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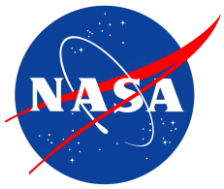

FINAL

ENGINEERING EVALUATION / COST ANALYSIS
OPERABLE UNIT 7
FORMERLY USED DEFENSE SITE
PROJECT 15 CONSTRUCTION DEBRIS LANDFILL
WALLOPS FLIGHT FACILITY FORMERLY USED DEFENSE SITE
WALLOPS ISLAND, VIRGINIA

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia

October 2022

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Final

Engineering Evaluation / Cost Analysis
Operable Unit 7
Formerly Used Defense Site
Project 15 Construction Debris Landfill
Wallops Flight Facility Formerly Used Defense Site
Wallops Island, Virginia

National Aeronautics and Space Administration
Goddard Space Flight Facility
Wallops Flight Facility
Wallops Island, Virginia

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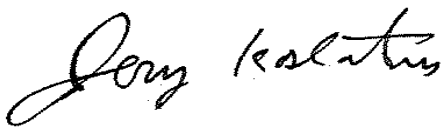

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CERTIFICATION

I certify that the information contained in or accompanying this document is true, accurate, and complete.

As to any portion of this document for which I cannot personally verify its accuracy, I certify under penalty of law that this document and all attachments were prepared in accordance with procedures designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, or the immediate supervisor of such person(s), the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Signature: DAVID LIU Digitally signed by DAVID LIU Date: 2022.10.25 11:50:11 -04'00'

Name: David Liu

Title: NASA Project Coordinator

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Figures

Tables

Acronyms and Abbreviations

3-D	three-dimensional
AECOM	AECOM Technical Services, Inc.
ALM	Adult Lead Methodology
amsl	above mean sea level
AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
CDL	Construction Debris Landfill
CENAB	United States Army Corps of Engineers, Baltimore District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPEC	chemical of potential ecological concern
C/S	Central/Southern exposure area
CSM	conceptual site model
CTE	Central Tendency Exposure
DCE	dichloroethylene
DPT	direct push technology
EE/CA	Engineering Evaluation / Cost Analysis
ELCR	excess lifetime cancer risk
ERA	Ecological Risk Assessment
ESC	Erosion and Sediment Control
ESV	Ecological Screening Value
FUDS	Formerly Used Defense Site
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HI	hazard index
IEUBK	Integrated Exposure Uptake Biokinetic
LUC	Land Use Control
LSI	limited site investigation
LTM	Long-Term Monitoring
MADEP	Massachusetts Department of Environmental Protection
MIP	membrane interface probe
NASA	National Aeronautics and Space Administration
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration

NTCRA	Non-Time-Critical Removal Action
N/W	Northern/Western exposure areas
O&M	operation & maintenance
PAH	polycyclic aromatic hydrocarbon
PbB	blood lead
PCE	tetrachloroethene
ppt	parts per trillion
PRG	Preliminary Remediation Goal
RAO	Removal action objective
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
RSL	Regional Screening Level
SFI	Supplemental Field Investigation
SLERA	Screening Level Ecological Risk Assessment
SVOC	semi- Volatile Organic Compounds
TAL	target analyte list
TBC	to be considered
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TCL	target compound list
TEQ	toxicity equivalence
UCL	upper confidence limit
µg/dL	micrograms per deciliter
µg/kg	micrograms per kilogram
U.S.	United States
USACE	United States. Army Corps of Engineers
USATEC	United States Army Topographic Engineering Center
USEPA	United States Environmental Protection Agency
VAC	Virginia Administrative Code
VDEQ	Virginia Department of Environmental Quality
VI	Vapor Intrusion
VOC	Volatile Organic Compound
WFF	Wallops Flight Facility

Executive Summary

The Supplemental Field Investigation (SFI) Data Report and the Final Remedial Investigation (RI) Report of the Operable Unit 7, Project 15 Construction Debris Landfill (CDL), National Aeronautics and Space Administration (NASA) Wallops Flight Facility (WFF) Formerly Used Defense Site (FUDS) identified, “Unacceptable risks associated with the Central and Southern [Areas of Concern] are present at the site. Solid waste is clearly evident at the surface and persists to a depth of at least 13 feet in some areas.” (United States [U.S.] Army Corps of Engineers [USACE], 2011).

Action is necessary to address the potential for direct contact with exposed landfill wastes by human and ecological receptors. NASA is the lead Agency for WFF, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and has determined that a Non-Time-Critical Removal Action (NTCRA) is necessary because waste is exposed at or near the surface of the CDL. This Engineering Evaluation / Cost Analysis (EE/CA) addresses landfill waste and surrounding soil; groundwater, sediment, and surface water will be addressed in the Feasibility Study (FS).

The NTCRA process places emphasis on conducting an EE/CA. NASA contracted AECOM Technical Services, Inc. (AECOM) under contract number 80KSC019D0010, delivery order 80GSFC20F0047 to prepare this EE/CA. Section 1.2 of the U.S. Environmental Protection Agency (USEPA) NTCRA guidance states, "The goals of the EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives." (USEPA, 1993). An EE/CA is intended to satisfy environmental review requirements for removal actions and provide a framework for evaluating and selecting alternative technologies. In doing so, the EE/CA identifies the objectives of the removal action and analyzes the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. Thus, an EE/CA serves an analogous function to, but is more streamlined than, the RI/FS conducted for remedial actions. The results of the EE/CA and USEPA’s response decision are summarized in an Action Memorandum. This EE/CA evaluates proposed actions to remove the threat to human and ecological health from exposed waste.

WFF is in Accomack County, Virginia, on the Atlantic Coast of the Delmarva Peninsula. Analysis of historical aerial photographs, as reported in the RI, documents a series of ground scars indicative of waste disposal in areas at the northeast corner of WFF that are visible in 1949, 1954, 1959, and 1963 aerial photographs. By 1963, some of these features are no longer visible, and by 1974, none of them remained visible (USATEC, 2000). There are two areas of waste: one in the Central Area of Concern (AOC) and one in the Southern AOC. In these areas, debris is generally buried under clean fill; however, along the edge of the marsh, including the area between the AOCs, waste is observed near the surface.

The following removal action objective (RAO) was developed for the Project 15 CDL site: reduce or eliminate direct exposures to waste and Chemicals of Concern (COCs) in soil by human and ecological receptors as well as mitigate transport of these COCs to surface water or sediment receptors.

Three removal alternatives are evaluated in the EE/CA: Alternative 1: No Action; Alternative 2: Excavation and Off-site Disposal of Waste and Affected Soil; and Alternative 3: Standard Landfill Cap with Consolidation of Sediments Below the Cap, Land-Use Controls (LUCs), and Long-Term Monitoring (LTM).

Based on a comparison of effectiveness, implementability, and cost, the recommended alternative for the NTCRA for the CDL is Alternative 2: Excavation and Off-site Disposal of Waste and Affected Soil. Alternative 2 provides the best balance of all options considering the overarching mandate to protect human health and the environment, and achieve the best combination of effectiveness, implementability, and cost effectiveness.

1. Introduction

The Final Supplemental Field Investigation (SFI) Data Report and the Final Remedial Investigation (RI) Report of the Operable Unit 7, Project 15 Construction Debris Landfill (CDL), National Aeronautics and Space Administration (NASA) Wallops Flight Facility (WFF) Formerly Used Defense Site (FUDS) identified, “Unacceptable risks associated with the Central and Southern [Areas of Concern] are present at the site. Solid waste is clearly evident at the surface and persists to a depth of at least 13 feet in some areas.” (United States [U.S.] Army Corps of Engineers [USACE], 2011). The NASA Goddard Space Flight Center WFF qualifies as a USACE FUDS property pursuant to the Environmental Restoration Defense Account and the Defense Environmental Restoration Program, Chapter 160 of the Superfund Amendments and Reauthorization Act of 1986. As part of the USACE FUDS program, USACE-Baltimore District (CENAB) is responsible for oversight of USACE FUDS activities at the former WFF-FUDS. In February 2015, the Department of Army and NASA signed a Memorandum of Agreement for the purpose of transferring FUDS funding to NASA to conduct necessary response actions under CERCLA at the FUDS. In January 2021, NASA and the EPA entered an Administrative Agreement and Order on Consent, which applies to past releases of hazardous substances, waste, and/or constituents at WFF FUDS and identifies CERCLA response requirements, policies, and guidance as the primary process for planning and performing the work necessary to address those releases.

Action is necessary to address the potential for direct contact with exposed landfill wastes and affected soil by human and ecological receptors. NASA is the lead Agency for WFF under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and has determined that a Non-Time-Critical Removal Action (NTCRA) is necessary because waste is exposed at or near the surface of the CDL. This Engineering Evaluation / Cost Analysis (EE/CA) addresses landfill waste and surrounding soil; groundwater, sediment, and surface water will be addressed in the Feasibility Study (FS).

The NTCRA process places emphasis on conducting an EE/CA. NASA contracted AECOM Technical Services, Inc. (AECOM) under contract number 80KSC019D0010, delivery order 80GSFC20F0047 to prepare this EE/CA. Section 1.2 of the U.S. Environmental Protection Agency (USEPA) NTCRA guidance states, "The goals of the EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives." (USEPA, 1993). Thus, an EE/CA serves an analogous function to, but is more streamlined than, the Remedial Investigation (RI)/FS conducted for remedial actions. The results of the EE/CA and USEPA’s response decision are summarized in an Action Memorandum. This EE/CA evaluates proposed actions to remove the threat to human and ecological health from exposed waste.

The basis for drafting this EE/CA and proceeding with a removal action is the National Contingency Plan (NCP). Section 300.415(b)(4) of the NCP states that, “Whenever a planning period of at least six months exists before on-site activities must be initiated, and the lead agency determines, based on a site evaluation, that a removal action is appropriate: (i) The lead agency shall conduct an EE/CA or its equivalent.” Section 300.415(b)(2) of the NCP lists eight criteria to determine whether a removal action is appropriate. The factor most applicable to current site conditions is Section 300.415(b)(2)(viii) - *Other situations or factors that may pose threats to public health or welfare of the United States or the environment*. The situation that may pose threats to public health or welfare at the WFF CDL is the threat to human and ecological health from waste exposed at or near the surface of the CDL. CERCLA and the NCP

require that removal actions, to the extent practicable, contribute to the efficient performance of any anticipated long-term remedial action.

This EE/CA has been prepared with the guidance set forth in the NCP (40 Code of Federal Regulations [CFR] 300.415, Removal Action) and the USEPA guidance document on removal actions, *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993). These documents provide information on the procedures and activities to be followed while conducting NTCRAs under CERCLA and the NCP.

2. Site Characterization

This section provides a description of the Site, including site location, and previous environmental studies. This section also includes a discussion of the nature and extent of the contamination as well as a streamlined risk evaluation.

2.1 Site Description and Background

WFF is in Accomack County, Virginia, on the Atlantic Coast of the Delmarva Peninsula (**Figure 2-1**), approximately 5 miles south of the Maryland/Virginia state boundary, and immediately west of Chincoteague Island. WFF is bounded on the north and east by Little Mosquito Creek, Simoneaston Bay to the east, and Wattsville Branch to the west, and it sits just above mean sea level (amsl), at 20 to 30 feet amsl. WFF consists of three separate land areas: Wallops Main Base, Wallops Mainland, and Wallops Island. The Project 15 CDL is located northeast of the runways, on the approximately 2,230-acre Main Base (**Figure 2-1**).

Analysis of historical aerial photographs, as reported in the RI, documents a series of ground scars indicative of waste disposal in areas at the northeast corner of WFF that are visible in 1949, 1954, 1959, and 1963 aerial photographs. By 1963, some of these features are no longer visible, and by 1974, none of them remained visible (USATEC, 2000).

2.2 Site Physical Characteristics

Site soils have been classified as Molena loamy sand. Molena loamy sand is characterized by 0 to 6 percent slopes, with rapid permeability and is somewhat excessively drained. The background study (Tetra Tech, 2021) found that Molena loamy sand had concentrations of naturally occurring metals that are statistically distinct from concentrations of these metals in the other soil type found on Wallops Main Base, the Bojac soils.

2.2.1 Site Topography and Drainage

Elevations on the WFF range from mean seal level to 42 feet amsl, with slopes of 1 to 2% (Versar 2011). In general, the land surface at the CDL slopes from north to south and west to east. Elevations ranged from just over 1-foot amsl on the southeastern edge of the Southern AOC to just under 21 feet amsl west of the access road, across from the Central AOC. In the northern portion of the CDL, elevations decrease from about 19 feet west of the access road in the Northern AOC to about 10 feet, near the edge of the marsh east of the Northern AOC. In the southern part of the Site, elevations just west of the access road are about 12 to 13 feet amsl; near the edge of the marsh, elevations are 3 to 4 feet amsl.

The Site is bound on the east by a narrow tidal channel of Mosquito Creek; water flows north to south in the immediate vicinity of the CDL. The tidal channel turns eastward south of the Site and rejoins Mosquito Creek.

Drainage on and adjacent to the CDL is controlled by ditches on the west side of the access road as well as two concrete culverts that connect the drainage ditch to west-to-east drainage features: one located north of the Central AOC and the other located south of the Southern AOC. Another, smaller man-made drainage ditch receives surface water flow off the Southern AOC**.**

2.2.2 Site Geology

The site geology is defined based on information collected during the RI completed by Versar (2011) as well as the boring logs completed during the SFI. From the surface downward, the materials present at the Site and investigated during the RI and SFI include fill (including waste); Pleistocene-age sands, silts, and clays; and the Yorktown Formation.

Fill and Waste

Fill is present in the Central and Southern AOCs (**Figures 2-2** and **2-3**) and consists of both natural materials (predominantly sand) and man-made materials disposed of in the AOCs (waste). Natural material (sand) appears to have been used to grade the topography as well as to cover disposed waste material. The eastern extent of the waste is the western edge of the marsh in the Central AOC and the Southern AOC.

Within the Central AOC waste is found at the surface but is also buried beneath as much as 11 feet of sand fill. The waste includes empty metal drums, paint, scrap metal, rebar, glass bottles, bricks, cable, springs, tires, and broken concrete. During the SFI, waste was found at depths of up to 12 feet bgs; during the RI the maximum depth of waste in the Central AOC was about 13 feet bgs.

As in the Central AOC, waste in the Southern AOC is found both at the surface and buried beneath a layer of sand fill (up to 4 feet deep). Waste in the Southern AOC consists of cinders and burned rubbish (glass, cans, wires) (Versar, 2011) as well as plastic, plates, scrap metal, bathroom fixtures, railroad ties, and metal pipes. The maximum thickness of cover material (fill) was 4 feet of fine silty sand, but in most locations, only about 1 foot of cover sand was present. The maximum thickness of waste found during the SFI was 5 feet.

Pleistocene Deposits

Deep temporary wells were constructed during the SFI to sample the lower part of the surficial aquifer. The borings for these wells terminated at the top of the Yorktown Formation clay. Based on the logs from these four borings, the Pleistocene deposits are as much as 68 feet thick at the Site. The unit consists predominantly of fine to coarse quartz sands, coarsening downward and containing trace gravel in the lower part of the unit. Sands and minor organic clay layers consistent with the sandy estuarine and beach deposits are found in the upper part of the Pleistocene deposits near the marsh.

In the southern part of the Project 15 CDL site, a significant clay unit—the Columbia Clay—is found within the Pleistocene deposits. At the Town of Chincoteague supply well TOC-06, this orange-brown and gray clay is present from 21 to 42 feet bgs. At DTW-4, located 140 feet east-northeast of TOC-06, the olive-grey clay and silt are present from 24.6 to 39.6 feet bgs.

Yorktown Formation

The Yorktown Formation clays and sands underlie the Pleistocene deposits. The top of the Yorktown Formation is a clay, distinguished by a distinctive greenish color, present at a depth of about 60 to 68 feet; the Yorktown clay was found in each of the deep temporary borings drilled in the SFI. The deep borings completed during SFI did not penetrate more than approximately 5 feet into the Yorktown clay. At TOC-06, the Yorktown clay is 33 feet thick (from 84 to 117 feet bgs). A second clay is found from 127 to 156 feet bgs. The well is screened from 154 to 225 feet bgs in fine to coarse sand, shell, and clay. A third significant clay within the Yorktown formation is found from 228 to 238 feet bgs (the maximum depth of the well boring).

2.2.3 Site Hydrogeology

At the Project 15 CDL site, the surficial aquifer is approximately 50 feet thick (water table to top of Yorktown Clay). The aquifer consists of very fine to very coarse-grained sand and silty sand at the CDL site (Versar, 2011). A discontinuous clay is found within the surficial aquifer of the southern part of the Site.

