration prior to the 2007-X-115 Removal Action.
[3] US EPA Region 3 BTAG screening values (1995 values and 2005 Ecological Screening Level updates).
[4] Hazard Quotient (HQ) is defined as Maximum Concentration (Post-X-115 Removal) divided by Ecological Screening Toxicity Value.
NC – not calculated
mg/kg – milligram per kilogram

TABLE 2-8
COC CONCENTRATIONS EXPECTED TO PROVIDE ADEQUATE PROTECTION OF ECOLOGICAL RECEPTORS
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VA

Habitat Type/Name	Exposure Medium	COC	Protective Level NOEC-LOEC [1]	Units	Basis	Assessment Endpoint
upland/palustrine	soil/sediment	Chromium	80.3 - 219	mg/kg	LOEC/NOEC	soil/sediment invertebrates
		Copper	48.6 - 166	mg/kg	LOEC/NOEC	soil/sediment invertebrates
		Lead	131 - 228	mg/kg	LOEC/NOEC	soil/sediment invertebrates
		Zinc	378 - 948	mg/kg	LOEC/NOEC	soil/sediment invertebrates
		PCBs	1	mg/kg	Food Web	Mammals, Reptiles, and Amphibians

DDTR - Summation of 4,4-dichlorodiphenyltrichloroethane and metabolites.
COC - chemical of concern
LOEC - Lowest Observed Effects Concentration
NOEC - No Observed Effects Concentration
Blank Cell = No Criteria
** - No ecological preliminary goals were developed for polychlorinated biphenyls (PCBs) or DDTR. Remedial actions will be conducted to optimize reduction of these chemicals.
1 NOEC LOEC range

TABLE 2-9
CLEANUP GOALS FOR CONTAMINATED SOIL AT
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

COC	Basis for Cleanup Goal	Cleanup Goal (mg/kg)
Chromium	Eco-NOEC	80.3
Copper	Eco-NOEC	48.6
Lead	Eco-NOEC	131
Zinc	Eco-NOEC	378
PCBs (total)	HH/Eco	1.0
Benzo(a)anthracene	HH-10^{-5}	6.2
Benzo(a)pyrene	HH-10^{-5}	0.62
Benzo(b)fluoranthene	HH-10^{-5}	6.2
Dibenzo(a,h)anthracene	HH-10^{-5}	0.62
Indeno(1,2,3-cd)pyrene	HH -10^{-5}	6.2

Eco-NOEC – Protection of ecological receptors at the no observed effects concentration.
HH-10^{-5} – Protection of human health at the 1x10^{-5} incremental lifetime cancer risk for the potential future resident.
mg/kg: milligram per kilogram
COC: chemical of concern

Table 2-10
Summary of Federal and State ARARs
NASA Wallops Island
Sites 5 and 12

FEDERAL		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status[(1)]**
Federal Endangered Species Act 1973: 16 U.S.C. §1536 (a) (1) and (2)		
50 CFR Sections 402.10 (a) and (c)	Requires a determination as to whether any action is likely to jeopardize the continued existence of any endangered species or the critical habitat designated for such species. Endangered or threatened species have not been documented as roosting, nesting or living in the area of the Sites 5 and 12 actions, but the possibility of an incidental occurrence exists during the implementation of the remedial action. If endangered species are identified at Sites 5 and 12 during the remedial action, construction activities will be suspended and the EPA and VDEQ will be consulted on the path forward.	R/A
Clean Water Act (Federal Water Pollution Control Act): 33U.S.C. § 1344 (Section 404)		
Section 404 (B)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material		
40 CFR 230.10 to .12, .20 to .32, .41 to .43, .51 to .53, .60 to .77, and .93 to .98	Regulates dredging and discharge of dredged materials (spoils) in navigable waters of the United States. Section 404 requires that degradation or destruction of wetlands and other aquatic sites be avoided to the extent possible. Dredged or fill material must not be discharged to navigable waters if the activity contributes to the violation of Virginia water quality standards; violates any toxic effluent standard covered in CWA Sec. 307; jeopardizes endangered or threatened species; or violates requirements of Title III of the Marine Protection, Research, and Sanctuaries Act of 1972. In the case where a wetland has already been severely degraded due to prior discharges of waste, dredging activities conducted as part of the remedy would serve as an economic benefit and, therefore, the lead agency would not be obligated under Section 404 to mitigate the impacts which preceded the remedial fill operation. However, for those dredging actions that impact a wetland and cannot be avoided or minimized, enhancement, restoration or creation of another wetland may be required. The remedy must comply with the substantive provisions of the Clean Water Act; however, Permits are not required for portions of the remedy conducted entirely on site. The selected remedy at the Site is being conducted to remediate severely degraded wetlands. Although releases during the remedial action to wetlands and navigable waters beyond the extent of the Sites are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work will be used to control potential releases.	A

Table 2-10 (continued)
Summary of Federal and State ARARs
NASA Wallops Island
Sites 5 and 12

FEDERAL		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Toxic Substances Control Act		
Polychlorinated biphenols (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibitions		
40 CFR 761.61 Sections (a)(5) (ii) and (c)	Allows for off-site disposal of PCB-contaminated waste, if the waste is dewatered onsite or transported offsite in appropriate containers. Establishes locations where PCB remediation waste may be disposed. Although not anticipated, contaminated soils with PCBs at concentrations greater than 50 ppm were previously identified at the Sites and removed. Prior to transportation of contaminated soil and sediment off site, contaminated media will be analyzed to determine PCB concentrations. These data will be used to identify onsite waste storage and transportation requirements.	R/A
Coastal Zone Management Act		
15 CFR 930.30 and 930.34	Ensures that all Federal Agency activities are undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of approved management programs. Requires Federal agencies to perform a consistency determination on activities affecting any coastal use or resource. Because the contaminated sediment is within a water body in the Virginia coastal zone, planned remedial activities will affect a coastal resource. The selected remedy is consistent with the substantive requirements of this regulation. The preparation of the Remedial Investigation, Feasibility Study, and Proposed Remedial Action Plan meet the requirements of this Act.	A

STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 4 – Conservation and Natural Resources		
Agency 15 – Department of Game and Inland Fisheries		
Chapter 20 – Definitions and Miscellaneous in General		
4 VAC 15-20-130 and -140	These regulations adopt the federal list of endangered or threatened species and expand upon that list for purposes of actions in the Commonwealth of Virginia. Endangered or threatened species have not been documented as roosting, nesting or living in the area of the Sites 5 and 12 actions, but the possibility of an incidental occurrence exists during the implementation of the remedial action. If endangered species are identified at Sites 5 and 12 during the remedial action, construction activities will be suspended and the EPA and VDEQ will be consulted on the path forward.	R/A