At the Project 15 CDL site, the Yorktown Aquifer is separated from the overlying surficial aquifer by a 63-foot thick confining layer (aquitard) of clay and silt, as was detailed in the geologic log for the Town of Chincoteague water supply well TOC-06. The top of the shallowest confined aquifer of the Yorktown Formation at WFF is found at depths of approximately 100 feet bgs. Note that well TOC-06 is located within the Site boundary.

Two rounds of water level monitoring at the six site monitoring wells were conducted immediately prior to each groundwater sampling event. Based on these measurements, shallow groundwater flow is toward the northeast.

2.3 Site History

Prior to development of the Site by the U.S. government, the current WFF property was farmland and marshland. The Department of Navy acquired the property in 1942 and established a World War II training facility. The Navy discontinued naval training operations at the facility in 1959, when NASA took custody of the Main Base as well as the northern portion of Wallops Island and the Mainland. NASA excised approximately 397 acres of the Main Base to the U.S. Fish and Wildlife Service in 1975.

2.3.1 Site Operational History

Analysis of historical aerial photographs, as reported in the RI (Versar, 2011), document a series of ground scars indicative of waste disposal in areas at the northeast corner of WFF that are visible in 1949, 1954, 1959, and 1963 aerial photographs. By 1963, some of these features are no longer visible, and by 1974, none of them remained visible (USATEC, 2000). Investigations, described in the following subsections, confirmed that the area had been used for disposal of construction debris and ash.

2.3.2 Site Investigation History

As described in the RI report (Versar, 2011), the Project 15 CDL site was discovered in 2000, when the U.S. Army Topographic Engineering Center (USATEC) produced a historical analysis report of area ground scars, disturbances, channels, and other activities at WFF dating back to pre-U.S. involvement in WWII (USATEC, 2000). The analysis of aerial photographs revealed several ground disturbances in the northeast corner of WFF that are clearly visible in 1949, 1954, 1959, and 1963 aerial photographs. By 1963, some of these features were no longer visible, and by 1974, none of them remained visible (USATEC, 2000). Based on the aerial photographic analysis, four Areas of Concern (AOCs) within the CDL, shown on **Figure 2-4,** were defined and named with respect to their geographic position to each other: Northern, Central, Southern, and Western AOCs**.** In previous investigations, these AOCs have also been described by the nature of their apparent historical site use:

- Northern AOC – Disturbed Ground – This AOC was an area of disturbed ground in 1949 and identified as an excavation in the 1954 aerial photograph.

- Central AOC – Mounds of Material – This AOC was an area with several mounds of unidentified material in 1954 and was identified as an excavation in the 1959 aerial photograph.
- Southern AOC – Burning Dump – This AOC was an area of disturbed ground with two man-made channels; the AOC's use as a burning ground was confirmed on a 1950 site map.
- Western AOC – Shallow Excavation – This AOC is interpreted to be a shallow excavation that is now located inside the runway area fence.

In 2001, the Department of Defense and USACE assumed responsibility for various sites, including the CDL, under the FUDS program. Since then, the AOCs have been the subject of five prior investigations:

- A limited site investigation (LSI) in 2002 conducted by Science Applications International Corporation (SAIC, 2003)
- A forensic soil sampling and analysis event
- A soil gas investigation in March and April 2004
- An RI conducted in 2007
- A Supplemental Field Investigation (SFI) conducted from 2015 to 2017

Data from the RI were used to develop the draft FS (Versar 2012). Additional information and analytical data were needed to allow a refinement of the remedial alternatives presented in the draft FS, so an SFI was completed. Data from the RI also informed the planning of the SFI field activities and are used with the SFI data to refine the Conceptual Site Model (CSM).

In addition, NASA conducted a site background soil and groundwater investigation for the Main Base in 2004 (Tetra Tech, 2021) to provide data to represent background conditions at WFF. The background data sets are used for comparison in site-specific studies, such as the Project 15 CDL RI and SFI.

2.3.2.1 Limited Site Investigation – 2002

In 2002, SAIC conducted an LSI and collected soil and groundwater samples from the areas southeast of the Central and Southern AOCs. Information about the LSI presented here is summarized from the final RI report (Versar, 2011).

The objective of the investigation was to determine if past activities had contaminated soil and groundwater near the AOCs. Samples were collected from three direct push technology (DPT) borings (SB-CDL-01, SB-CDL-02, and SB-CDL-03). SB-CDL-01 was located east of the southern end of the Central AOC; SB-CDL-02 and SB-CDL-03 were located east of the Southern AOC. The RI report noted that the exact locations of SB-CDL-02 and SB-CDL-03 are not known. Significant findings from the LSI include:

- In SB-CDL-02, a black sheen with associated volatile organic vapors was found from 7.5 to 16 feet below ground surface (bgs) (the bottom of the borehole). Soil samples were collected from immediately above and below the water table and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), target analyte

list (TAL) metals, and mercury. A groundwater sample was also collected (the depth of the sample is not known).

- A variety of polynuclear aromatic hydrocarbons (PAHs) (a subset of SVOCs) were detected in the SB-CDL-01 soil sample collected above the water table. No VOCs were detected in that sample. Fewer SVOCs were detected in a sample from a depth of 9 feet (below the water table). VOCs in the deeper sample include1,2-dochloropropane (2,000 microgram per kilogram [µg/kg]), ethylbenzene 12,000 µg/kg), m-and/or p-xylene at 9,600 µg/kg, and tetrachloroethene (PCE) at 1,100 µg/kg.
- The groundwater sample from SB-CDL-01 (identified as sample HP-CDL-01) contained several VOCs, including relatively low levels of chlorinated solvents (1.1 micrograms per liter [µg/l] of trichloroethylene [TCE], 0.7 µg/l chloromethane, 12 µg/l cis-1,2-dichloroethene [DCE], and 12 µg/l of PCE) and higher concentrations of petroleum hydrocarbons (920 µg/l ethylbenzene, 3,700 µg/l m-and p-xylenes, and 12,000 µg/l toluene). Concentrations of PCE and xylenes exceeded risk-based criteria.
- Concentrations of metals in SB-CDL-02 and SB-CDL-03 were higher than in SB-CDL-01. Soil from all three borings contained concentrations of arsenic that exceeded soil screening criteria. Groundwater from SB-CDL-01 contained concentrations of iron and manganese that exceeded the USEPA Regional Screening Levels (RSLs).

2.3.2.2 Forensic Soil Investigation – 2004

In 2004, USACE collected a single soil sample from the contaminated soil layer found at approximately 7.5 feet in boring SB-CDL-01. The sample was analyzed for volatile petroleum hydrocarbons and extractable hydrocarbons using the Massachusetts Department of Environmental Protection (MADEP) method and USEPA Method 8015 gas chromatograph fingerprinting analysis. The chromatograph produced by the analysis appeared to be weathered JP-5 aviation fuel with a significant number of the lower boiling point hydrocarbons missing. The results of the MADEP method also suggest that the contamination is a distillate fuel.

2.3.2.3 Soil Gas Investigation – 2004

In 2004, soil gas samples were collected via a passive soil gas survey (Gore-Sorber® technique) conducted across the Site and including all or part of each AOC. The survey measured elevated levels of benzene, toluene, ethylbenzene, and xylene (BTEX) as well as chlorinated solvents (defined in the survey as PCE, TCE and DCE). BTEX compounds were found in heaviest concentrations east of the southern end of the Central AOC and, to a lesser degree, in the northeast part of the Central AOC, the northern end of the Western AOC, and the southern end of the Southern AOC. Chlorinated solvents were detected in soil gas in the northeastern end of the Southern AOC and the southeastern end of the Central AOC.

2.3.2.4 Background Soil and Groundwater Investigation – 2004/2021

NASA completed a background soil and groundwater investigation in 2004 and an Updated Background Threshold Values Report in 2021 (Tetra Tech, 2021) (the Background Study) to provide data sets that evaluated the background conditions (concentrations of analytes) in soil and groundwater at the Main Base. The data used in the study included samples collected in prior studies and samples collected specifically for the Background Study. Only samples that were located away from and/or upgradient of suspected contaminant source areas were used in the study.

Data from the two types of soils found at the Main Base—Molena and Bojac Series—were evaluated and found to be statistically distinct from each other; background concentrations were evaluated for each soil type. The Molena soils are found on the Project 15 CDL. The constituent concentrations in surface and subsurface soil within each series were also found to be statistically distinct.

Groundwater samples were collected from only the shallowest water-bearing zone, the surficial aquifer. The Background Study also found that groundwater samples collected via low-flow sampling techniques provide a better representation of groundwater conditions.

2.3.2.5 Remedial Investigation – 2007

An RI was conducted in 2007, and the data were used for a baseline Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA). The RI, HHRA, and ERA results were reported in the final RI report (Versar 2011). The results of the RI and risk assessment were used to develop a draft FS (Versar 2012). RI activities included:

- Conducting electromagnetic and ground penetrating radar geophysical surveys to find buried metal and non-metal debris.
- Conducting a membrane interface probe (MIP) survey. The MIP is a direct push instrument that contains photoionization, flame ionization, and electron capture detectors. VOCs in soil migrate through the probe membrane and are analyzed by the detectors.
- Excavating, logging, and soil sampling of 10 test pits. At least two soil samples (a surface soil from 0 to 6 inches bgs and a subsurface sample from 6 to 24 inches bgs) were collected from each test pit and analyzed for target compound list (TCL) VOCs, SVOC, pesticides and TAL metals. Ten test pits (TP1 through TP10) were excavated: two test pits were excavated in each of the Northern, Western and Central AOCs, and four test pits were excavated in the Southern AOC. At a minimum, soil samples from 0 to 0.5 and 0.5 to 2.0 feet bgs were collected for risk assessment purposes. Additional samples were collected if waste were encountered.
- Installing and sampling six shallow monitoring wells to depths about 7 feet below the water table. Soil samples were collected from the boring during drilling. One monitoring well, MW-1, was installed upgradient of the AOCs and served as a location for background data. MW-6 and MW-2 were installed downgradient of the Northern and Western AOCs, respectively, where no evidence of debris was found during the test pit investigations. MW-5 and MW-4 were installed downgradient of the Central AOC, and, as mentioned previously, MW-3 was installed downgradient of the Southern AOC. Two rounds of groundwater samples were collected and analyzed for TCL VOCs, SVOCs, and TAL metals.
- Collecting 10 sediment samples and analyzing them for TCL VOCs, SVOCs, pesticides, and TAL metals, and total organic carbon.
- Collecting 10 surface water samples and analyzing them for TCL VOCs, SVOCs, and TAL metals.
- Measuring water levels, hydraulic gradients, and hydraulic conductivity of the shallow surficial aquifer.

Significant findings of the RI are summarized here; full evaluation of data collected in the RI is provided in the final RI report (Versar, 2011).

- The geophysical investigation identified five anomalies located in either the Central or Southern AOCs. Geophysical investigation anomalies are locations where conductivity readings are either above or below 0 millimhols per meter and/or magnetic susceptibility readings are either above or below 0 parts per trillion (ppt). Four of the five anomalies (Anomalies A through D) were located along the eastern edges of the AOCs; near the edge of the marsh. The fifth anomaly (Anomaly E) was located in the northwest part of the Central AOC.
- Elevated detector values were found in one of the eight MIP borings, MIP-5, located in the north-central part of the Central AOC. When the MIP probe was pulled from the ground, the probe drill rods were covered in gray paint.
- No waste was encountered in the test pits located in the Northern or Western AOCs.
- Surface soil (0 to 0.5 feet bgs) from the Northern AOC did not contain any organic compounds. Only bis(2-ethylhexyl)phthalate, at a concentration below site background levels, was detected in subsurface soils. Concentrations of detected metals did not exceed site background levels.
- The only organic compound detected in shallow soil (0 to 0.5 feet bgs) from the Western AOC was the pesticide, 4,4-dichlorodiphenyldichloroethylene . The concentration is less than the mean concentration of DDE found in site background soil samples.
- Waste drums were found at depths up to 13 feet in a test pit located near MIP-5 in the Central AOC. Waste was also found at the surface over the eastern third of the Central AOC.
- Waste (cinders and burned debris) was encountered at the surface and at depths up to 8 feet in the Southern AOC.
- During drilling of the monitoring wells, petroleum staining was noted in SB-4 (completed as MW-4), located on the southeastern edge of the Central AOC (**Figure 2-5** provides the depth intervals at which staining was observed in the subsurface). Staining was found in this boring from about 9 feet to about 14 feet, decreasing with depth. Monitoring well MW-3, located within the Southern AOC, is screened within waste material.

2.3.2.6 Supplemental Field Investigation – 2015 to 2017

The SFI consisted of several events conducted between May 2015 and November 2017. Field activities included trenching, collecting soil samples from trenches and from DPT borings, sampling shallow and deep temporary wells, collecting two rounds of surficial aquifer groundwater samples from monitoring wells, collecting a Yorktown Aquifer groundwater sample from water supply well TOC-06, and collecting pore water and sediment samples from Little Mosquito Creek. The trenching and temporary well activities were phased to allow evaluation of preliminary analytical results and field observations to inform the locations of subsequent data collection.

The location of all the trenches and temporary monitoring wells (shallow and deep) are shown on **Figure 2-6.** Note that **Figure 2-6** also shows the location of test pits excavated during the RI.
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The SFI was performed to collect information and analytical data to allow a refinement of the remedial alternatives presented in the draft FS (Versar, 2012). The primary objectives of the field investigation were:

- To determine if the lower part of the surficial aquifer were contaminated and, if so, determine if the upper Yorktown Aquifer were contaminated.
- Refine the extent of the waste material at the CDL.

The initial field investigation determined that dioxin congeners were present in site soil and groundwater. USEPA, the Virginia Department of Environmental Quality (VDEQ), NASA, and USACE determined that additional sediment samples, as well as pore water samples, should be collected to further refine the areas of sediment contamination and update the ERA to determine if additional chemical of potential ecological concern (pCOPECs) were present. Similarly, an HHRA addendum was developed to evaluate the presence of additional chemicals of potential concern (pCOPCs) and the additional risk posed to future receptors based on the additional COPCs or recent toxicity values. The objectives of the SFI have been achieved, and the data collected were used to complete the FS.

To identify the areas of the lower surficial aquifer most likely to be contaminated, trenches were excavated, and soil from the trenches was sampled and analyzed to identify areas of heavy soil contamination. Shallow surficial aquifer temporary wells were installed and sampled in areas of heaviest soil contamination. Deep temporary wells were installed in areas where heaviest contamination was found in the shallow surficial aquifer as well as between those areas and the upper Yorktown Aquifer water supply well TOC-06. The contamination found in the shallow parts of the surficial aquifer extends to greater depths but is contained within the surficial aquifer.

Trenching and soil borings were used to delineate the edge of observed waste and document the types of debris and sources of contaminants present at the Site. There are two areas of waste: one in the Central AOC and one in the Southern AOC. In these areas, debris is generally buried under clean fill. However, along the edge of the marsh, including the area between the AOCs, waste was observed near the surface.

In addition to waste, observations and soil analytical data allow the delineation of petroleum-stained areas. The location, depth, and thickness of waste and zones of stained sand were used as inputs to a three-dimensional (3-D) model. The model extrapolated the extent of both the waste and stained sand, although the western extent of stained sand was not well-defined with field observations. The 3-D model was used to calculate the volume of waste debris (7,450 cubic yards) and the volume of stained sand (8,065 cubic yards).

The analytical data and field observations from trenches and borings allow the development of a CSM of the migration of COPCs and COPECs through the environment. Key elements of the CSM include:

- Waste and fuel are sources of contamination. When disposed on the ground surface, liquid fuels infiltrated through the sand to the water table and then moved laterally, floating on the water table.
- Tidal fluctuations create a “smear zone” of fuel-stained sand at the water table.
- Contaminants leached from waste and stained sand via infiltrating precipitation and migrated to the groundwater.

- Groundwater flow is northeast and east, toward the marsh and tidal channel. The adjacent marsh and tidal waters are a regional groundwater discharge zone for the surficial aquifer.
- Contaminants in the VOC and SVOC shallow groundwater found in the Central AOC were not detected in the pore water of the marsh sediment, indicating that contaminant concentrations are attenuating before they reach the marsh sediments. Attenuation processes likely include aerobic and anaerobic degradation of VOCs, adsorption of SVOC, dioxin and metal contaminants on sediment and organic matter, and dilution via advection, diffusion, and dispersion.
- The regionally extensive Yorktown clay confines the upper Yorktown Aquifer where the water supply well is screened, protecting the aquifer from the low levels of contamination found in the deep surficial aquifer.
- Volatile components of the fuel volatilize from the groundwater to air in soil pore spaces, migrate upward, and are released to the atmosphere.
- In the groundwater, anaerobic, and possibly aerobic, degradation of some contaminants has occurred, as seen in the marked decrease in concentrations of cis-1,2-dichloroethene and toluene in groundwater in MW-4 between 2007 and 2016.
- Contaminants adsorbed to fine soil particles and organic material, such as metals, dioxin congeners, and SVOCs, are washed into drainage ditches via overland flow. Once in the drainage ditches, the contaminants travel with surface water flow to the ditch discharge point in the tidal channel. The highest concentrations of some metals and dioxin TEQ at, or immediately downstream from, the discharge ditches indicate that this has been an active contaminant migration pathway.
- Tidal flow will distribute contaminants that are adsorbed to fine soil particles and organic matter until they settle into the sediments. Note that wave action and flooding during severe storm events can re-mobilize contaminants adsorbed to soil and organic matter.

2.3.2.7 Human Health Risk Assessment Addendum - 2022

The HHRA was revised after the SFI was completed. The Revised HHRA presents a site-specific, quantitative analysis of the Site under current and future land use scenarios based on the nature of the COPCs detected in environmental media, potential exposure pathways to human receptors, and the degree to which these exposures may pose adverse health effects. The Revised HHRA uses all data collected in 2007 for the RI and collected between May 2015 and November 2017 for the SFI, which include soil, sediment, surface water, and groundwater data.

A quantitative HHRA was completed at the Site to evaluate risks to human health potentially posed by COPCs in the affected media beneath and within the vicinity of the Site that cannot be eliminated using screening criteria.

The Revised HHRA addressed the following exposure media: surface soil (0 to 2 feet bgs), subsurface soil (2 to 10 feet bgs), groundwater (from wells located downgradient of the CDL Site and from upgradient potable well TOC well 06), sediment, and surface water from the adjacent Little Mosquito Creek. Future excavation activities could result in the subsurface soil being brought to the surface and “mixed” together. Therefore, a total soil data set (0 to 10 feet bgs) was derived for the surface soil and/or subsurface soil COPCs, assuming future land re-development occurs. Based on the historical aerial photographic analysis (U.S. Army

Topographic Engineering Center, 2000), four AOCs within the CDL Site were defined and named with respect to their geographic position to each other: Northern, Central, Southern, and Western AOCs**.** For the Revised HHRA, soil media were divided into two different exposure areas: Central/Southern and Northern/Western. The Western and Northern AOCs were evaluated together because site investigations did not indicate the presence of buried waste. The Central and Southern AOCs were evaluated together because the buried waste was present, as observed during site investigations. The term “exposure area” is from USEPA’s 1989 Risk Assessment Guidance for Superfund (USEPA, 1989). An exposure area is defined as “the intersection of activity patterns and contamination” (USEPA, 1989), and it is a way to group data to evaluate exposure. The term AOC was not used since the 4 AOCs were not evaluated individually. Exposure area was used to differentiate the two areas evaluated from the AOCs.

The following potential current and future land use scenarios and exposure pathways were addressed in the Revised HHRA:

- Current/future outdoor maintenance worker: direct contact with the surface soil (current) and total soil (future) media (i.e., incidental ingestion, dermal contact, and inhalation of wind-blown dust and vapors), inhalation of vapors migrating from groundwater to outdoor air, and incidental ingestion and dermal contact with sediment in the upgradient drainage area.

- Current/future teen trespasser: direct contact with the surface soil (current) and total soil (future) media (i.e., incidental ingestion, dermal contact, and inhalation of wind-blown dust and vapors), incidental ingestion and dermal contact with surface water, and incidental ingestion and dermal contact with sediment. Even though the teen trespasser may go fishing or crabbing, the consumption of fish or crab tissue is likely to be infrequent and is not evaluated in this revised HHRA. The consumption of fish and crab tissue exposure pathway is evaluated under the outdoor recreator (child/adult) scenario and is considered protective of the teen trespasser.

- Current/future outdoor recreator (child/adult): direct contact with the surface soil (current) and total soil (future) media (i.e., incidental ingestion, dermal contact, and inhalation of wind-blown dust and vapors), incidental ingestion and dermal contact with surface water, ingestion of fish in surface water, incidental ingestion and dermal contact with sediment, and ingestion of Blue Crab in sediment.

- Future indoor/outdoor commercial worker: direct contact with the total soil media (i.e., incidental ingestion, dermal contact, and inhalation of wind-blown dust and vapors), and inhalation of vapors migrating from groundwater to outdoor air, and vapor intrusion (VI) to indoor air.

- Future construction worker: direct contact with the total soil media (i.e., incidental ingestion, dermal contact, and inhalation of wind-blown dust and vapors) and direct contact with the groundwater media (i.e., incidental ingestion, dermal contact and inhalation of vapors in a trench).

- Future hypothetical resident (child/adult): for the soil exposure areas, the following exposure pathways are evaluated - direct contact with the surface soil (current) and total soil (future) media (i.e., incidental ingestion, dermal contact, and inhalation of wind-blown dust and vapors), and inhalation of vapors migrating from groundwater to outdoor air. For the site-wide exposure area, the following surficial groundwater aquifer exposure pathways are evaluated - direct contact with the groundwater media (i.e., incidental

ingestion, dermal contact and inhalation of vapors while showering or bathing), inhalation of vapors migrating from groundwater to outdoor air, and VI to indoor air.

- Off-site current/future resident (child/adult): direct contact with the groundwater media from the Yorktown Aquifer (i.e., incidental ingestion, dermal contact and inhalation of vapors while showering or bathing). The VI exposure pathway is not evaluated for the Yorktown Aquifer due to its deep depth (roughly 154 feet bgs).

Various state and federal regulatory agencies mandate target or "acceptable" carcinogenic risk and noncarcinogenic hazard levels. The VDEQ regulations establish a target cumulative risk level (i.e., from all pathways for a single receptor group) of 1×10^{-4} (1E-04) for potential excess lifetime cancer risk (ELCR). The USEPA identifies the acceptable cancer risk range to be 1×10^{-4} to 1×10^{-6} (1E-04 to 1E-06). In effect, estimated ELCR that are less than 1×10^{-6} (1E-06) are generally considered negligible. Potential ELCR in the intermediate range between 1×10^{-4} to 1×10^{-6} (1E-04 to 1E-06) can be considered acceptable on a case-by-case basis. The cancer risk of 1×10^{-6} is used as the risk goal for individual carcinogens, with a not-to-exceed ELCR of 1×10^{-4} for all carcinogens. Both the VDEQ and USEPA accept a cumulative noncarcinogenic hazard target level, or Hazard Index (HI), of 1. When an HI is above 1 for a receptor, the chemical non-hazard hazard quotients are segregated based on the target organ endpoint, and separate target organ-specific HIs are calculated. Only chemicals that act upon the same target organ are expected to be additive.

For each exposure scenario (i.e., receptor and exposure area) with a potential ELCR/HI above the USEPA target levels, chemicals of concern (COCs) were identified as COPCs that contributed to the cumulative ELCR to exceed 1E-04 and/or the target organ endpoint HI to exceed 1, at one significant figure.

The Revised HHRA evaluated reasonable maximum exposure (RME) and central tendency exposure (CTE) for each receptor. The RME scenario is intended to assess the highest exposure that is reasonably expected to occur at a site. The CTE scenario refers to individuals who have average or typical intake of exposure media.

The HHRA results indicate that unacceptable risk is possible for the following exposure areas and human receptors:

- Central/Southern exposure area – Future outdoor worker, current/future outdoor recreator (adult/child) exposure to surface and total soil; indoor/outdoor commercial worker exposure to surface and total soil and indoor vapors (VI) from surficial groundwater; construction worker exposure to surface and total soil, and outdoor vapors (trench) from surficial groundwater; and future hypothetical resident (child/adult) exposure to surface and total soil and surficial groundwater (potable use, VI, and showering/bathing).
  - Adverse health effects could be possible from exposure to the following soil COCs at the Central/Southern exposure area: 1,1,2-Trichloroethane, 2-Hexanone, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene, Indeno(1,2,3-cd)pyrene, 2,3,7,8-TCDD TEQ, Aluminum, Arsenic, Cadmium (Diet), Chromium, Total, Cobalt, Copper, Iron, Lead, Manganese, Thallium, and Vanadium.
  - Lead modeling results for the southern portion the Central/Southern exposure area indicate that the future outdoor maintenance worker, teen trespasser, and construction worker results were above the 5% probability percent threshold for total soil indicating these receptors have a greater than 5% chance of having blood lead (PbB) levels over

5 micrograms per deciliter (µg/dL). The hypothetical child resident results were also above the 5% probability thresholds for surface and total soil. Adverse health effects from exposure to lead in soil are possible.

- Northern/Western – indoor/outdoor commercial worker exposure to indoor vapors (VI) from surficial groundwater; construction worker exposure to outdoor vapors (trench) from surficial groundwater; future hypothetical resident (child/adult) exposure to surficial groundwater (potable use, VI, and showering/bathing).

2.3.2.8 Ecological Risk Assessment Addendum Summary - 2022

The primary purpose of the ERA is to identify COPECs and assess the need and the level of effort necessary to perform further evaluation of the current and future Site risk. The ERA fulfills this purpose by: (1) identifying potential ecological receptors and habitats at the Site; (2) determining which pathways are potentially complete; (3) evaluating if constituents of interest present within complete exposure pathways have the potential to pose significant environmental risk; and (4) to determine if this potential for risk warrants additional ecological risk characterization.

Potential ecological exposure was evaluated under current conditions using recent analytical data collected in relevant exposure media (i.e., surface soil, sediment, surface water, and pore water). Exposures were evaluated for four source AOCs and several nearby wetland areas potentially impacted by overland flow and groundwater to surface discharge.

The results of the Screening Level Ecological Risk Assessment (SLERA), Baseline Ecological Risk Assessment (BERA) Step 3a COPEC refinement, and consideration of the uncertainties present in the evaluation support the following scientific management decision points for WFF:

- “There is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk” (USEPA, 1997) for the following:
    - Northern AOC: soil macroinvertebrates and terrestrial wildlife
    - Western AOC: soil macroinvertebrates and terrestrial wildlife
- The information indicates a potential for adverse ecological effects
    - Central AOC: soil macroinvertebrates and terrestrial wildlife
    - Southern AOC: soil macroinvertebrates and terrestrial wildlife

The contaminants of Potential Ecological Concern (COPEC) in soil are barium, chromium, copper, manganese, mercury, nickel, and zinc.

2.4 Source, Nature, and Extent of Contamination

Based on field observations made during the RI and SFI, there are two areas of waste: one in the Central AOC and one in the Southern AOC (**Figure 2-7**). In these areas, debris is generally buried under clean fill; however, along the edge of the marsh, including the area between the AOCs, waste is observed near the surface. This buried and surficial waste may be the source of some of the chemicals of concern identified in Section 2.6.

Within the Central AOC, waste is found at the surface but is also buried beneath as much as 11 feet of sand fill. The waste includes empty metal drums, paint, scrap metal, rebar, glass bottles,

bricks, cable, springs, tires, and broken concrete. During the SFI, waste was found at depths of up to 12 feet bgs; during the RI, the maximum depth of waste in the Central AOC was about 13 feet bgs.

As at the Central AOC, waste in the Southern AOC is found both at the surface and buried beneath a layer of sand fill (up to 4 feet deep). Waste in the Southern AOC consists of cinders and burned rubbish (glass, cans, wires) (Versar, 2011) as well as plastic, plates, scrap metal, bathroom fixtures, railroad ties, and metal pipes. The maximum thickness of cover material (fill) was 4 feet of fine silty sand, but in most locations, only about 1 foot of cover sand was present. The maximum thickness of waste found during the SFI was 5 feet.

2.5 Analytical Data

Analytical data are discussed in the RI (Versar, 2011) and SFI (AECOM, 2022).

2.6 Streamlined Risk Evaluation

The surface and near surface waste pose a risk to human receptors. The HHRA completed for the SFI report (AECOM, 2022) indicated that the RME and CTE results for the Upgradient Drainage and Downgradient/Estuarine exposure areas have cumulative ELCR and HI results below the USEPA target levels and are eliminated from further evaluation. The carcinogenic risk and/or noncarcinogenic hazard results for some receptors at the Central/ Southern (C/S) and Northern/Western (N/W) exposure areas either equaled or were above EPA target cumulative levels for exposure to soil and/or vapor intrusion (VI) from groundwater. There are no soil-related risks at the N/W exposure area.

Based on Tables 6-4 and 7-4 of the HHRA (AECOM, 2022), the C/S exposure area RME and/or CTE evaluation carcinogenic and noncarcinogenic Chemicals of Concern for ingestion or dermal contact with soil or inhalation of vapors from soil are 1,1,2-trichloroethane, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalence (TEQ), 2-hexanone, aluminum, antimony, arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, cadmium, chromium (total), cobalt, copper, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, iron, manganese, nickel, thallium, and vanadium. Chemicals of Concern for industrial soil are 1,1,2-trichloroethane, 2-hexanone, benzo(a)pyrene, arsenic, chromium, and manganese. Based on the waste observed in test pits (see Section 2.2.2), there is a potential connection between the buried construction debris and the residential soil chemicals of concern found at depth; however, there is less potential for connection between surficial soil chemicals of concern and buried waste. The industrial soil chemicals of concern occur in the surficial soil, above the waste, and there is little potential for connection between the buried waste and the surficial chemicals of concern.

Since this EE/CA does not include groundwater remediation, the Chemicals of Concern for ingestion or dermal contact with groundwater or inhalation of vapors from groundwater are not presented.

The lead modeling results for the Southern AOC of the Central/Southern exposure area using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) and Adult Lead Methodology (ALM) models, indicate that the future outdoor maintenance worker, teen trespasser, and construction worker results were above the 5% probability percent threshold for total soil, indicating these receptors have above a 5% chance of having PbB levels over 5 µg/dL. The hypothetical child resident results were also above the 5% probability thresholds for surface and total soil.

A SLERA and BERA Step 3a COPEC refinement were performed for each AOC. Ecological screening values (ESVs) were used in SLERA Step 2 to identify conditions that are not expected to lead to adverse ecological harm so that Constituents of Interest could be eliminated from further evaluation due to a lack of potential risks. Therefore, the screening benchmarks are highly conservative (to avoid eliminating a Constituent of Interest that may cause a risk), do not reflect site-specific conditions, and cannot account for potentially antagonistic or synergistic effects between different compounds. Refinements made during BERA Step 3a were used to minimize uncertainty generated during SLERA Step 2 screening by using Lowest Observed Effect Concentration (LOEC)- and Lowest Observed Adverse Effect Level (LOAEL)-based benchmarks when available. This screening is summarized in Table 4-5 of the ERA (AECOM, 2022).

The SLERA and BERA Step 3a evaluation and the consideration of the uncertainties present in the evaluation support the following conclusions:

- “There is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk” (USEPA, 1997) for the following:
    - Northern AOC: soil macroinvertebrates and terrestrial wildlife.
    - Western AOC: soil macroinvertebrates and terrestrial wildlife.
- The information indicates a potential for adverse ecological effects for the following:
    - Central AOC: soil macroinvertebrates (nickel) and terrestrial wildlife (nickel).
    - Southern AOC: soil macroinvertebrates (barium, chromium, copper, manganese, mercury, and zinc) and terrestrial wildlife (total DDD/DDE/DDT and total TEQ [mammal]). Because these compounds are detected in surficial soil, there is no obvious connection between the buried construction debris and these surficial chemical compounds that have a potential for adverse ecological effects on soil macroinvertebrates and terrestrial wildlife.

3. Identification of Removal Action Objectives

RAOs are designed to protect human health and the environment. The development of RAOs is the first step in the formulation and development of removal alternatives.

The following RAO was developed for the Project 15 CDL site: to reduce or eliminate direct exposures to waste and Chemicals of Concern (COCs) in soil by human and ecological receptors as well as mitigate transport of these COCs to surface water or sediment receptors. The NTCRA and this EE/CA addresses buried and exposed waste at the CDL and affected soil; groundwater, surface water, and sediment will be addressed in the FS. Therefore, groundwater, surface water, and sediment RAOs are not discussed here.

3.1 Statutory Limits on Removal Actions

This is a Department of Defense-funded removal action; therefore, no statutory limits are applicable.

3.2 Preliminary Remediation Goals

The HHRA and ERA identified chemicals contributing to elevated risk but did not specify at what concentration excess risk is exceeded. The goal of a remedial action at a site is to ensure that the residual risks that remain at the site after cleanup will be below cumulative target risk and hazard levels. The first step, to specify the cumulative target risk, hazard levels, and ecological effects that will be considered acceptable, was presented in Sections 2.3.2.7 and 2.3.2.8. Based on this, the risk assessors can then solve the basic risk equations to find the concentration of a chemical that corresponds to the specified target risk, hazard levels, or ecological effects. Concentration values derived in this way are thus referred to as preliminary remediation goals (PRGs) for human health and ESVs for ecological risk. PRGs and ESVs are either risk-based levels or Background Threshold Values (BTVs).