Table 2-10 (continued)
Summary of Federal and State ARARs
NASA Wallops Island
Sites 5 and 12
Page 3

STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 4 – Conservation and Natural Resources		
Agency 20 – Marine Resources Commission		
Chapter 390 – Wetlands Mitigation Compensation Policy		
4 VAC 20-390-10, -20, -30, -40, and -50	Requires that any activity which would destroy tidal wetland be undertaken only if in the public interest and, then, the destroyed wetlands must be mitigated with creation of wetlands. This ARAR includes the substance of the requirement, not the requirement to procure a permit. The selected remedy at the Site is being conducted to remediate severely degraded wetlands and at the completion of the remediation, wetlands will be allowed to be re-established. In addition, prior to the start of the remedial action, the boundary of the existing and new wetlands will be determined. Excavation and regrading of wetland areas will be conducted to ensure no net loss of wetlands at the site. Therefore, no additional compensation will be required.	R/A
Agency 50 – Virginia Soil and Water Conservation Board		
Chapter 30 – Erosion and Sediment Control Regulations		
4 VAC 50-30-10, -40, and -60	Establishes minimum standards for the control of erosion, sediment deposition, and runoff, and requires that an erosion and sediment control plan be implemented and maintained. The Remedial Design/Remedial Action Work Plan will identify erosion and sedimentation controls in accordance with State requirements.	R/A
4 VAC 50-60-10, -50, -60.A and B.1, -70,A -80.A and B, -310.A and B, -380.B, -420, and -430.	Establishes the minimum requirements for the control of releases to state waters of stormwater from land disturbing activities. The Remedial Design/Remedial Action Work Plan will identify any stormwater controls in accordance with State requirements.	A
Title 9 – Environment		
Agency 5 – State Air Pollution Control Board		
Chapter 30 – Ambient Air Quality Standards		
9 VAC 5-30-10, -60, -65, and -66	These regulations are designed to ensure that ambient concentrations of air pollutants are consistent with established criteria, and, unless specified otherwise, apply throughout the Commonwealth of Virginia. Any air emissions from the remedial activities at the Site must meet these standards. If during remedial actions, sustained visible dust emissions are noted, NASA will control these releases by reducing dust generation operations and/or hydrating the materials. Dust control measures will be detailed in the Remedial Design/Remedial Action Work Plan.	R/A
Chapter 50 – New and Modified Stationary Sources		
9 VAC 5-50-80 and -90	Identifies standards for the discharge of visible emissions into the atmosphere. If during remedial actions, sustained visible dust emissions are noted, NASA will control these releases by reducing dust generation operations and/or hydrating the materials. Dust control measures will be detailed in the Remedial Design/Remedial Action Work Plan.	R/A

Table 2-10 (continued)
Summary of Federal and State ARARs
NASA Wallops Island
Sites 5 and 12

STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 9 – Environment		
Agency 20 – Virginia Waste Management Board		
Chapter 60 – Hazardous Waste Management Regulations		
9 VAC 20-60-261.3, -261.20, -261.24, and Appendix I	These regulations incorporate by reference 40 CFR 261 regulations. Solid wastes generated during this remedial action that are identified for disposal in a Virginia landfill will be characterized for potential as a characteristic hazardous waste prior to offsite disposal. Based on the existing site data, contaminated soil and sediment at the Sites have not exhibited evidence of hazardous waste characteristics.	R/A
Chapter 81 – Solid Waste Management Regulations		
9 VAC 20-81-10 and 95	Section 10 defines "remediation waste." Section 95 defines a solid waste as any discarded material (by referencing 40 CFR 261.2 as incorporated by 9 VAC 20-60-261). These definitions would apply to wastes generated by the remedial action.	A
9 VAC 20-81-610 and -630	Section 610 establishes procedures for the disposal of special wastes. Special wastes are defined as wastes that require special handling and precautions. Nonhazardous wastes generated during the remedial action, including IDW and materials containing PCBs, will be handled as special waste. Section 630 clarifies PCB disposal requirements at 40 CFR 761, and makes clear that PCB remediation waste containing PCB concentrations between 1.0 ppm and 50 ppm are restricted to disposal in sanitary landfills or industrial waste landfills with leachate collection, liners, and appropriate ground water monitoring systems in the State of Virginia.	A
Chapter 110 – Regulations Governing the Transportation of Hazardous Materials		
9 VAC 20-110-10, -20.C, -50, -80, -110	These regulations apply to any person who transports hazardous materials or hazardous radioactive materials, or offers such materials for shipment. Based on the existing site data, contaminated soil and sediment at the site have not exhibited evidence of hazardous waste characteristics.	R/A

Table 2-10 (continued)
Summary of Federal and State ARARs
NASA Wallops Island
Sites 5 and 12

STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 9 – Environment		
Agency 25 – State Water Control Board		
Chapter 31 – Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation		
9 VAC 25-31-50, -100.G.7, -220.A.1,-220.B.1, -220.D, and -220.E	Regulates the discharge of wastes and deleterious substances into State water. Prohibits discharges of wastes that would alter the physical, chemical, or biological properties of a State water and result in detrimental effects on the beneficial use of the water. Under CERCLA, an onsite discharge of waste water to surface water must meet the substantive requirements of VPDES, but it is not necessary to obtain a permit or comply with the administrative requirements of the permitting process. For an offsite discharge, it would be necessary to comply with the administrative requirements of the regulation. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid and solid wastes will be containerized for offsite disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work Plan will be used to control potential releases.	A
Chapter 32 – Virginia Pollution Abatement (VPA) Permit Regulation		
9 VAC 25-32-30, -80, and -100	Prohibits direct discharges into water except in accordance with Virginia Pollution Abatement permits issued pursuant to the State Water Quality Control Law. While CERCLA does not require that permits be obtained for remedial activities, it is necessary for the remedial action to comply with effluent limitations that would be established under a permit and notification requirements in the event of exceedances of limits. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid and solid wastes will be containerized for offsite disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work Plan will be used to control potential releases.	R/A
Chapter 210 – Virginia Water Protection Permit Program Regulation		
9 VAC 25-210-10, -45, -50, and -110	Prohibition on discharging any pollutant into, or adjacent to surface waters that would alter the physical, chemical or biological properties of surface waters and make them detrimental to the public health, or to animal or aquatic life. Includes Section 115 for substantive requirements only and does not include administrative permitting requirements. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid waters and wastes and contaminated soil will be containerized for off site disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work Plan will be used to control potential releases. Also, the wetlands to be remediated will be delineated during the Remedial Design.	A

STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 9 – Environment		
Chapter 260 – Water Quality Standards		
9 VAC 25-260-5, -10, -20, -30, -50 (class II) -140, -160, and -185.	Establishes water quality standards to protect surface waters. If contaminants are discharged to a surface water body, the cleanup level at the discharge point would be the more stringent of the established cleanup levels for the Virginia or Federal surface water standard or criterion for protection of aquatic life. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid waters and wastes and contaminated soil will be containerized for off site disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work will be used to control potential releases.	R/A
Chapter 380 – Wetlands Policy		
9 VAC 25-380-20.D	This policy establishes the preservation and protection of wetlands ecosystems by: requiring proper control of any construction activities and of non-point sources to prevent discharges which would impair the quality of the wetland area; ensuring that wastewaters will be kept below a level that would not alter the natural, physical, chemical, or biological integrity of the wetland; minimizing the alteration of the quality and quantity of the natural flow of water to the ecosystem; protection of the wetlands from adverse dredging or filling practices, solid waste management practices, siltation, or the addition of contamination from non-point source wastes and through construction activities; and preventing violations of applicable water quality standards. There is no planned discharge of wastes or water to wetlands under the selected remedy. Liquid waters and wastes and contaminated soil will be containerized for off site disposal. Although releases during the remedial action to State wetlands are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work will be used to control potential releases. The use of nutrients during site restoration will be minimized.	A
Chapter 390 – Water Resources Policy		
9 VAC 25-390-20 (2), (9) and -30.3a, .3b, .4f, and .8.	Establishes requirements to protect water resources and the ecosystems from unnecessary pollution, degradation or destruction. There is no planned extraction of State water or discharge of wastes or water to wetlands or waters under the selected remedy. Liquid and solid wastes will be containerized for offsite disposal. Although releases during the remedial action to State water are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work will be used to control potential releases.	R/A

(1) A=Applicable; R/A=Relevant and Appropriate

TABLE 2-11
SUMMARY OF COMPARATIVE ANALYSIS OF SITE 5 AND SITE 12 REMEDIAL ALTERNATIVES
SITES 5 AND 12
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 – Excavation and Off-Site Disposal of Ecological LOEC-Contaminated Soil/Sediment and Land Use Controls to Protect Human Health (Residential Use – 1 x 10^{-5} ILCR)	Alternative 3 - Excavation and Off-Site Disposal of Ecological NOEC-Contaminated Soil/Sediment and Excavation and Off-Site Disposal of PAH-Contaminated Soil for Protection of Human Health (Residential Use – 1 x 10^{-5} ILCR)	Alternative 4 - Excavation and On-Site Consolidation Under a Soil Cover of Ecological NOEC-Contaminated Soil/Sediment, Excavation and On-Site Consolidation Under a Soil Cover of Wetland-Vicinity-PAH-Contaminated Soil/Sediment for Protection of Human Health (Residential Use – 1 x 10^{-5} ILCR), and LUCs and Long-Term Maintenance of Soil Cover for Protection of Human Health (Residential Use – 1×10^{-5} ILCR) and Environment
Overall Protection of Human Health and Environment	Would not be protective of human health and the environment because no action would occur. Continued impact to ecological receptors, and if the site was developed for residential use, potential future impact to human health.	Would remove the majority of the contaminants that are causing unacceptable risks to ecological receptors and would protect human receptors by prohibiting residential development at the site.	Would remove all of the contaminants that are causing actual and potential unacceptable risks to ecological receptors and all of the contaminants that would result in risk to potential future human receptors.	Would consolidate and prevent exposure to all of the contaminants that are causing actual and potential unacceptable risks to ecological receptors and all of the contaminants that would result in risk to potential future human receptors. LUCs would be used to identify and help maintain the integrity of the cover.
Compliance with ARARs and TBCs:				
Chemical-Specific Location-Specific Action-Specific	No chemical-specific ARARs. No location-specific ARARs. No action-specific ARARs.	If soil/sediment is excavated with PCBs greater than 50 ppm, TSCA regulations would apply. Sediment excavation would trigger wetland ARARs. Alternative would comply with ARARs. Sediment excavation would trigger wetland ARARs. Transportation and off site disposal of contaminated soil/sediment would trigger RCRA regulations. Alternative would comply with ARARs.	If soil/sediment is excavated with PCBs greater than 50 ppm, TSCA regulations would apply. Sediment excavation would trigger wetland ARARs. Alternative would comply with ARARs. Sediment excavation would trigger wetland ARARs. Transportation and off site disposal of contaminated soil/sediment would trigger RCRA regulations. Alternative would comply with ARARs.	If soil/sediment is excavated with PCBs greater than 50 ppm, TSCA regulations would apply. Sediment excavation would trigger wetland ARARs. Alternative would comply with ARARs. Sediment excavation would trigger wetland ARARs. Consolidation and capping of contaminated soil/sediment would trigger RCRA regulations. Alternative would comply with ARARs.
Long-Term Effectiveness and Permanence	Not effective in the long term or permanent, because no action would occur. Metal and PCB contamination would remain indefinitely at the site. Some PAH degradation may occur.	Moderately effective and permanent in the long term. Majority of the contamination at the site would be removed and land use controls would be used to prohibit residential development.	Effective and permanent in the long term. Site contaminants would be removed and no further action would be required for the site.	Moderately effective and permanent in the long term. Periodic maintenance of the cover will be required and land use controls will be required to prohibit residential development at the sites and to maintain the integrity of the covers.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.