As indicated in Section 2.10 of the ERA, surface soil ESVs were selected as the minimum of either terrestrial plant or soil macroinvertebrate benchmarks. The following hierarchy of sources was used to identify terrestrial, direct contact ESVs:

- USEPA (2008b). Ecological Soil Screening Levels (USEPA Eco-SSLs).
- USEPA (2018). USEPA Region 4 ESVs.
- USEPA (2003). USEPA Region 5 Ecological Screening Levels (ESLs).
- LANL (2017). Los Alamos National Laboratory (LANL) NOEC ESLs.

If no direct contact ESV was available from the sources above, soil ESVs were modeled for non-ionic, organic compounds using the adapted biotic ligand models from USEPA (2018). ESVs for the Central AOC and Southern AOC were presented in Tables 3 and 4 of Attachment D of the ERA and are copied to this document as **Tables 3-1** and **3-2**, respectively.

Table 3-3 presents the PRGs for industrial soil in the Central/Southern Exposure Area. **Table 3-4** summarizes the BTVs, PRGs, and ESVs for soil and includes the value used to determine if soil needs to be excavated and disposed offsite at those locations. Soil that has been sampled and exceeds an industrial PRG or an ESV will be excavated and shipped offsite for disposal along with the waste.

3.3 Determination of Removal Scope

To achieve the RAOs, the scope of the removal action alternatives evaluation will focus on waste at or near the ground surface, buried waste, and affected soil. The scope of the removal action is to remove waste and affected soil. Affected soil is soil with an analytical result that exceeds a PRG or ESV. Stained soil will be included in the removal action only where the soil analytical result exceeds a PRG or ESV.

USEPA's EE/CA guidance states that appropriate federal or state ARARs should be identified as part of defining the scope of work for the removal action. According to USEPA's National Contingency Plan (the NCP 40 CFR Part 300.430), a requirement may be either "applicable" or "relevant and appropriate" to a remedial action, but not both. The terms are defined below:

- Applicable requirements are standards, criteria, or limitations promulgated under federal/state environmental or facility siting laws that specifically address a hazardous substance, remedial action, location, or other circumstance at a CERCLA site. The remedial action or circumstance at the site must satisfy all the jurisdictional prerequisites of the requirement.

- Relevant and appropriate requirements address problems or situations sufficiently similar to those at a CERCLA site, although the requirements do not meet the conditions for applicability. The degree to which a requirement is relevant and appropriate can be assessed by comparing the hazardous substances involved, the physical circumstances, or the remedial action characteristics to those addressed in the requirement.

USEPA provides guidance illustrating three categories of ARARs that address a pollutant, action, location, or other circumstance at a site. The three types of ARARs, promulgated under federal or state law, are discussed below:

- **Chemical-specific requirements** set health- or risk-based concentration limits or ranges for specific substances in various environmental media (e.g., maximum contaminant levels for public drinking water). If a given chemical has more than one such requirement, the more stringent ARAR should be met. Because relatively few chemicals are covered by such pre-established requirements, USEPA's ARAR guidance stipulates that it may be necessary to turn frequently to chemical-specific advisory levels, such as carcinogenic potency factors or reference doses, to establish cleanup levels. Chemical-specific standards are also used to indicate an acceptable level of discharge, to determine treatment and disposal requirements for a particular remedial activity, and to assess the effectiveness of a response action.

- Performance, design, or other **action-specific requirements** set controls or restrictions on the design, implementation, and performance of specific action related to the management of hazardous substances (e.g., Clean Water Act pretreatment standards for discharges to publicly owned treatment works, or RCRA standards for the design and operation of hazardous waste management facilities). These standards specify performance levels, actions, technologies, and specific levels for discharge of residual chemicals; they also provide a basis for assessing the feasibility and effectiveness of the remedial alternatives. These requirements are not chemical- specific, but rather are specific to given remedial actions; however, they may specify acceptable methods meeting technology-based performance standards.

- **Location-specific requirements** set restrictions on activities depending on characteristics of the site or its immediate environs (e.g., federal and state siting laws; ordinances pertaining to development in a 100-year floodplain; proximity to wetlands or man-made features such as landfills, disposal areas, and/or local historic buildings).

In addition to the three types of ARARs, to be considered (TBC) criteria may also be evaluated. TBC criteria are proposed standards, advisories, and guidance developed by federal and state environmental and health programs that are intended to provide useful information and recommendations but are not legally binding. TBC criteria should be used only when they are scientifically defensible and in the absence of a specific ARAR.

Since the HHRA (AECOM, 2022) indicated there is chemical risk at the Site (there are direct contact risks), there are chemical-specific ARARs. No known historic, archaeological, or cultural resources are present on the Site. The U.S. Army Corps of Engineers, Baltimore District, conducted archaeological monitoring of trenches conducted as part of a remedial investigation of the Central AOC and Southern AOC in May and June 2015. The Virginia Department of Historic Resources (VDHR), in a letter dated April 29, 2016, determined that archaeological monitoring for additional investigative trenching and borings was not warranted.

Under Section 106 of the National Historic Preservation Act and Title 36, Part 800 of the Code of Federal Regulations, NASA WFF has determined the proposed NTCRA of waste and soil removal, as well as future remedial actions for groundwater, sediment, and surface water at the CDL, will not affect historic resources. NASA WFF submitted the determination to VDHR on May 25, 2022, requesting concurrence. On June 22, 2022, VDHR concurred that no further identification efforts are warranted. NASA WFF sent a copy of the determination to the Catawba Indian Nation on June 1, 2022. The Catawba responded on July 12, 2022, indicating they have no immediate concerns with regard to traditional cultural properties, sacred sites or Native American archaeological sites within the boundaries of the proposed project areas. VDHR and appropriate Native American tribes will be notified of any artifacts and/or human remains encountered during ground disturbance activities. NASA also contacted Native American tribes and the Catawba tribe sent a letter to NASA dated July 12, 2022 which stated they have no immediate concerns within the proposed project areas. **Tables 3-5, 3-6, and 3-7** summarize applicable federal and state chemical, location, and action specific ARARs, respectively.

The objective of taking a removal action at the CDL is to protect the employees and workers from the physical hazards associated with waste disposed of at the CDL and affected soil adjacent to the waste while the preparation of the FS, Proposed Plan, and Record of Decision (ROD) for the CDL proceeds. The CDL RI (Versar, 2011) showed that waste has been found exposed at and near the surface of the CDL.

The goal of this removal action, in accordance with 40 CFR 300.415(b)(2)(i),(iii), and (viii) is to:

- Minimize the potential contact with waste at or near the land surface on the CDL by human receptors who traverse across the Site,
- Mitigate contact by ecological receptors, and
- Contribute to the efficient performance of any anticipated long-term remedial action at the CDL.

A removal action is intended to expeditiously mitigate risks to human health and the environment, but it is not required, or necessarily intended, to be the final action. The action

implemented as a result of this EE/CA will be evaluated in a FS to determine if additional, or different, actions are needed to permanently mitigate the risks identified.

3.4 Determination of Removal Schedule

The key components of the removal action are anticipated to occur as follows (see **Figure 3-1** for a detailed schedule):

- Announcement within a local newspaper declaring that the EE/CA is available for review and comment – October 28, 2022;
- Public Comment Period – October 28, 2022 to November 27, 2022;
- Final Action Memorandum on or near – December 2022;
- Final Removal Action Work Plan on or near – November 2022;
- Fieldwork Mob – February 2023;
- Substantial completion of field work – May 2023; and
- Final Submission of After Action Report – August 2023.

4. Identification and Analysis of Removal Action Alternatives

This section presents the identification and screening of potentially applicable removal technologies for addressing the exposed waste at the CDL site. The following factors were determined to be the most relevant and likely have the greatest impact at the Site: (i) to prevent actual or potential exposure to nearby human populations from exposed waste materials and affected soil, (ii) to prevent actual or potential exposure of ecological receptors to exposed waste materials and affected soil, and (iii) to prevent actual or potential exposure to exposed waste materials that may pose a threat of release until a final remedy is chosen and implemented.

Three removal action alternatives are described and evaluated in this section based on the following criteria: implementability, effectiveness, and cost. The alternative determined to be the most effective to achieve the RAO is identified in **Section 6**.

This EE/CA is not a detailed design document. The exact locations and site-specific details of the selected Alternative will be determined and finalized in the subsequent design and construction documents.

4.1 Identification of Possible Removal Alternatives

This section presents removal alternatives for the CDL.

4.1.1 Alternative 1: No Action

Under Alternative 1, no corrective action would be employed. This alternative would not address direct contact with waste materials by current and future human receptors. However, the No Action Alternative must be evaluated per 40 CFR 300.430(e)(6) to establish a baseline of comparison regarding future performance and risk for the remaining alternatives.

4.1.2 Alternative 2: Excavation and Off-site Disposal of Waste and Affected Soil

Alternative 2 includes removal of the waste and contaminated soil utilizing conventional construction and excavation techniques. **Figure 4-1** shows the extent of excavation recommended. Following removal, the waste and soil would be transported off-site for disposal and replaced with clean soil and the area may be graded to achieve a desired contour and seeded to minimize the potential for erosion. The goal is to remediate the site to ESVs and industrial risk standards. Since the goal includes remediation to industrial risk standards, Land-Use Controls (LUCs) will be implemented to prevent residential use of the site. LUCs will be part of a final remedy/ROD. The details of the excavation disposal and LUCs are provided in the cost summary **Table 4-1**. Only full excavation of all waste materials would require no follow-on O&M program.

4.1.3 Alternative 3: Standard Landfill Cap with Consolidation of Sediments below the Cap, Land-Use Controls, and Long-Term Monitoring

Alternative 3 consists of installation of an impermeable cap on the CDL. The details of the cap are provided in the cost summary **Table 4-2**. A graphic of an impermeable cap is provided in **Figure 4-2**. LUCs, which include annual inspections and Long-Term Monitoring (LTM) of groundwater and surface water will be addressed in the ROD.

4.2 Analysis Criteria of Possible Removal Alternatives

The NCP [40 CFR 300.430 (e)(7)] cites the general evaluation criteria of effectiveness, implementability, and cost. Each of these criteria is considered in the evaluation of alternatives. The types of specific considerations within each of these general criteria are listed below.

4.2.1 Effectiveness

Effectiveness may be evaluated as both short-term and long-term effectiveness. Short-term effectiveness addresses the effects of the alternative during construction and implementation until the RAOs are met. This criterion considers the protection of the community and workers, including the air quality effects and hazards from excavation, transportation, and on-site treatment. In addition, the expected length of time for completion of the removal action is considered.

Long-term effectiveness addresses the degree, extent, and manner in which the alternative continues to protect human health and the environment in terms of residual hazard remaining at the Site after the RAOs have been met. This criterion considers the residuals following completion of the Alternative, expected duration of the alternative, and the degree of controls required to ensure protectiveness of the Alternative.

4.2.2 Implementability

Implementability is a measure of (1) technical feasibility; (2) administrative feasibility to construct, operate, and maintain a removal action alternative; and (3) availability of services and materials. The implementability evaluation criteria are defined in the NCP [40 CFR 300 (e)(7)(ii)].

Technical feasibility is evaluated based on constructability, reliability (e.g., demonstrated performance and operation), maintenance, and timeliness/schedule of implementation.

Administrative feasibility considers the degree of coordination required by the regulatory agencies. Administrative feasibility also considers permits required, easements or rights-of-way required, impact on adjoining property, ability to impose institutional controls, and likelihood of obtaining an exemption from statutory limits (if needed).

This availability of services and materials is evaluated based on the availability of necessary equipment, specialists, and prospective technologies.

4.2.3 Cost

Cost involves developing the level of engineering detail and preparing a sufficiently accurate cost estimate for each alternative so that a relative and appropriate cost comparison can be made between competing alternatives. For purposes of this EE/CA, the cost estimates for construction were based on fiscal year 2021 costs. The cost estimates were developed based on vendor rates, professional experience, and accumulation of cost for similar projects.

4.3 Individual Analysis of Possible Removal Alternatives

4.3.1 Alternative 1- No Action

Alternative 1 is not considered effective and does not require any further comprehensive analysis. There is no cost associated with the No Action Alternative. The following sections present the attributes of this alternative in greater detail.

4.3.1.1 Effectiveness

The No Action Alternative would not reduce, mitigate, or otherwise prevent direct contact with waste materials by current and future receptors. No action-specific ARARs would be triggered under the No Action Alternative. Buried waste would remain in place, and no actions would be implemented to mitigate or prevent direct contact by current and future human receptors with waste materials. This alternative would not employ any treatment that would reduce the toxicity, mobility, or volume of buried waste.

4.3.1.2 Implementability

There are no technical implementability concerns posed by this option because no actions would be undertaken. However, it is unlikely that project stakeholders (including regulatory authorities) would administratively approve a No Action Alternative, as waste would remain in place and no controls would be employed to prevent direct contact with waste materials. Implementation of this alternative does not pose additional risks to the community, the workers, or the environment because there are no removal activities associated with it; however, it does not mitigate any existing or potential future risks.

4.3.1.3 Cost

There are no costs associated with Alternative 1.

4.3.2 Alternative 2 – Excavation and Off-site Disposal of Waste and Affected Soil

Alternative 2 includes removal of the waste and contaminated soil utilizing conventional construction and excavation techniques. Following removal, the waste and soil would be transported off-site for disposal and replaced with clean soil, or the area may be re-graded to achieve a desired contour and seeded to minimize the potential for erosion.

4.3.2.1 Effectiveness

Alternative 2 would be protective of human health and the environment. Excavation and off-site disposal of waste and contaminated soil would eliminate direct contact with waste materials and affected soil.

Two chemical-specific, 14 location-specific, and 22 action specific ARARs are identified with this alternative (refer to **Tables 3-5, 3-6, and 3-7**). CERCLA requires that NASA only meets the substantive permit requirements during implementation of remedial actions and does not require the actual permit to be obtained. AECOM's approach includes adhering to the Virginia Administrative Code (VAC) Section 4VAC50-30-40, as required by CERCLA, for the proposed site work. NASA will adhere to the general requirements for stormwater management and sediment control by preparing and adhering to an Erosion and Sediment Control (ESC) plan.

Dust control measures would also be employed during completion of maintenance activities, in accordance with the requirements outlined in 9VAC5-40-90.

Under Alternative 2, buried waste would be removed. Long-term effectiveness and permanence will be addressed when the FS (USACE, 2019) is revised.

Implementation of Alternative 2 would reduce the toxicity and volume of buried waste at the Site. This alternative satisfies the statutory preference for employing treatment as a principal element.

Alternative 2 would pose moderate short-term risks to current site workers and construction workers due to increased traffic through WFF and the National Oceanic and Atmospheric Administration (NOAA) and on to the site during excavation of the waste and soil (i.e., during the delivery of equipment and materials). Risks would be mitigated during the design phase through development of a traffic control plan, application of dust suppression techniques, and development of a health and safety plan. The duration of construction activities is anticipated to be 2 years, due to funding availability.

4.3.2.2 Implementability

Alternative 2 is technically feasible and would utilize standard construction equipment and methods for the excavation and off-site disposal of the waste and affected soil. There are no technical implementability concerns associated with Alternative 2, and installation of erosion and sediment controls would be required. Significant administrative coordination with NASA, NOAA, and other entities would be required during design, site preparation, and excavation.

4.3.2.3 Cost

The estimated present worth cost to implement Alternative 2 would be $3,173,025. The cost estimate and detailed assumptions associated with the implementation of Alternative 2 are presented in **Table 4-1**.

4.3.3 Alternative 3 - Installation of an Impermeable Cap

Alternative 3 would include installation of an impermeable cap across the CDL.

4.3.3.1 Effectiveness

Alternative 3 would be protective of human health and the environment. Installation of an impermeable cap over the CDL would eliminate direct contact with waste materials and affected soil, and by controlling erosion and conducting routine inspections, prevent future contact with waste materials.

Two chemical-specific, 14 location-specific, and 22 action specific ARARs are identified with this alternative (refer to **Tables 3-5, 3-6, and 3-7**). CERCLA requires that NASA only meets the substantive permit requirements during implementation of remedial actions and does not require the actual permit to be obtained. AECOM's approach includes adhering to Section 4VAC50-30-40 as required by CERCLA for the proposed site work. NASA will adhere to the general requirements for stormwater management and sediment control by preparing and adhering to an ESC plan.

Dust control measures would also be employed during completion of maintenance activities, in accordance with the requirements outlined in 9VAC5-40-90.

Under Alternative 3, buried waste would remain in place but contained beneath an impermeable cap. Long-term effectiveness and permanence will be addressed in the FS.

Alternative 3 would not reduce the toxicity or volume of buried waste at the Site, and it does provide a reduction in the physical mobility of buried waste. No measures would be employed to prevent mobilization of impacts from buried waste via groundwater or surface water runoff. This alternative does not satisfy the statutory preference for employing treatment as a principal element.

Alternative 3 would pose moderate short-term risks to current site workers and construction workers due to increased traffic through NASA/NOAA and on to the Site during construction of the cap (i.e., during the delivery of equipment and materials). Risks would be mitigated during the design phase through development of a traffic control plan, application of dust suppression techniques, and development of a health and safety plan. The duration of construction activities is anticipated to be 1 to 2 months.

4.3.3.2 Implementability

Alternative 3 is technically feasible and would utilize standard construction equipment and methods for the installation of the impermeable cap. There are no technical implementability concerns associated with cap construction at the CDL, and installation of erosion and sediment controls would be required. Significant administrative coordination with NASA, NOAA, and other entities would be required during design, site preparation, and installation of the impermeable cap.

4.3.3.3 Cost

The estimated present worth cost to implement Alternative 3 is $1,558,534. The costs and detailed assumptions associated with the implementation of Alternative 3 are presented in **Table 4-2**.

5. Comparative Analysis of Removal Action Alternatives

Consistent with EE/CA guidance, each alternative is evaluated with respect to its effectiveness, implementability, and cost.

5.1 Effectiveness

Under Alternatives 1 and 3, buried waste would remain in place, and no measures would be employed to reduce the toxicity or volume of buried waste at the site.

Alternative 1 would be the least effective of the three alternatives, and it would not reduce, mitigate, or otherwise prevent direct contact with waste materials by current and future receptors. The No Action Alternative would not provide any mechanisms to achieve RAOs. Therefore, this No Action Alternative is not effective in the long-term.

The effectiveness of Alternatives 2 and 3 is comparable with respect to the following:

- Protection of human health and the environment; they both would prevent direct contact with waste materials.
- Both would pose moderate short-term risks to current site workers and construction workers due to increased traffic through NASA/NOAA and on to the Site during construction.

Alternatives 2 and 3 are equally effective in preventing direct contact with waste materials. The ROD will determine effectiveness in the long term.

5.2 Implementability

For Alternatives 2 and 3, the action would occur adjacent to the NOAA Access Road and significant administrative coordination between NASA and NOAA would be required during design, site preparation, and excavation or installation of the cap to ensure access to the NOAA facility is not impeded.

Both Alternatives 2 and 3 would utilize standard construction equipment and methods. Alternative 3 presents the greatest technical implementation challenges since it would require the installation of several layers of low permeability material and drainage layers.

Alternative 2 is the least implementable; it will require more labor, equipment, material, and time. Thus, Alternative 3 is the most implementable alternative.

5.3 Cost

Based on the present worth estimates of the opinion of probable costs for the removal alternatives (**Tables 4-1** and **4-2**), Alternative 2 would be the costliest alternative, followed by Alternative 3. The additional costs associated with Alternative 2 would increase the degree of protection offered by this alternative. Alternative 3 would offer the same prevention of direct contact with waste materials by current and future receptors as Alternative 2, but Alternative 3 would not provide for a reduction of waste material.

As is indicated in **Section 4.3**, Alternative 1 is the lowest cost alternative, at $0. Alternative 3 is the next lowest cost, followed by Alternative 2, which is the highest cost.

While there would be no costs associated with Alternative 1, this zero-cost alternative would not employ any mechanisms to prevent direct contact with waste materials. Consequently, Alternative 3 is the lowest cost alternative that satisfies the RAOs.

6. Recommended Removal Action Alternative

The recommended alternative for the NTCRA for the CDL is Alternative 2: Excavation and Off-site Disposal. Alternative 2 provides the best permanence and long-term effectiveness in meeting the RAOs. Although it has more technical implementation challenges than Alternative 3 and will require more labor, equipment, material, and time than Alternative 3, only Alternative 2 reduces the volume of waste at the CDL. Alternative 2 provides the best balance of all options considering the overarching mandate to protect human health and the environment, and it will achieve the best combination of effectiveness, implementability, and cost effectiveness. In addition, Alternative 2 is likely compatible with the final CDL ROD remedy selected.

The proposed alternative is the removal of the waste and contaminated soil utilizing conventional construction and excavation techniques. Following removal, the waste and soil would be transported off-site for disposal and replaced with clean soil.

7. Plan for Public Participation

Pursuant to Section 300.415(n) and 300.820 of the NCP the following actions will be initiated for public participation:

- Publish notice of availability for the administrative record file and availability of the EE/CA – Upon completion of the EE/CA, a public notice will be posted in the local newspapers attesting to the availability of the EE/CA for public review and comment. The notice will be posted in a local newspaper prior to the anticipated public comment period. An affidavit of publication will be included as part of the After Action Report.

- Thirty-day public comment period – The Final EE/CA will be reproduced in full and posted at local libraries. This document will be available for public review for a minimum of 30 days. The Final EE/CA will be posted at the following libraries:

  Eastern Shore Public Library
  23610 Front Street
  Accomack, Virginia 23301
  (757) 787-3400

  Chincoteague Island Library
  4077 Main Street
  Chincoteague, Virginia 23336
  (757) 336-3460

- Written Response to Significant Comments – Following the 30-day public comment period, written responses to significant comments will be prepared and included with the administrative record.

8. References

AECOM, 2022. Final Supplemental Field Investigation Data Report Revision 2, Human Health Risk Assessment update, and Ecological Risk Assessment update, Project 15 Construction Debris Landfill, Wallops Flight Facility Formerly Used Defense Site, Wallops Island, Virginia. June 2022.

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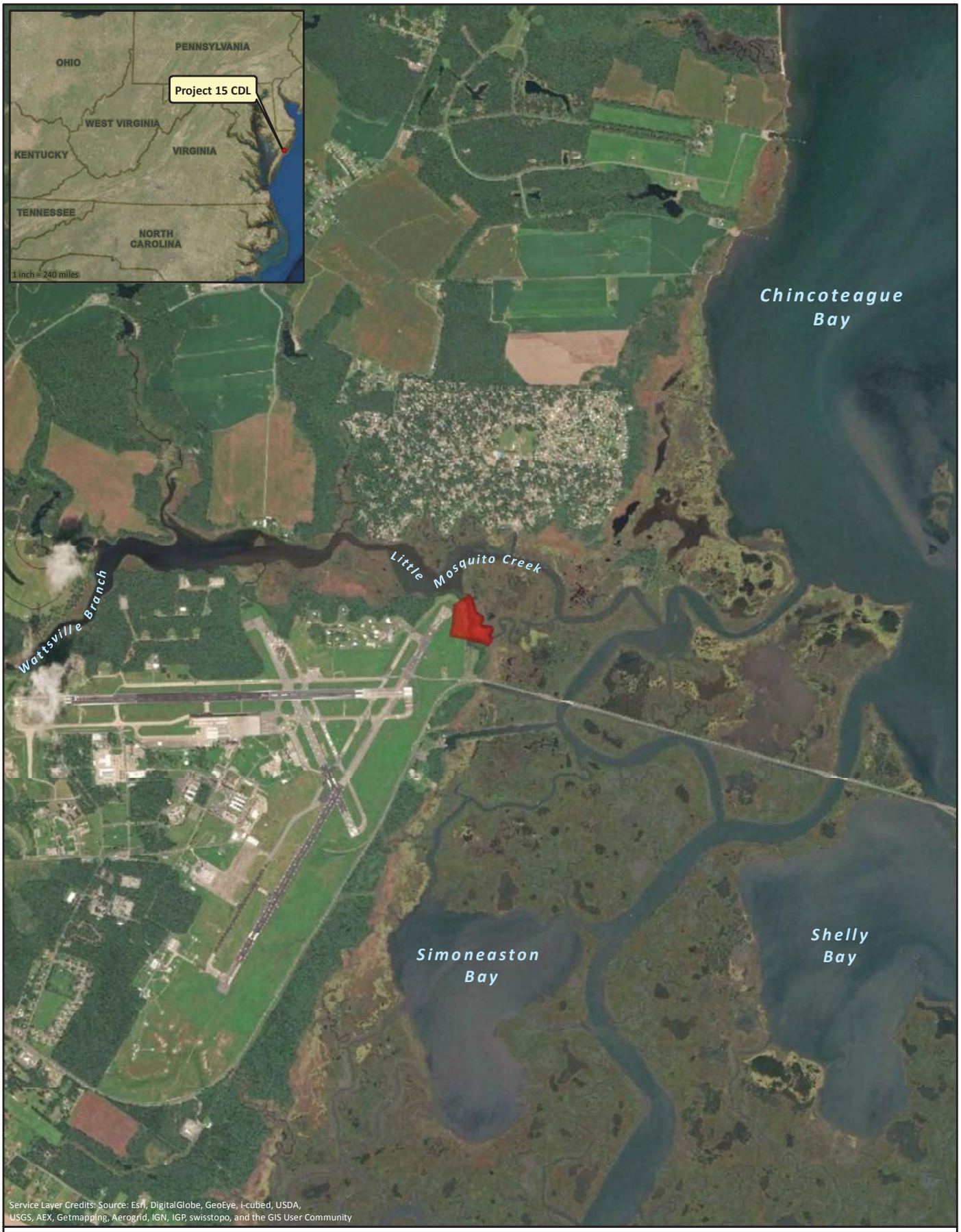
Figures



N

Legend

CDL Boundary

Location of Project 15, Construction Debris Landfill on Wallops Flight Facility

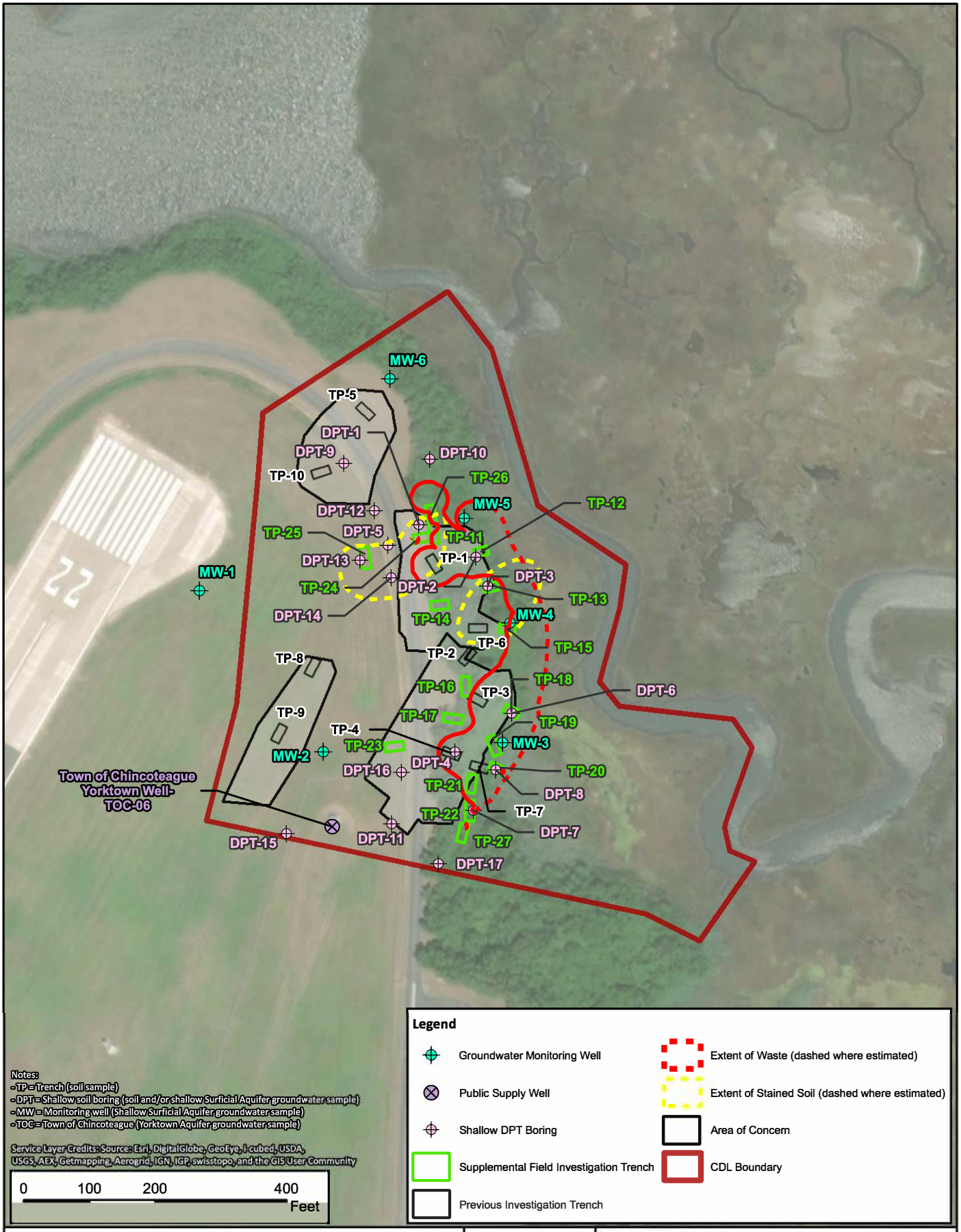
0 0.25 0.5 1 Miles

Project 15 CDL FS

WFF FUDS

Figure 2-1

FarmerRA C:_projects\Wallops Island CDL\GIS\MXD\SupplementalFieldInvestigation\Figure1-1_Project15_CDL_FP_Site_Location.mxd 6/18/2018



CLIENT	NASA WFF CDL SFI & NTCRA			
NOTES	Supplemental Field Investigation			
REVISED	12/17/2020	GIS BY	MS	12/17/2020
SCALE	1:2,400	CHK BY	JK	12/17/2020
Base Map: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID,		PM	JK	12/17/2020

N

Extent of Waste and Stained Sand, Project 15 CDL, Wallops Island, Virginia

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-2

\\na.aecomnet.com\lfs\AMER\Germantown-USGRM2\DCS\Projects\ENV\GEARS\GEO\NASA\WFF CDL SFI\GIS\MXD\AECOM_Figures\Fig_4-1_Wallops_Island_Extent_of_Waste_Stained_Sand_12152020.mxd

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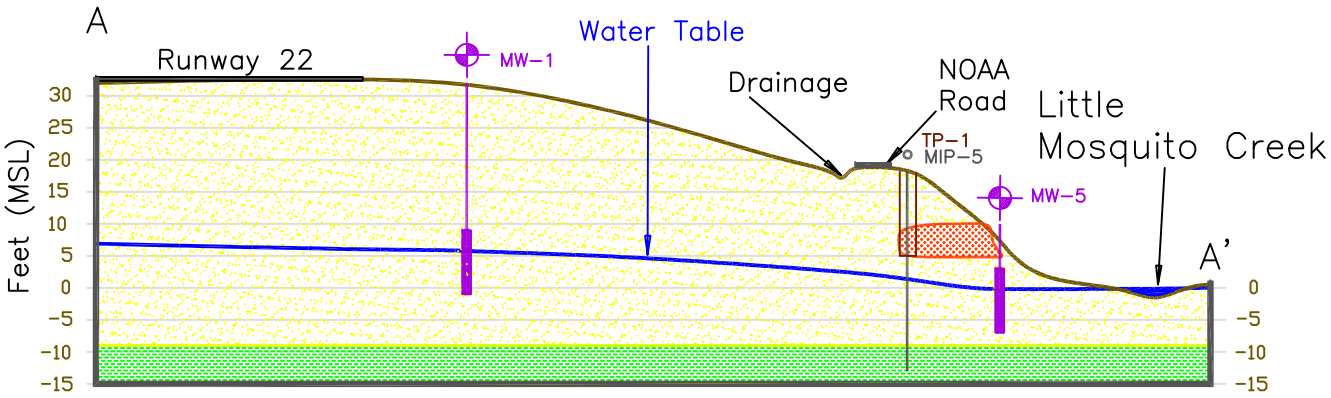
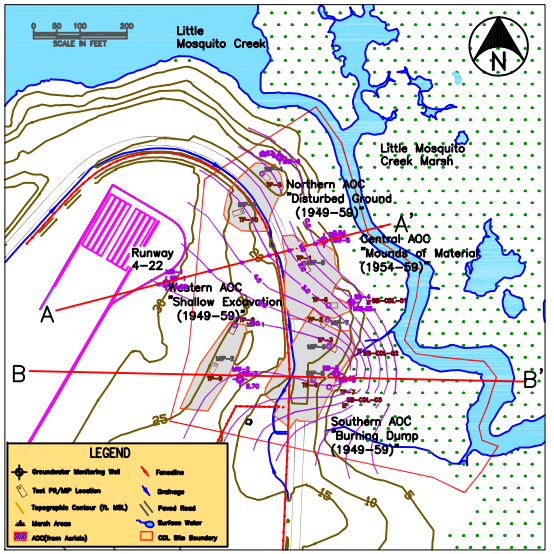
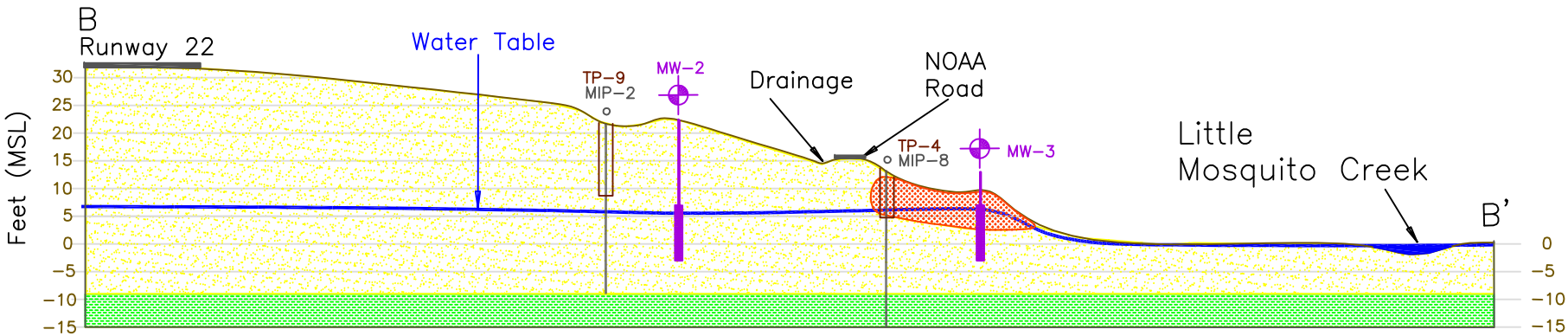