TABLE 2-11
SUMMARY OF COMPARATIVE ANALYSIS OF SITE 5 AND SITE 12 REMEDIAL ALTERNATIVES
SITES 5 AND 12
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 – Excavation and Off-Site Disposal of Ecological LOEC-Contaminated Soil/Sediment and Land Use Controls to Protect Human Health (Residential Use – 1 x 10^{-5} ILCR)	Alternative 3 - Excavation and Off-Site Disposal of Ecological NOEC-Contaminated Soil/Sediment and Excavation and Off-Site Disposal of PAH-Contaminated Soil for Protection of Human Health (Residential Use – 1 x 10^{-5} ILCR)	Alternative 4 - Excavation and On-Site Consolidation Under a Soil Cover of Ecological NOEC-Contaminated Soil/Sediment, Excavation and On-Site Consolidation Under a Soil Cover of Wetland-Vicinity-PAH-Contaminated Soil/Sediment for Protection of Human Health (Residential Use – 1 x 10^{-5} ILCR), and LUCs and Long-Term Maintenance of Soil Cover for Protection of Human Health (Residential Use – 1×10^{-5} ILCR) and Environment
Short-Term Effectiveness	Would not result in any short-term risk to site workers or adversely impact the surrounding community or environment because no construction actions would occur.	• Would result in a slight risk with exposing site workers, surrounding community, and environment to contaminated soil/sediment during removal and transportation activities. These risks would be reduced through site-specific health and safety procedures and the implementation and maintenance of best management practices during construction. • Short term impacts associated with removing contaminated sediment from the wetland would occur. After the removal action is complete, equivalent or better quality wetlands should develop.	• Would result in a slight risk with exposing site workers, surrounding community, and environment to contaminated soil/sediment during removal and transportation activities. These risks would be reduced through site-specific health and safety procedures and the implementation and maintenance of best management practices during construction. • Short term impacts associated with removing contaminated sediment from the wetland would occur. After the removal action is complete, equivalent or better quality wetlands should develop.	• Would result in a slight risk with exposing site workers, surrounding community, and environment to contaminated soil/sediment during removal and consolidation activities. These risks would be reduced through site-specific health and safety procedures and the implementation and maintenance of best management practices during construction. • Short term impacts associated with removing contaminated sediment from the wetland would occur. After the removal action is complete, equivalent or better quality wetlands should develop.
Implementability	Technical and administrative implementation would be extremely simple because there would be no action to implement.	• This alternative incorporates conventional construction techniques using locally available labor, equipment, and materials. • Substantive portions of a wetland permit may be required. Since action will lessen impact to ecological receptors and may allow the formation of a better quality wetland to become established, this action should be achievable.	• This alternative incorporates conventional construction techniques using locally available labor, equipment, and materials. • Substantive portions of a wetland permit may be required. Since action will lessen impact to ecological receptors and may allow the formation of a better quality wetland to become established, this action should be achievable.	• This alternative incorporates conventional construction techniques using locally available labor, equipment, and materials. • Substantive portions of a wetland permit may be required. Since action will lessen impact to ecological receptors and may allow the formation of a better quality wetland to become established, this action should be achievable. • Placement of the covers would interfere with NASA WFF plans to re-develop this area.
Costs: Capital O&M 30-Year NPW	 $0 $16,500 every 5 years $36,000	 $971,000 $2,900 per year, 16,500 every 5 years 1,043,000	 $1,383,000 $0 $1,383,000	 $1,141,000 $14,300 per year; $32,000 every 5 years $1,389,000

ARARs Applicable or Relevant and Appropriate Requirements
NPW Net Present Worth
WFF Wallops Flight Facility
NOEC No Observed Effects Concentrations
PAH Polynuclear aromatic hydrocarbons
RCRA Resource Conservation and Recovery Act
ppm part per million
TBCs To Be Considered
O&M Operation and Maintenance
LOEC Lowest Observed Effects Concentrations
ILCR Incremental Lifetime Cancer Risk
PCB Polychlorinated biphenyls
O&M Operation and Maintenance

TABLE 2-12
PART 1

CAPITAL COST ESTIMATE SUMMARY FOR THE SELECTED REMEDY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA
PAGE 1 OF 2

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans including Permits	350	hr			$37.00		$0	$0	$12,950	$0	$12,950
1.2 Office Support	9	day			$296.00		$0	$0	$2,664	$0	$2,664
1.3 Completion Report	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilizatior	4	ea			$163.00	$414.00	$0	$0	$652	$1,656	$2,308
3 FIELD SUPPORT											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	2	mo		$220.00	$370.00		$0	$440	$740	$0	$1,180
3.2 Survey Support	3	day	$1,025.00				$3,075	$0	$0	$0	$3,075
3.3 Site Superintendent	9	week	$680.00		$1,442.30		$6,120	$0	$12,981	$0	$19,101
3.4 Site Health & Safety and QA/QC	9	week	$680.00		$1,322.10		$6,120	$0	$11,899	$0	$18,019
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,140.00	$2,100.00	$1,450.00	$0	$1,140	$2,100	$1,450	$4,690
4.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$300.00	$0	$1,500	$2,000	$300	$3,800
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	1	mo				$730.00	$0	$0	$0	$730	$730
4.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$660.00	$0	$0	$0	$660	$660
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$950.00				$950	$0	$0	$0	$950
5 SITE PREPARATION											
5.1 Underground Utility Clearance	1	ls	$7,750.00				$7,750	$0	$0	$0	$7,750
5.2 Building X-115 Utility Removal	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
5.3 Pavement & Building Demolition	21	day			$1,362.80	$1,002.20	$0	$0	$28,619	$21,046	$49,665
5.4 Off Site Disposal, Demo Debris	2,584	ton	$60.00				$155,040	$0	$0	$0	$155,040
5.5 Verification Samples: Full TCL	2	ea	$750.00	$10.00			$1,500	$20	$0	$0	$1,520
5.6 Silt Fence	700	lf		$0.34	$0.51		$0	$238	$357	$0	$595
6 EXCAVATION AND DISPOSAL											
6.1 Excavator, 2 cy	10	day			$318.80	$646.60	$0	$0	$3,188	$6,466	$9,654
6.2 Site Labor, (3 laborers)	10	day			$726.00		$0	$0	$7,260	$0	$7,260
6.3 MEC Technician	10	day	$136.00		$369.00		$1,360	$0	$3,690	$0	$5,050
6.4 Verification Samples: PAHs, PCB, Metals	10	ea	$385.00	$10.00			$3,850	$100	$0	$0	$3,950
6.5 Characterization/Offsite Disposal Soil Testing	3	ea	$850.00	$10.00			$2,550	$30	$0	$0	$2,580
6.6 Off Site Disposal, Non-Hazardous	2,100	ton	$70.00				$147,000	$0	$0	$0	$147,000
6.7 Off Site Disposal, Hazardous	0	ton	$285.00				$0	$0	$0	$0	$0
7 BACKFILL AND RESTORATION											
7.1 Vegetative Fill	1,382	cy		$18.00			$0	$24,876	$0	$0	$24,876
7.2 Dozer, 140 hp	5	day			$318.80	$664.40	$0	$0	$1,594	$3,322	$4,916
7.3 Site Labor, (3 laborers)	5	day			$726.00		$0	$0	$3,630	$0	$3,630
7.4 Seeding Disturbed Areas	28	msf	$74.00				$2,072	$0	$0	$0	$2,072
7.5 Wetland Restoration	1	ls	$7,000.00				$7,000	$0	$0	$0	$7,000
Subtotal							$354,387	$29,544	$99,873	$39,130	$522,935
Overhead on Labor Cost @ 30%									$29,962		$29,962
G & A on Labor Cost @ 10%									$9,987		$9,987
G & A on Material Cost @ 10%								$2,954			$2,954
G & A on Equipment Cost @ 10%										$3,913	$3,913