Cross-Section Location



SCALE

200 Feet

20 Feet

PLEISTOCENE COLUMBIA AQUIFER (SAND)

CLAY CONFINING LAYER (COLUMBIA GROUP)

WASTE DEPOSITS

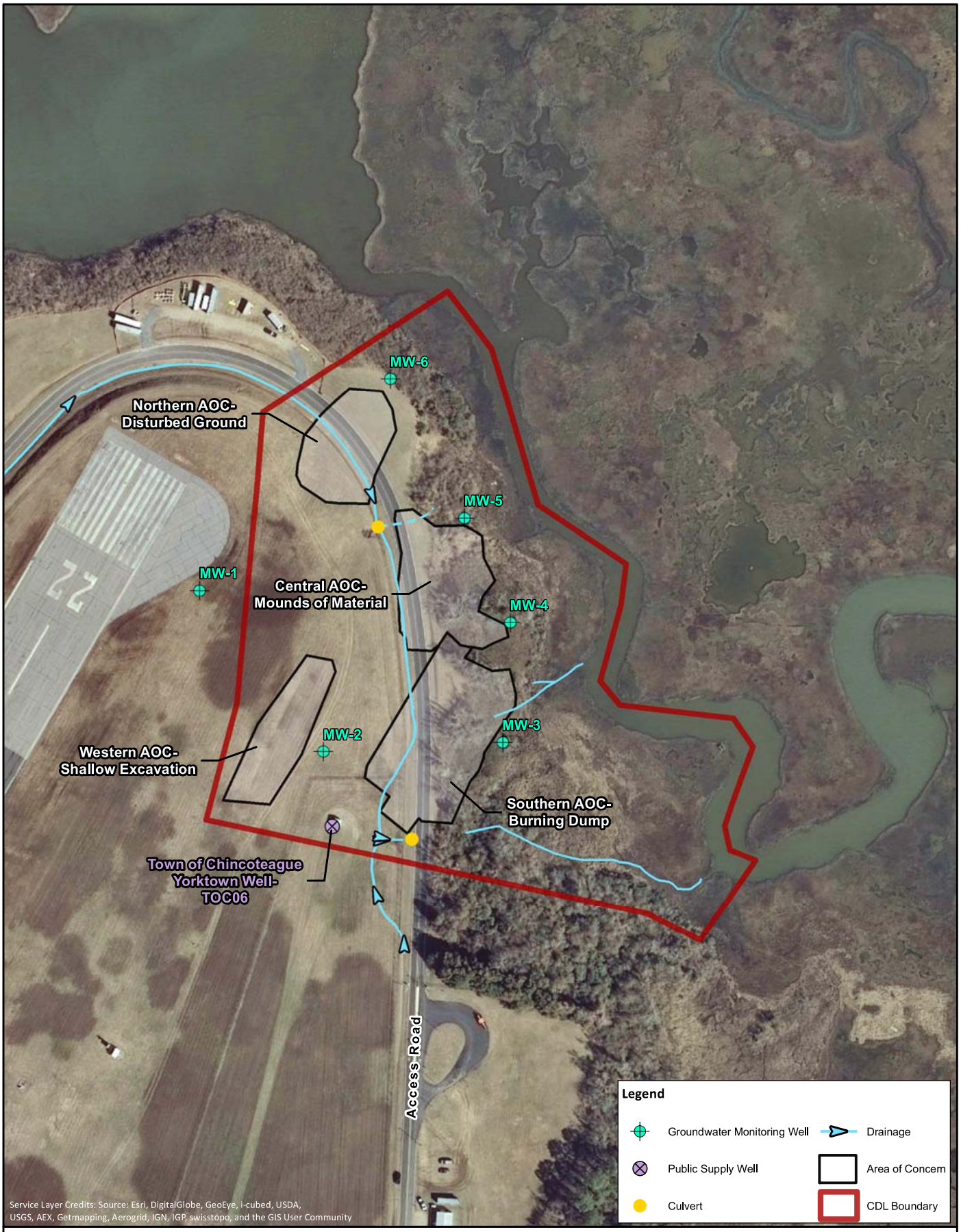
US ARMY CORPS OF ENGINEERS

DESIGNED N.G.S	DATE 04/30/10
DRAWN N.G.S	DATE 04/30/10

VERSAR INC.

GEOLOGIC CROSS-SECTIONS
CONSTRUCTION DEBRIS LANDFILL SITE
NASA WALLOPS FLIGHT FACILITY

PROJECT NO. 111328.0018	SCALE: 1:24,000
DRAWING NO.	FIGURE 2-3



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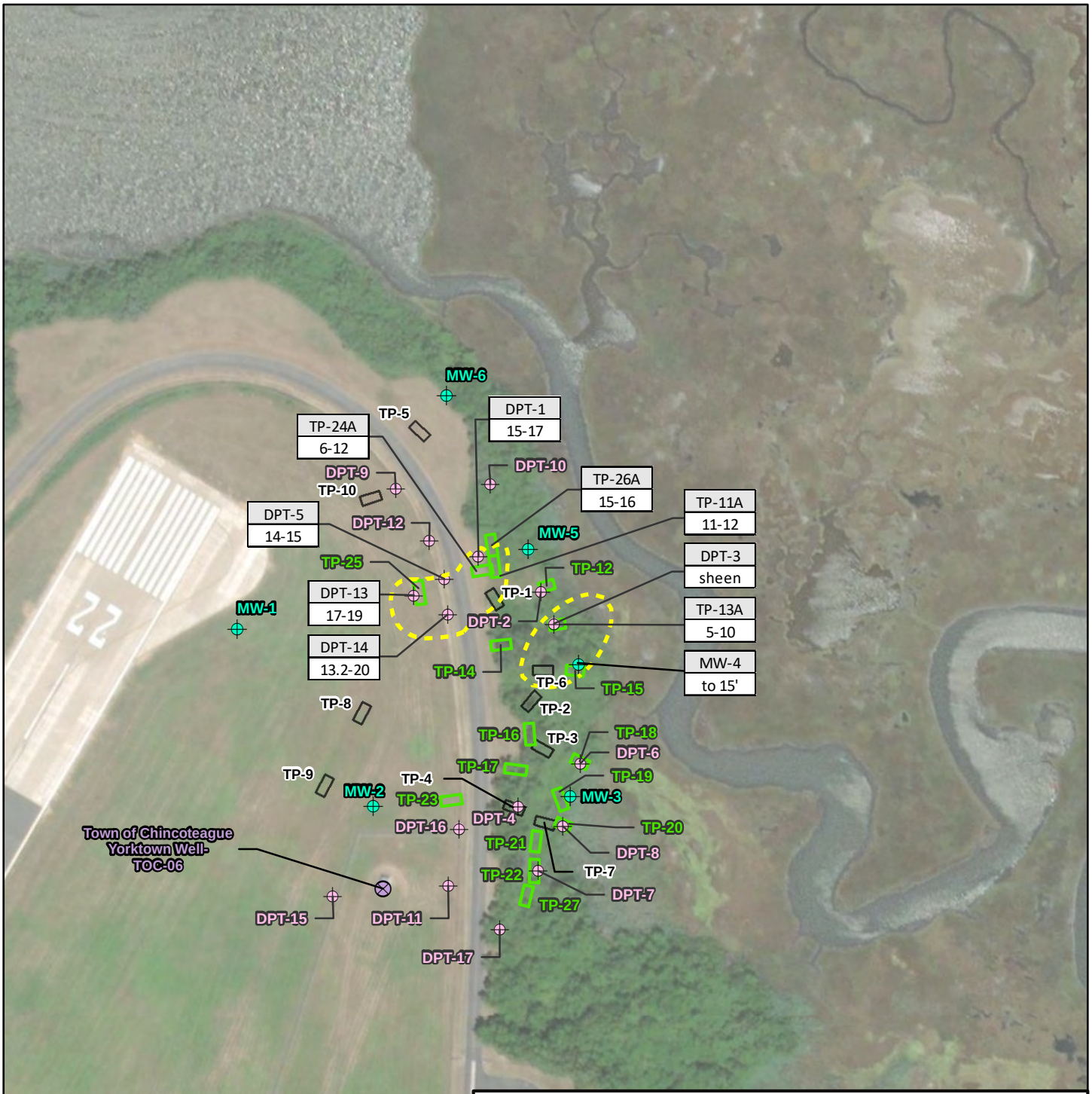
Site Features

0 100 200 400 Feet

Project 15 CDL FS
WFF FUDS

Figure 2- 4

FarmerRA C:_projects\Wallops Island CDL\GIS\MXD\SupplementalFieldInvestigation\Figure1-2_Project15_CDL_FP_CDL_Site_Features.mxd 7/1/2018



CLIENT	NASA WFF CDL SFI & NTCRA			
NOTES	Supplemental Field Investigation			
REVISED	2/16/2022	GIS BY	MS	2/16/2022
SCALE	1:2,400	CHK BY	JK	2/16/2022
Base Map: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User		PM	JK	2/16/2022

Extent of Staining Observed in the Subsurface

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-5

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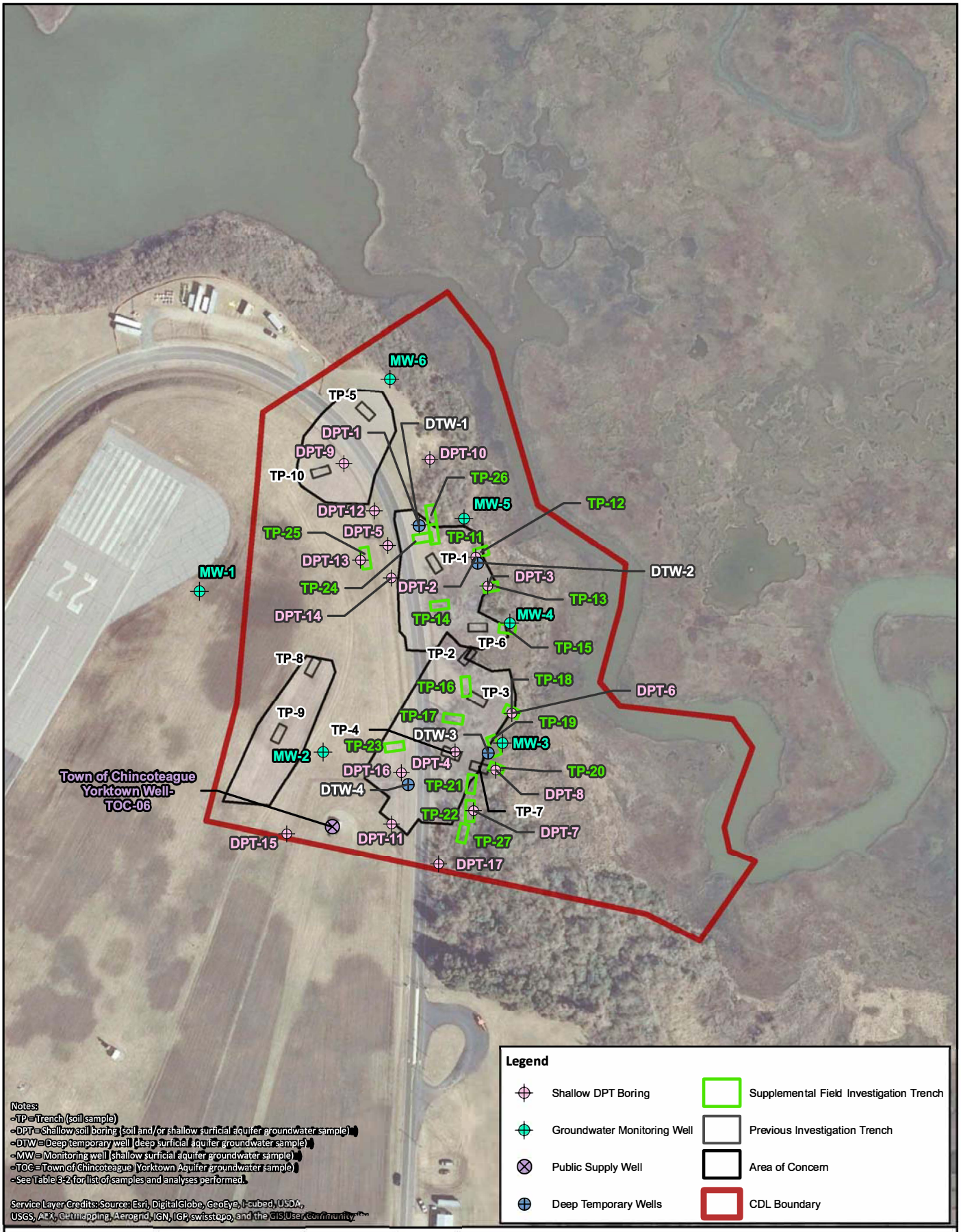
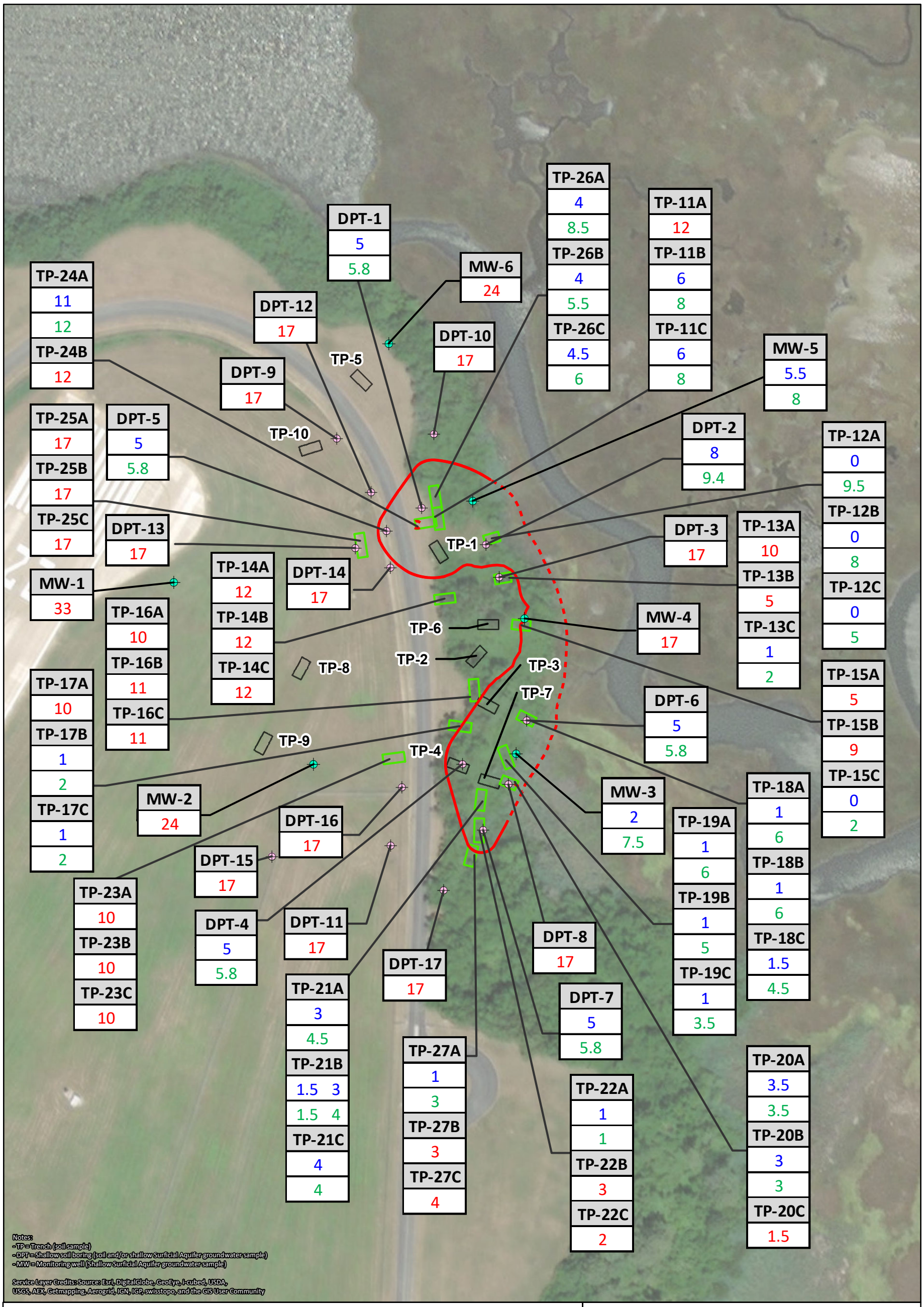


Supplemental Field Investigation Soil and Groundwater Sample Locations

Project 15 CDL FS
WFF FUDS

Figure 2-6

FarmerRA C:_projects\Wallops Island CDL\GIS\MXD\SupplementalFieldInvestigation\Figure3-1_Project15_CDL_Soil_GW_SampleLocs_20180410.mxd 4/10/2018



Legend

- Groundwater Monitoring Well
- Shallow DPT Boring
- Supplemental Field Investigation Trench
- Previous Investigation Trench
- Extent of Waste (dashed where estimated)

Location ID
Top of Waste (ft)
Bottom of Waste (ft)
Total Depth (ft)

Note: All previous investigation trenches (TP-1 - TP-10) do not have soil boring logs

0 100 200 400 Feet

N

Source: SFI Appendix A: Trench and Direct Push Technology Boring Logs, 2015-2016

Extent of Waste Based on Field Observations

CLIENT	NASA WFF CDL SFI & NTCRA			
PROJECT	Supplimental Field Investigation			
REVISED	2/16/2022	GIS BY	EG	2/16/2022
SCALE	1:1,560	CHK BY	MS	2/16/2022
Base Map: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN,		PM	JK	2/16/2022

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 2-7

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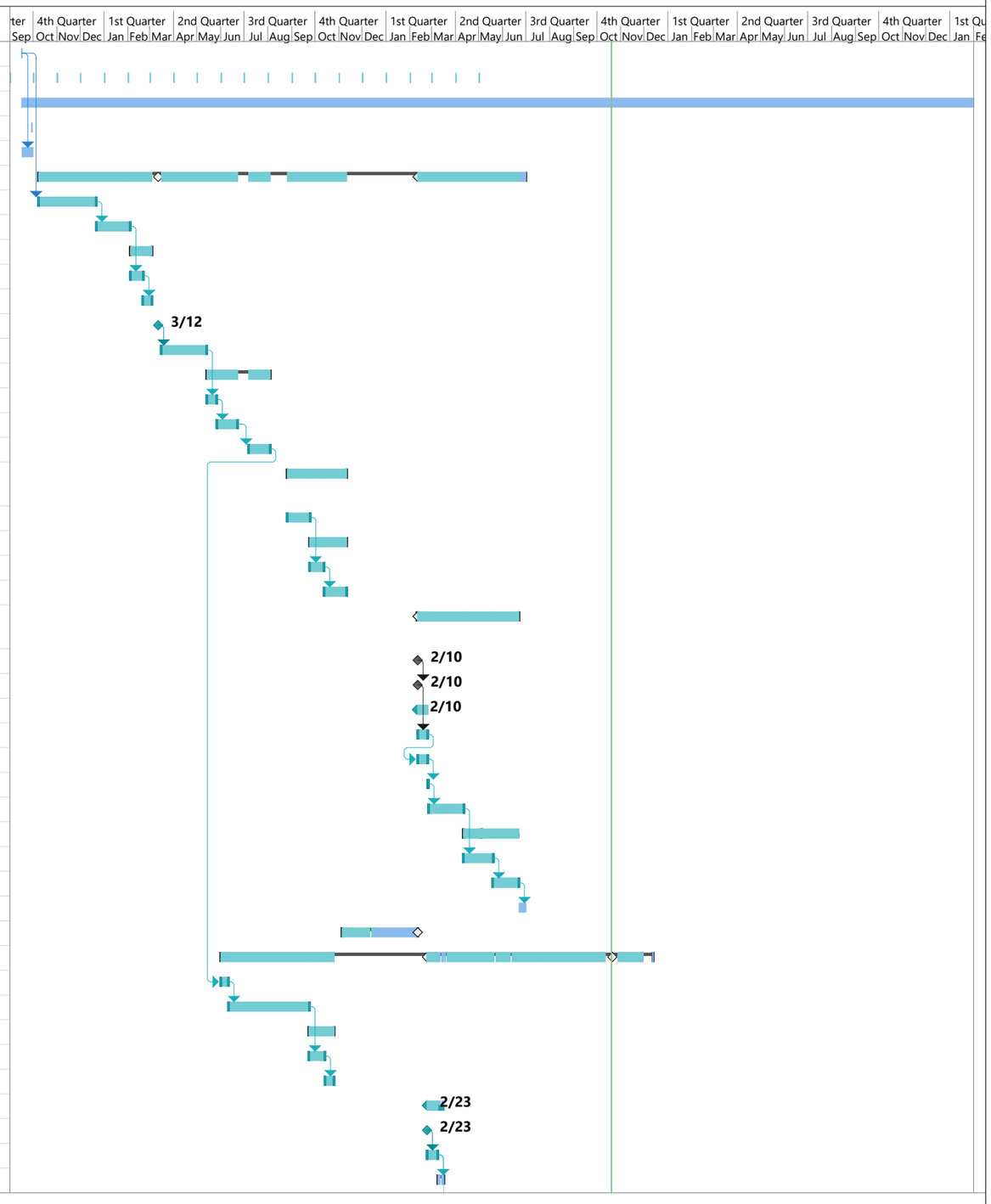
Anticipated Schedule for the CDL

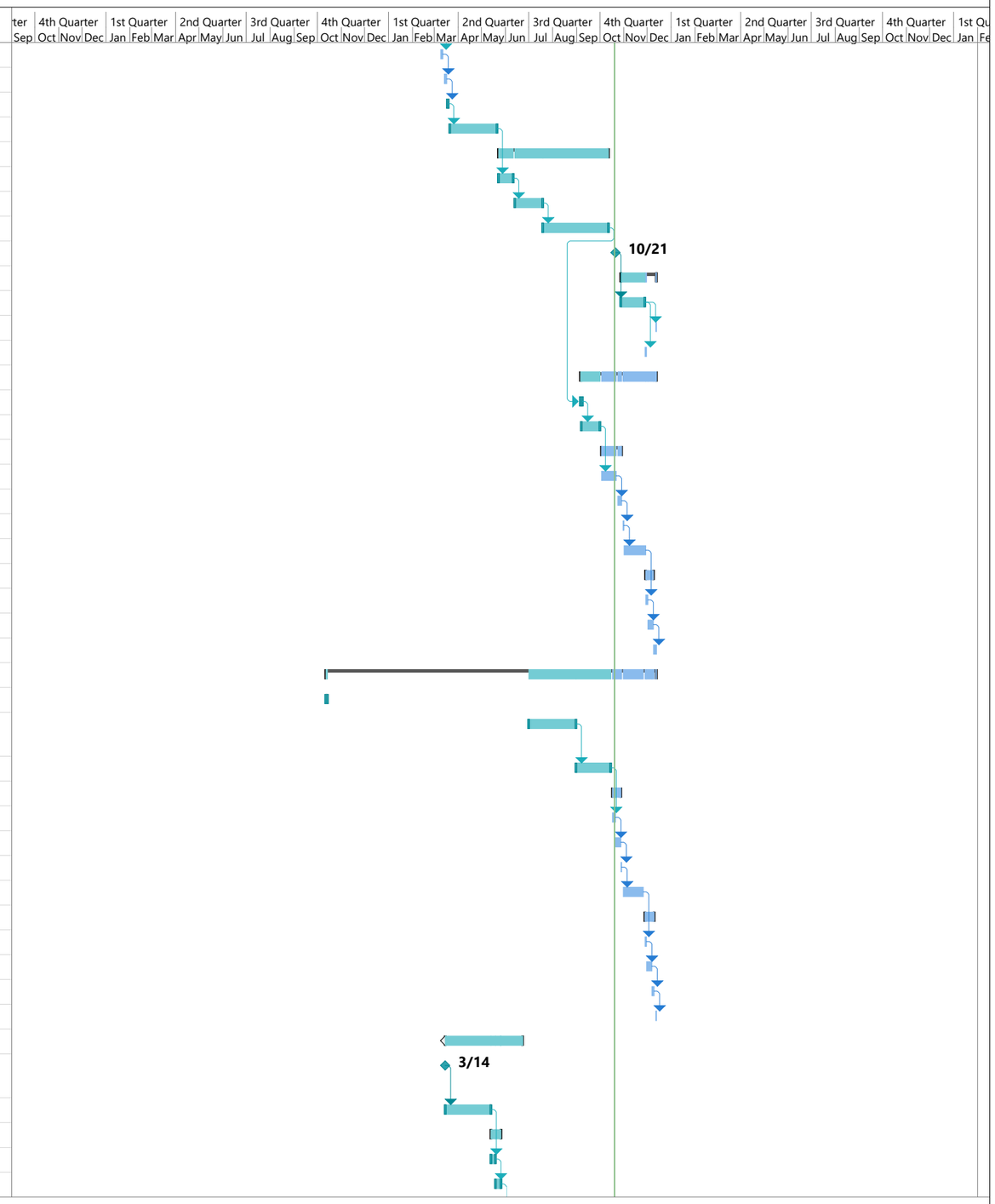
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Award**	1 day	9/16/2020	9/16/2020	
2		**Meetings and Conference Calls**	**881 days**	**9/16/2020**	**1/31/2024**	
29		Meetings and Conference Calls	881 days	9/16/2020	1/31/2024	
30		Kickoff Meeting with NASA at WFF	1 day	9/29/2020	9/29/2020	
31		**Baseline Schedule**	10 days	9/17/2020	9/30/2020	1
32		**Revised Supplemental Field Investigation Report**	**451 days**	**10/8/2020**	**6/30/2022**	
33		Darft Revised SFI Report (with BHHRA, ERA, COCs & RtC)	53 days	10/8/2020	12/21/2020	1
34		NASA Comments	32 days	12/22/2020	2/3/2021	33
35		*Resolution of Comments*	20 days	2/4/2021	3/3/2021	
36		AECOM response to comments	13 days	2/4/2021	2/20/2021	34
37		NASA acceptance of response to comments	9 days	2/20/2021	3/3/2021	36
38		Draft SFI Report	0 days	3/12/2021	3/12/2021	
39		Regulator Comments	43 days	3/16/2021	5/13/2021	38
40		*Resolution of Comments*	58 days	5/14/2021	8/3/2021	
41		AECOM response to comments and include recommended PRGs	9 days	5/14/2021	5/26/2021	39
42		NASA acceptance of response to comments	19 days	5/27/2021	6/22/2021	41
43		Regulator/NASA acceptance of response to comments with PRGs	20 days	7/7/2021	8/3/2021	42
44		*Darft Revised SFI Report (updated the HHRA and SFI to reflect regulatory acceptance of the background study)*	**55 days**	**8/26/2021**	**11/10/2021**	
45		NASA Comments	22 days	8/26/2021	9/24/2021	
46		Resolution of Comments	34 days	9/24/2021	11/10/2021	
47		AECOM response to comments	13 days	9/24/2021	10/12/2021	45
48		NASA acceptance of response to comments	21 days	10/13/2021	11/10/2021	47
49		*Darft Revised SFI Report (updated the HHRA and SFI to include the Geochemical Evaluation Study)*	**94 days**	**2/10/2022**	**6/21/2022**	
50		Prepare document and submit to NASA for review	0 days	2/10/2022	2/10/2022	71
51		NASA review and provide comments	0 days	2/10/2022	2/10/2022	50
52		*Resolution of Comments*	0 days	2/10/2022	2/10/2022	
53		AECOM response to comments	9 days	2/11/2022	2/23/2022	51
54		NASA acceptance of response to comments	9 days	2/11/2022	2/23/2022	53
55		Draft SFI that includes Background Study	1 day	2/24/2022	2/24/2022	54
56		Regulator Comments	32 days	2/25/2022	4/11/2022	55
57		*Resolution of Comments*	18 days	4/11/2022	5/4/2022	
58		AECOM response to comments	29 days	4/11/2022	5/19/2022	56
59		Regulator/NASA acceptance of response to comments	24 days	5/19/2022	6/21/2022	58
60		Final SFI Report	7 days	6/22/2022	6/30/2022	59
61		**Geochemical Evaluation Study**	**70 days**	**11/5/2021**	**2/10/2022**	
73		**EE/CA**	**400 days**	**6/1/2021**	**12/12/2022**	
74		Internal Darft EE/CA	8 days	6/1/2021	6/10/2021	43
75		NASA Comments	75 days	6/11/2021	9/23/2021	74
76		Resolution of Comments	23 days	9/23/2021	10/25/2021	
77		AECOM response to comments	15 days	9/23/2021	10/13/2021	75
78		NASA acceptance of response to comments	8 days	10/14/2021	10/25/2021	77
79		Revised Internal Draft EE/CA that incorporates Background Study	0 days	2/23/2022	2/23/2022	
80		Revised ID EE/CA submitted to NASA	0 days	2/23/2022	2/23/2022	
81		NASA Comments	10 days	2/23/2022	3/8/2022	80
82		Resolution of Comments	6 days	3/9/2022	3/16/2022	81



Grey shading = task complete. Red font = current task.