NOR

TABLE 2-12
PART 1

CAPITAL COST ESTIMATE SUMMARY FOR THE SELECTED REMEDY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
G & A on Subcontract Cost @ 10%							$35,439				$35,439
Tax on Materials and Equipment Cost @ 5%								$1,477		$1,957	$3,434
Total Direct Cost							$389,826	$33,976	$139,823	$45,000	$608,624
Indirects on Total Direct Cost @ 30%		(excluding transportation and disposal cost)									$91,690
Profit on Total Direct Cost @ 10%											$60,862
Subtotal											$761,176
Health & Safety Monitoring @ 1%											$7,612
Total Field Cost											$768,788
Contingency on Total Field Costs @ 25%											$192,197
Engineering on Total Field Cost @ 15%											$115,318
TOTAL CAPITAL COST											**$1,076,303**

TABLE 2-12
PART 2

CAPITAL COST ESTIMATE SUMMARY FOR THE SELECTED REMEDY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA

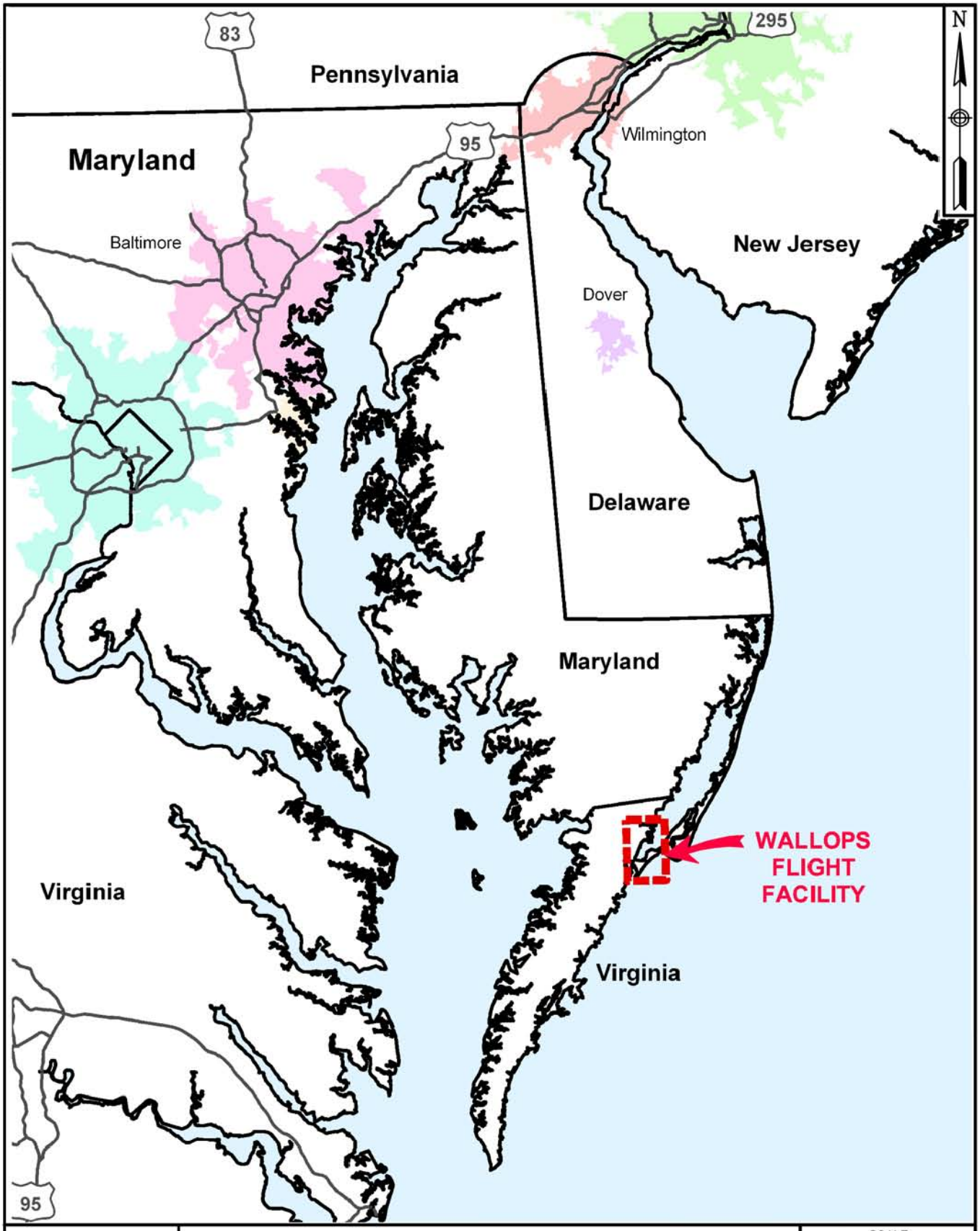
Item	Quantity	Unit	Unit Cost Subcontract	Material	Labor	Equipment	Extended Cost Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans including Permits	200	hr			$37.00		$0	$0	$7,400	$0	$7,400
1.2 Office Support	5	day			$296.00		$0	$0	$1,480	$0	$1,480
1.3 Completion Report	150	hr			$37.00		$0	$0	$5,550	$0	$5,550
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	0	ea			$163.00	$414.00	$0	$0	$0	$0	$0
3 FIELD SUPPORT											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	1	mo		$220.00	$370.00		$0	$220	$370	$0	$590
3.2 Survey Support	2	day	$1,025.00				$2,050	$0	$0	$0	$2,050
3.3 Site Superintendent	5	week	$680.00		$1,442.30		$3,400	$0	$7,212	$0	$10,612
3.4 Site Health & Safety and QA/QC	5	week	$680.00		$1,322.10		$3,400	$0	$6,611	$0	$10,011
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,140.00	$2,100.00	$1,450.00	$0	$1,140	$2,100	$1,450	$4,690
4.2 Temporary Equipment Decon Pad	0	ls		$1,500.00	$2,000.00	$300.00	$0	$0	$0	$0	$0
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	1	mo				$730.00	$0	$0	$0	$730	$730
4.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$660.00	$0	$0	$0	$660	$660
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$950.00				$950	$0	$0	$0	$950
5 EXCAVATION AND DISPOSAL											
5.1 Underground Utility Clearance	0	ls	$7,750.00				$0	$0	$0	$0	$0
5.2 Silt Fence	700	lf		$0.34	$0.51		$0	$238	$357	$0	$595
5.3 Excavator, 2 cy	10	day			$318.80	$646.60	$0	$0	$3,188	$6,466	$9,654
5.4 Site Labor, (3 laborers)	10	day			$726.00		$0	$0	$7,260	$0	$7,260
5.5 MEC Technician	10	day	$136.00		$369.00		$1,360	$0	$3,690	$0	$5,050
5.6 Verification Samples: PAHs, PCB, Metals	10	ea	$385.00	$10.00			$3,850	$100	$0	$0	$3,950
5.7 Characterization/Offsite Disposal Soil Testing	3	ea	$850.00	$10.00			$2,550	$30	$0	$0	$2,580
5.8 Off Site Disposal, Non-Hazardous	1,380	ton	$70.00				$96,600	$0	$0	$0	$96,600
5.9 Off Site Disposal, Hazardous	0	ton	$285.00				$0	$0	$0	$0	$0
6 BACKFILL AND RESTORATION											
6.1 Vegetative Fill	529	cy		$18.00			$0	$9,522	$0	$0	$9,522
6.2 Dozer, 140 hp	5	day			$318.80	$664.40	$0	$0	$1,594	$3,322	$4,916
6.3 Site Labor, (3 laborers)	5	day			$726.00		$0	$0	$3,630	$0	$3,630
6.4 Seeding Disturbed Areas	9	msf	$74.00				$666	$0	$0	$0	$666
6.5 Wetland Restoration	1	ls	$7,000.00				$7,000	$0	$0	$0	$7,000
Subtotal							$121,826	$12,450	$50,441	$16,128	$200,845
Overhead on Labor Cost @ 30%									$15,132		$15,132
G & A on Labor Cost @ 10%									$5,044		$5,044
G & A on Material Cost @ 10%								$1,245			$1,245
G & A on Equipment Cost @ 10%										$1,613	$1,613
G & A on Subcontract Cost @ 10%							$12,183				$12,183
Tax on Materials and Equipment Cost @ 5%								$623		$806	$1,429
Total Direct Cost							$134,009	$14,318	$70,617	$18,547	$237,491
Indirects on Total Direct Cost @ 30%			(excluding transportation and disposal cost)								$41,982
Profit on Total Direct Cost @ 10%											$23,749
Subtotal											$303,222

TABLE 2-12
PART 2

CAPITAL COST ESTIMATE SUMMARY FOR THE SELECTED REMEDY
SITES 5 AND 12
NASA WFF, WALLOPS ISLAND, VIRGINIA
PAGE 2 OF 2

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Health & Safety Monitoring @ 1%											$3,032
Total Field Cost											$306,254
Contingency on Total Field Costs @ 25%											$76,564
Engineering on Total Field Cost @ 15%											$45,938
TOTAL CAPITAL COST											**$428,756**

FIGURES

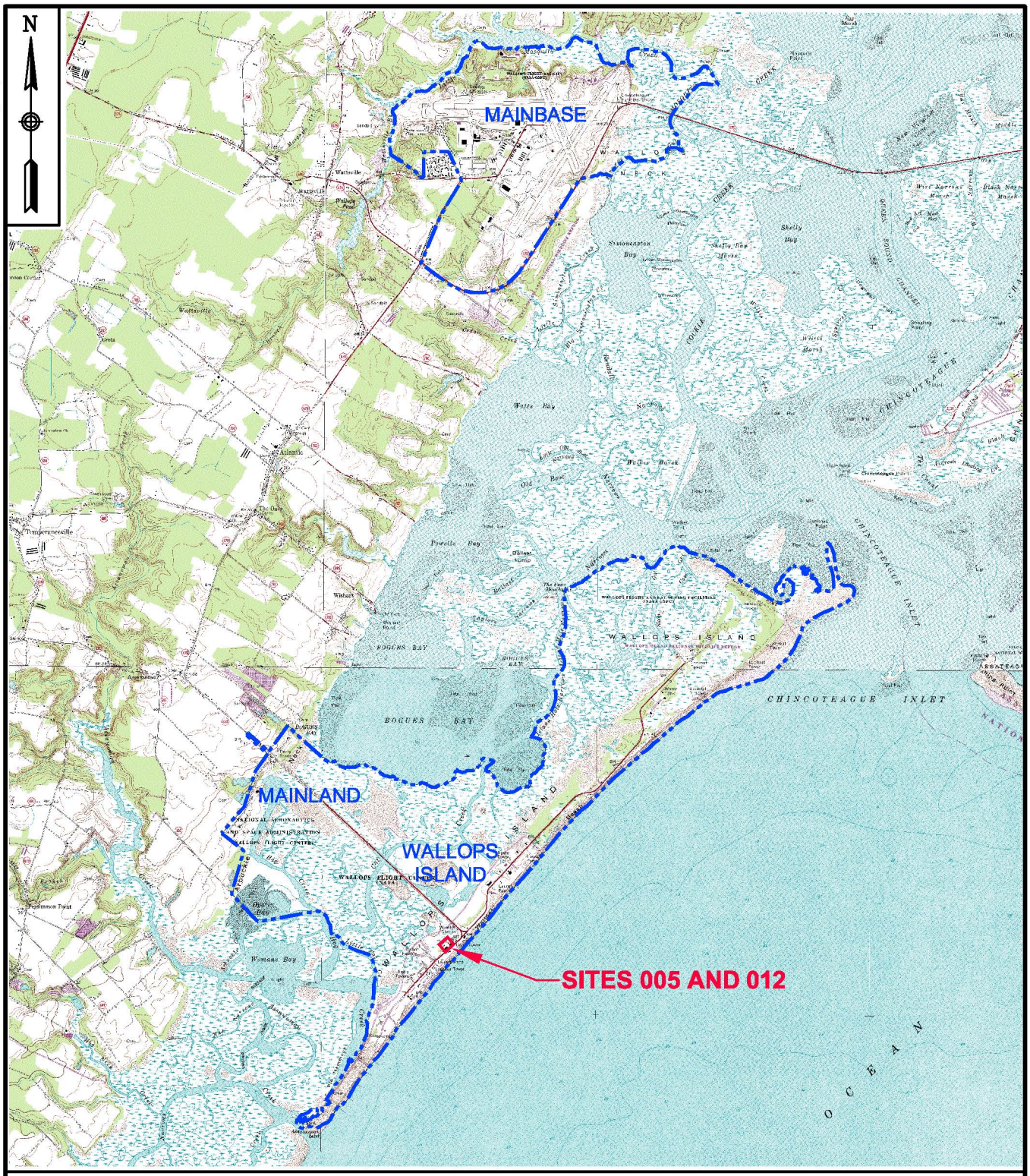


TETRA TECH NUS, INC.

FACILITY LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

SCALE	AS NOTED
FILE	1612BM02.DWG
REV	0
DATE	09/10/07
FIGURE NUMBER	FIGURE 2–1

112G00868\0310\112G00868BM02.DWG 02/03/10 MKB



0 6,400 12,800

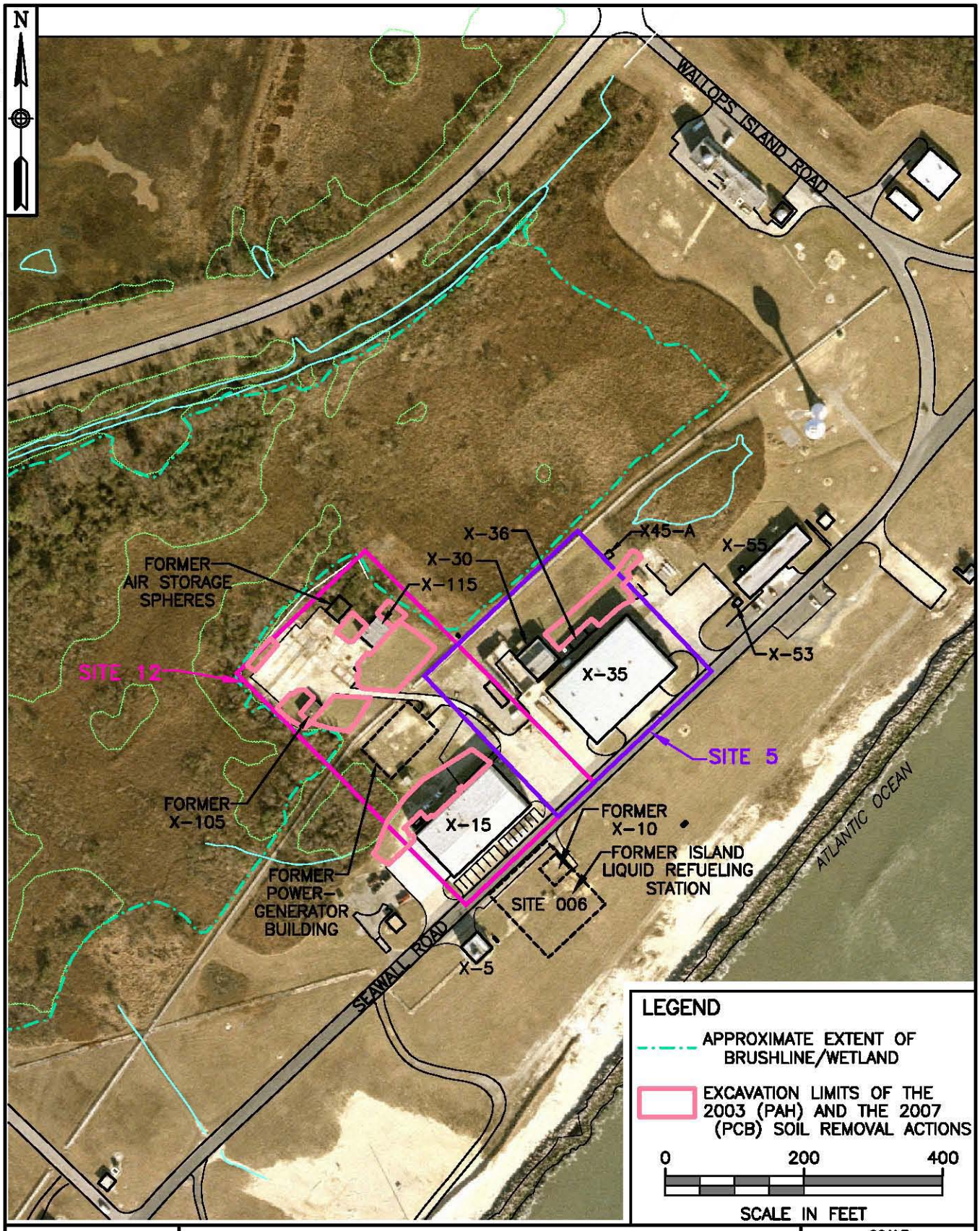
SCALE IN FEET

SOURCE: U.S.G.S. 7.5' QUADRANGLE MAPS, WALLOPS ISLAND, VA, BLOXOM, VA, CHINCOTEAGUE WEST, VA, AND HALLWOOD, VA.

TETRA TECH NUS, INC.

SITE LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

SCALE	AS NOTED
FILE:	112G00868BM02
REV	0
DATE	02/03/10
FIGURE NUMBER	FIGURE 2-2



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TETRA TECH NUS, INC.

SITE LAYOUT MAP
SITES 5 AND 12 FEASIBILTY STUDY
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

SCALE	AS NOTED
FILE	112G00868GM04
REV	0
DATE	03/03/10
FIGURE NUMBER	FIGURE 2-3

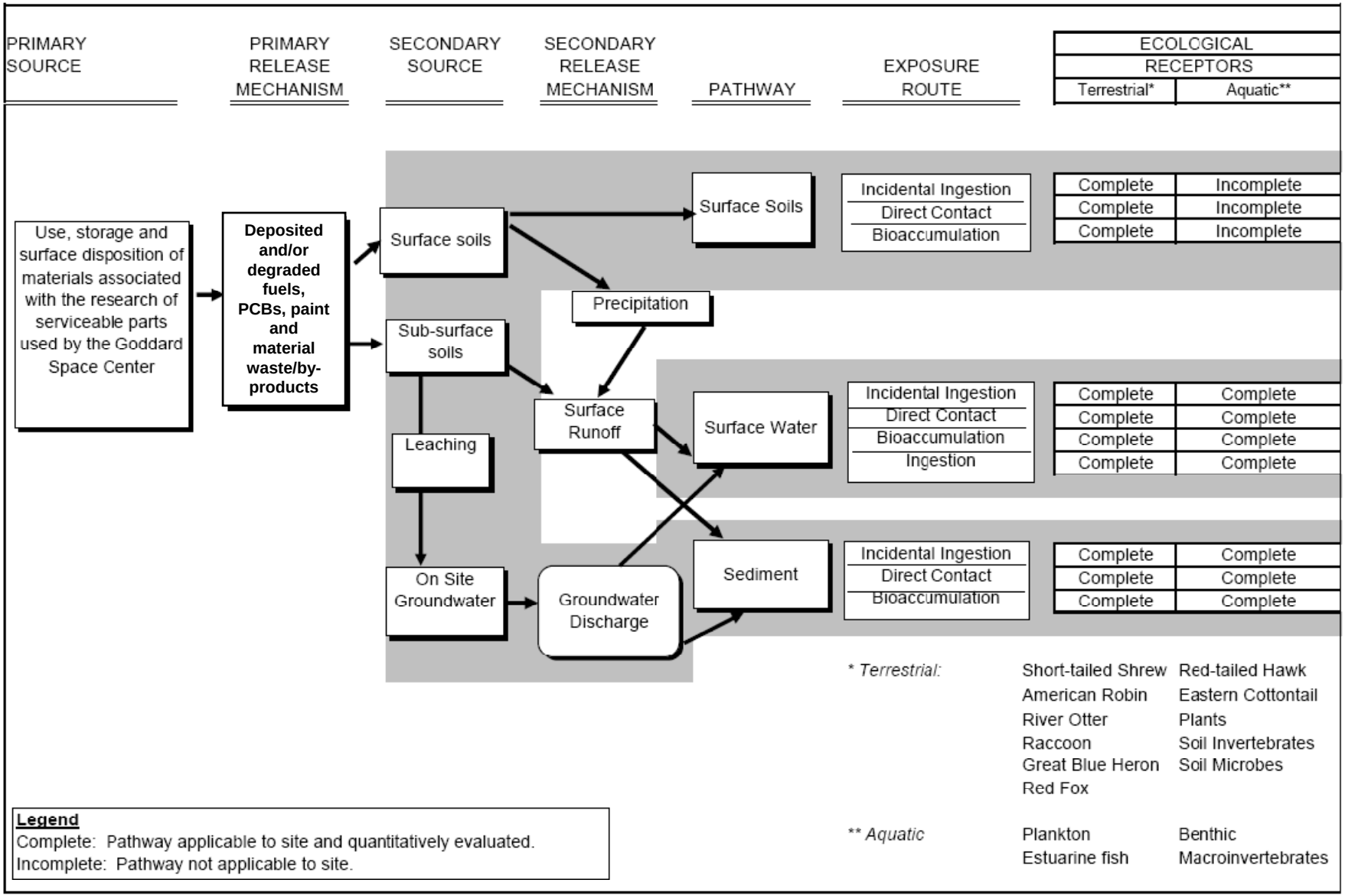
Figure 2-4
Human Health - Conceptual Site Model for Sites 5 and 12
Page 1 of 2

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Soil	Soil	Commercial/Industrial Worker	Adult	Ingestion	Quant	The firestation is manned 24 hours a day all year, with 3 firemen working 8-hour shifts. Assessing this commercial/industrial worker will be protective of the onsite worker, maintenance worker, security guard, and custodian who will be onsite less frequently and with less interaction with site media.
						Dermal Absorption	Quant	
						Inhalation	Quant	
				Construction Worker	Adult	Ingestion	Quant	Trench construction/utility work replacement will cause intrusive digging.
						Dermal Absorption	Quant	
						Inhalation	Quant	
				Groundskeeper	Adult	Ingestion	Quant	Grasscutting performed at Sites 005 and 012.
						Dermal Absorption	Quant	
						Inhalation	Quant	
	Groundwater	Groundwater	Groundwater	Construction Worker	Adult	Dermal Absorption	Quant	Due to shallow groundwater table, may contact groundwater while digging trench.
			Outdoor Air	Construction Worker	Adult	Inhalation of Volatiles	Quant	Due to shallow groundwater table, may inhale volatiles while digging trench.
	Surface Water	Surface Water	Surface Water	All	Adult	Ingestion	None	The phragmites and cat briar are too dense and workers do not perform work that would expose them to surface water.
						Dermal Absorption	None	
						Inhalation	None	
	Sediment	Sediment	Sediment	All	Adult	Ingestion	None	The phragmites and cat briar are too dense and workers do not perform work that would expose them to sediment.
						Dermal Absorption	None	
						Inhalation	None	
Future	Soil	Soil	Soil	Resident	Adult	Ingestion	Quant	Although a residential scenario is unlikely, direct exposure to soil on Site will be evaluated (and is evaluated to provide a baseline for future site management).
						Dermal Absorption	Quant	
						Inhalation	Quant	Although a residential scenario is unlikely, inhalation of soil particulates will be evaluated (and is evaluated to provide a baseline for future site management).
					Child	Ingestion	Quant	Although a residential scenario is unlikely, direct exposure to soil on Site will be evaluated (and is evaluated to provide a baseline for future site management).
						Dermal Absorption	Quant	
						Inhalation	Quant	Although a residential scenario is unlikely, inhalation of soil particulates will be evaluated (and is evaluated to provide a baseline for future site management).

Figure 2-4
Human Health - Conceptual Site Model for Sites 5 and 12
Page 2 of 2

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Groundwater	Groundwater	Groundwater	Resident	Adult	Ingestion	Quant	Although a residential scenario is unlikely (and is evaluated to provide a baseline for future site management), contact with groundwater through use as primary source of domestic water supply (i.e., drinking water and showering water) is considered.
						Dermal Absorption	Quant	
						Inhalation	Quant	Inhalation of volatiles from vapor intrusion and showering in a baseline residential scenario is considered.
					Child	Ingestion	Quant	Although a residential scenario is unlikely (and is evaluated to provide a baseline for future site management), contact with groundwater through use as primary source of domestic water supply (i.e., drinking water and bathing water) is considered.
						Dermal Absorption	Quant	
						Inhalation	Quant	Inhalation of volatiles from vapor intrusion and bathing in a baseline residential scenario is considered.

Figure 2-5
Ecological Conceptual Site Model for Sites 5 and 12



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N

FORMER AIR STORAGE SPHERES

SITE 5

SITE 12

X45-A

X-57

X-55

X-53

X-115

X-36

X-30

X-35

FORMER BUILDING X-105

FORMER POWER-GENERATOR BUILDING

X-15

X-91

WALLOPS ROAD

ATLANTIC OCEAN

0 80 160

SCALE IN FEET

NOTES:
1. ALTERNATIVE INCLUDES THE EXCAVATION OF SOIL/SEDIMENT WITH COC CONCENTRATIONS ABOVE ECOLOGICAL-NOEC-BASED PRGs TO A DEPTH OF 2 FEET. RESTORE EXCAVATIONS TO PRE-EXCAVATION GRADES FOLLOWING SOIL REMOVAL IN UPLAND AREAS. DO NOT BACKFILL EXCAVATION AREAS WITHIN THE WETLANDS.
2. ALTERNATIVE INCLUDES EXCAVATION AND OFF-SITE DISPOSAL OF PAH-CONTAMINATED SOIL/SEDIMENT TO REMOVE HUMAN HEALTH RISK FOR POTENTIAL RESIDENTS (NO LUCs NEEDED). RESTORE EXCAVATIONS TO PRE-EXCAVATION GRADES. DO NOT BACKFILL EXCAVATION AREAS WITHIN WETLANDS.

LEGEND

- APPROXIMATE EXTENT OF BRUSHLINE/WETLAND
- TOPOGRAPHIC CONTOUR IN FEET
- PROPOSED EXCAVATION LIMITS BASED ON THE ECOLOGICAL-NOEC-BASED PRGs
- PROPOSED EXCAVATION LIMITS BASED ON THE HUMAN HEALTH-BASED PRGs FOR PAHs

TETRA TECH NUS, INC.

ALTERNATIVE 3
EXCAVATION AND OFF-SITE DISPOSAL OF CONTAMINATED SOIL AND SEDIMENT
SITES 5 AND 12 FEASIBILITY STUDY
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE	SCALE
112G00868GM08	AS NOTED
FIGURE NUMBER	**REV / DATE**
FIGURE 2-6	0 / 01/19/10