Anticipated Schedule for the CDL

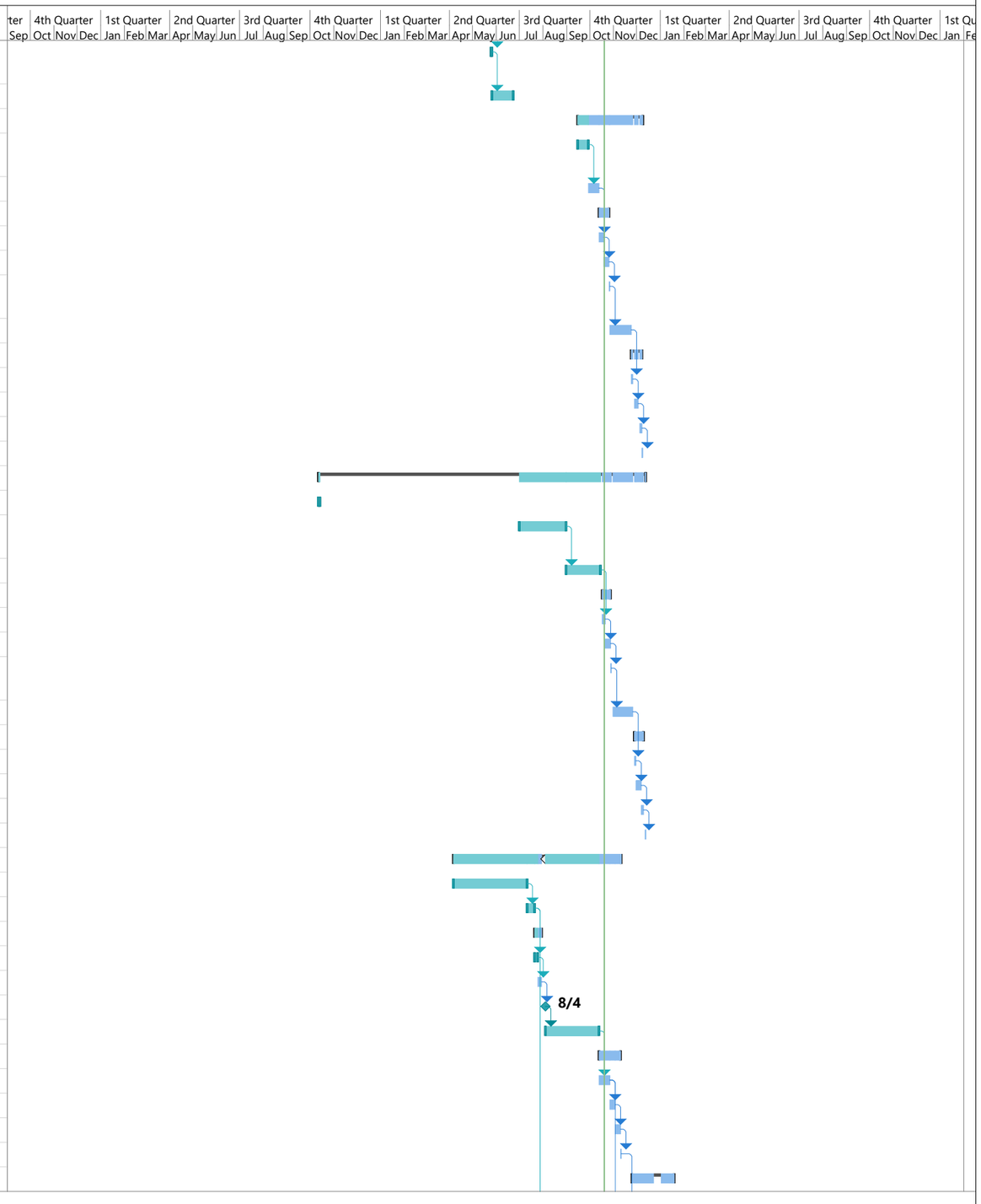
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
83		AECOM response to comments	3 days	3/9/2022	3/11/2022	81
84		NASA acceptance of response to comments	3 days	3/14/2022	3/16/2022	83
85		Draft EE/CA Submitted to Regulators	1 day	3/18/2022	3/18/2022	84
86		Regulator Comments	45 days	3/21/2022	5/20/2022	85
87		Resolution of Comments	102 days	5/23/2022	10/11/2022	
88		AECOM response to comments	15 days	5/23/2022	6/10/2022	86
89		NASA review of response to comments and approval to submit to Regulat	26 days	6/13/2022	7/18/2022	88
90		Regulator acceptance of response to comments	61 days	7/19/2022	10/11/2022	89
91		Final EE/CA	0 days	10/21/2022	10/21/2022	
92		Public Comment	32 days	10/28/2022	12/12/2022	
93		Public Comment Period	22 days	10/28/2022	11/27/2022	91FS+5 days
94		Public Meeting (if requested)	1 day	12/12/2022	12/12/2022	93FS+10 days
95		Address public comments and incorporate as necessary	2 days	11/28/2022	11/29/2022	93
96		**Action Memorandum**	**70 days**	**9/6/2022**	**12/12/2022**	
97		Internal Darft Action Memo	2 days	9/6/2022	9/7/2022	90
98		NASA Comments	18 days	9/7/2022	9/30/2022	97
99		*Resolution of Comments*	20 days	10/3/2022	10/28/2022	
100		AECOM response to comments	15 days	10/3/2022	10/21/2022	98
101		NASA acceptance of response to comments	5 days	10/24/2022	10/28/2022	100
102		Draft Action Memo	1 day	10/31/2022	10/31/2022	101
103		Regulator Comments	20 days	11/1/2022	11/28/2022	102
104		*Resolution of Comments*	8 days	11/29/2022	12/8/2022	
105		AECOM response to comments	3 days	11/29/2022	12/1/2022	103
106		Regulator/NASA acceptance of response to comments	5 days	12/2/2022	12/8/2022	105
107		Final Action Memo	2 days	12/9/2022	12/12/2022	106
108		**Wetlands and Waters Delineation Report**	**305 days**	**10/12/2021**	**12/12/2022**	
109		Wetlands and Waters Field Investigation	2 days	10/12/2021	10/13/2021	
110		Prepare Internal Draft Wetlands Delineation Report and submit to NASA for review	43 days	7/1/2022	8/30/2022	
111		NASA review and provide comments	33 days	8/31/2022	10/14/2022	110
112		*Resolution of Comments*	**9 days**	**10/17/2022**	**10/27/2022**	
113		AECOM response to comments	4 days	10/17/2022	10/20/2022	111
114		NASA acceptance of response to comments	5 days	10/21/2022	10/27/2022	113
115		Submit Draft Wetlands and Waters Delineation Report to regulators	1 day	10/28/2022	10/28/2022	114
116		Regulators provide comments	20 days	10/31/2022	11/25/2022	115
117		*Resolution of Comments*	**10 days**	**11/28/2022**	**12/9/2022**	
118		AECOM response to comments	2 days	11/28/2022	11/29/2022	116
119		NASA acceptance of response to comments	5 days	11/30/2022	12/6/2022	118
120		Regulators acceptance of response to comments	3 days	12/7/2022	12/9/2022	119
121		Submit Final Wetlands and Waters Delineation Report	1 day	12/12/2022	12/12/2022	120
122		**National Historic Preservation Act Support - Section 106 consultation letter**	**72 days**	**3/14/2022**	**6/22/2022**	
123		Prepare Internal Draft Section 106 consultation letter and submit to NASA for review	0 days	3/14/2022	3/14/2022	72
124		NASA review and provide comments	43 days	3/15/2022	5/12/2022	123
125		*Resolution of Comments*	**9 days**	**5/13/2022**	**5/25/2022**	
126		AECOM response to comments	4 days	5/13/2022	5/18/2022	124
127		NASA acceptance of response to comments	5 days	5/19/2022	5/25/2022	126



Grey shading = task complete. Red font = current task.

Anticipated Schedule for the CDL

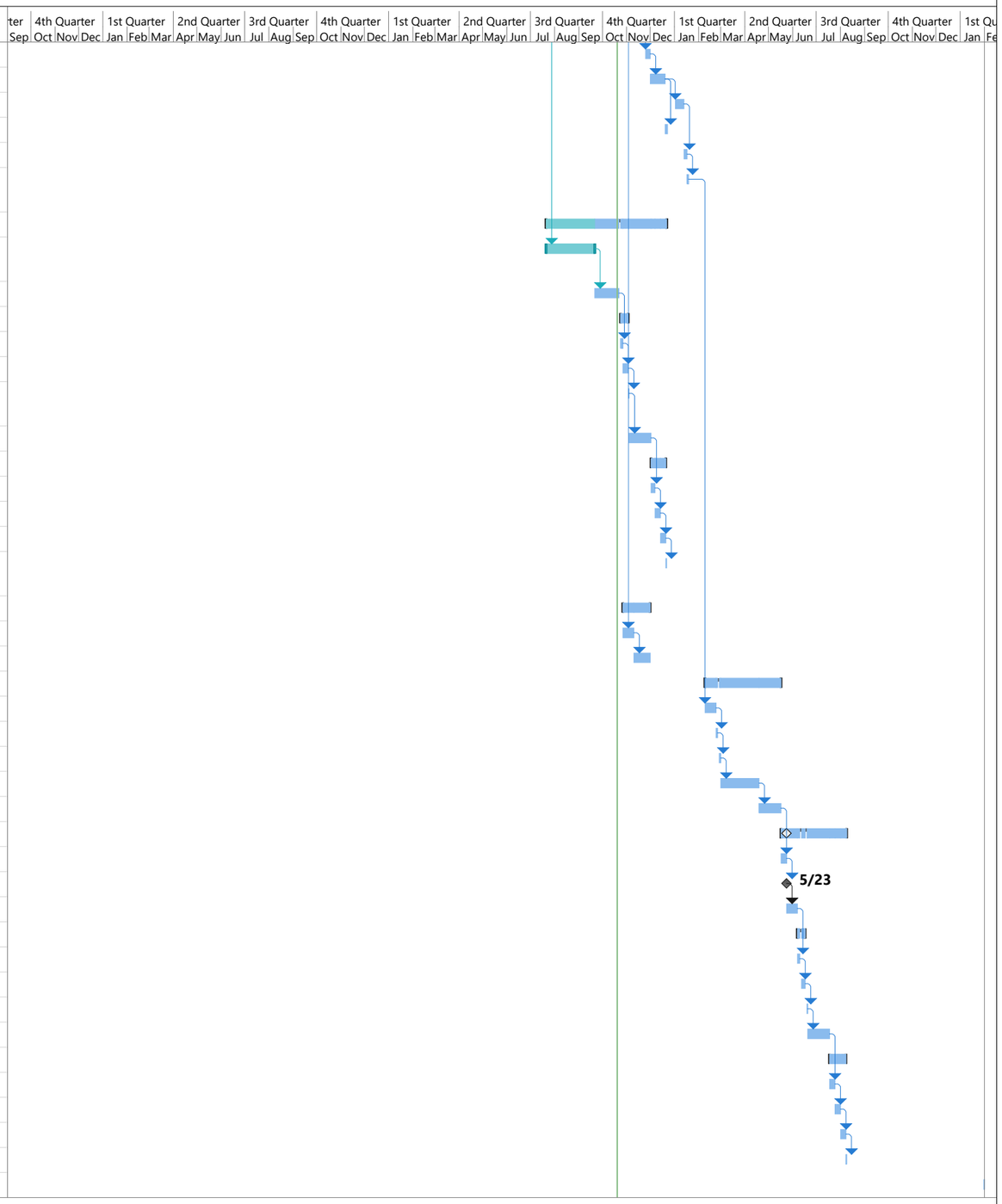
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
128		Submit Draft Section 106 consultation letter to regulators for review and comment	1 day	5/25/2022	5/25/2022	127
129		SHPO approves no further efforts warranted	20 days	5/26/2022	6/22/2022	128
130		**Coastal Zone Management Act Support - Federal Consistency Determination**	**61 days**	**9/15/2022**	**12/8/2022**	
131		Prepare Internal Draft Federal Consistency Determination and submit to NASA for review	10 days	9/15/2022	9/28/2022	72
132		NASA review and provide comments	10 days	9/29/2022	10/12/2022	131
133		*Resolution of Comments*	**9 days**	**10/13/2022**	**10/25/2022**	
134		AECOM response to comments	4 days	10/13/2022	10/18/2022	132
135		NASA acceptance of response to comments	5 days	10/19/2022	10/25/2022	134
136		Submit Draft Federal Consistency Determination to regulators for review and comment	1 day	10/26/2022	10/26/2022	135
137		Regulators provide comments	20 days	10/27/2022	11/23/2022	136
138		*Resolution of Comments*	**10 days**	**11/24/2022**	**12/7/2022**	
139		AECOM response to comments	2 days	11/24/2022	11/25/2022	137
140		NASA acceptance of response to comments	5 days	11/28/2022	12/2/2022	139
141		Regulators acceptance of response to comments	3 days	12/5/2022	12/7/2022	140
142		Submit Final Federal Consistency Determination	1 day	12/8/2022	12/8/2022	141
143		**Endangered Species Act Section 7 Consultation**	**305 days**	**10/12/2021**	**12/12/2022**	
144		Field Investigation	2 days	10/12/2021	10/13/2021	
145		Prepare Internal Draft Biological Evaluation Report and submit to NASA for review	43 days	7/1/2022	8/30/2022	
146		NASA review and provide comments	33 days	8/31/2022	10/14/2022	145
147		*Resolution of Comments*	**9 days**	**10/17/2022**	**10/27/2022**	
148		AECOM response to comments	4 days	10/17/2022	10/20/2022	146
149		NASA acceptance of response to comments	5 days	10/21/2022	10/27/2022	148
150		Submit Draft Biological Evaluation Report to regulators for review and comment	1 day	10/28/2022	10/28/2022	149
151		Regulators provide comments	20 days	10/31/2022	11/25/2022	150
152		*Resolution of Comments*	**10 days**	**11/28/2022**	**12/9/2022**	
153		AECOM response to comments	2 days	11/28/2022	11/29/2022	151
154		NASA acceptance of response to comments	5 days	11/30/2022	12/6/2022	153
155		Regulators acceptance of response to comments	3 days	12/7/2022	12/9/2022	154
156		Submit Final Biological Evaluation Report	1 day	12/12/2022	12/12/2022	155
157		**UFP-SAP to sample soil for disposal parameters**	**157 days**	**4/6/2022**	**11/10/2022**	
158		Prepare Internal Draft UFP-SAP and submit to NASA for review	69 days	4/6/2022	7/10/2022	
159		NASA review and provide comments	8 days	7/11/2022	7/20/2022	158
160		*Resolution of Comments*	**7 days**	**7/21/2022**	**7/29/2022**	
161		AECOM response to comments	3 days	7/21/2022	7/24/2022	159
162		NASA acceptance of response to comments	5 days	7/25/2022	7/29/2022	161
163		Submit Draft UFP-SAP to regulators for review and comment	0 days	8/4/2022	8/4/2022	162
164		Regulators provide comments	50 days	8/4/2022	10/12/2022	163
165		*Resolution of Comments*	**20 days**	**10/13/2022**	**11/9/2022**	
166		AECOM response to comments	10 days	10/13/2022	10/26/2022	164
167		NASA acceptance of response to comments	5 days	10/27/2022	11/2/2022	166
168		Regulator acceptance of response to comments	5 days	11/3/2022	11/9/2022	167
169		Submit Final UFP-SAP	1 day	11/10/2022	11/10/2022	168
170		**Sample soil for disposal parameters**	**39 days**	**11/25/2022**	**1/18/2023**	



Grey shading = task complete. Red font = current task.

Anticipated Schedule for the CDL

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
171		Mob to CDL and collect soil samples	4 days	11/25/2022	11/30/2022	169FS+10 days
172		Laboratory analysis	13 days	12/1/2022	12/19/2022	171
173		Data Validation	9 days	1/2/2023	1/12/2023	172FS+9 days
174		Review analytical results and share with landfill to prepare manifests	3 days	12/20/2022	12/22/2022	172
175		Summarize data and assess usability	2 days	1/13/2023	1/16/2023	173
176		Make adjustments to excavation area, if needed after reviewing analytical results	2 days	1/17/2023	1/18/2023	175
177		**Excavation Final Slope Design and Erosion and Sediment Control Plan**	**110 days**	**7/21/2022**	**12/21/2022**	
178		Prepare Internal Draft (60%) Excavation Final Slope Design and Erosion and Sediment Control Plan and submit to NASA for review	44 days	7/21/2022	9/20/2022	159
179		NASA review and provide comments	23 days	9/21/2022	10/21/2022	178
180		*Resolution of Comments*	**8 days**	**10/24/2022**	**11/2/2022**	
181		AECOM response to comments	3 days	10/24/2022	10/26/2022	179
182		NASA acceptance of response to comments	5 days	10/27/2022	11/2/2022	181
183		Submit Draft Excavation Final Slope Design and Erosion and Sediment Control Plan to regulators for review and comment	1 day	11/3/2022	11/3/2022	182
184		Regulators provide comments	20 days	11/4/2022	12/1/2022	183
185		*Resolution of Comments*	**13 days**	**12/2/2022**	**12/20/2022**	
186		AECOM response to comments	3 days	12/2/2022	12/6/2022	184
187		NASA acceptance of response to comments	5 days	12/7/2022	12/13/2022	186
188		Regulator acceptance of response to comments	5 days	12/14/2022	12/20/2022	187
189		Submit Final Excavation Final Slope Design and Erosion and Sediment Control Plan	1 day	12/21/2022	12/21/2022	188
190		**Health and Safety Plan (HASP)**	**25 days**	**10/27/2022**	**11/30/2022**	
191		Submit HASP to NASA	10 days	10/27/2022	11/9/2022	166
192		NASA acceptance of HASP	15 days	11/10/2022	11/30/2022	191
193		**Removal Action**	**69 days**	**2/9/2023**	**5/16/2023**	
194		Mob, Obtain Equipment, Establish Work Areas	10 days	2/9/2023	2/22/2023	176FS+15 days
195		Install Erosion Control Measures	2 days	2/23/2023	2/24/2023	194
196		Tree and brush clearance and mulching	2 days	2/27/2023	2/28/2023	195
197		Excavate Soil and Load Trucks for Offsite disposal	35 days	3/1/2023	4/18/2023	196
198		Backfilling and Site restoration	20 days	4/19/2023	5/16/2023	197
199		**After Action Report**	**60 days**	**5/17/2023**	**8/8/2023**	
200		Prepare After Action Report Internal Draft	5 days	5/17/2023	5/23/2023	198
201		Submit Internal Draft After Action Report to NASA for review	0 days	5/23/2023	5/23/2023	200
202		NASA review and provide comments	10 days	5/24/2023	6/6/2023	201
203		*Resolution of Comments*	**8 days**	**6/7/2023**	**6/16/2023**	
204		AECOM response to comments	3 days	6/7/2023	6/9/2023	202
205		NASA acceptance of response to comments	5 days	6/12/2023	6/16/2023	204
206		Submit Draft After Action Report to Regulators for review	1 day	6/19/2023	6/19/2023	205
207		Regulator review and provide comments	20 days	6/20/2023	7/17/2023	206
208		*Resolution of Comments*	**15 days**	**7/18/2023**	**8/7/2023**	
209		AECOM response to comments	5 days	7/18/2023	7/24/2023	207
210		NASA acceptance of response to comments	5 days	7/25/2023	7/31/2023	209
211		Regulators acceptance of response to comments	5 days	8/1/2023	8/7/2023	210
212		Submit Final After Action Report	1 day	8/8/2023	8/8/2023	211
213		**POP end date**	1 day	1/31/2024	1/31/2024	



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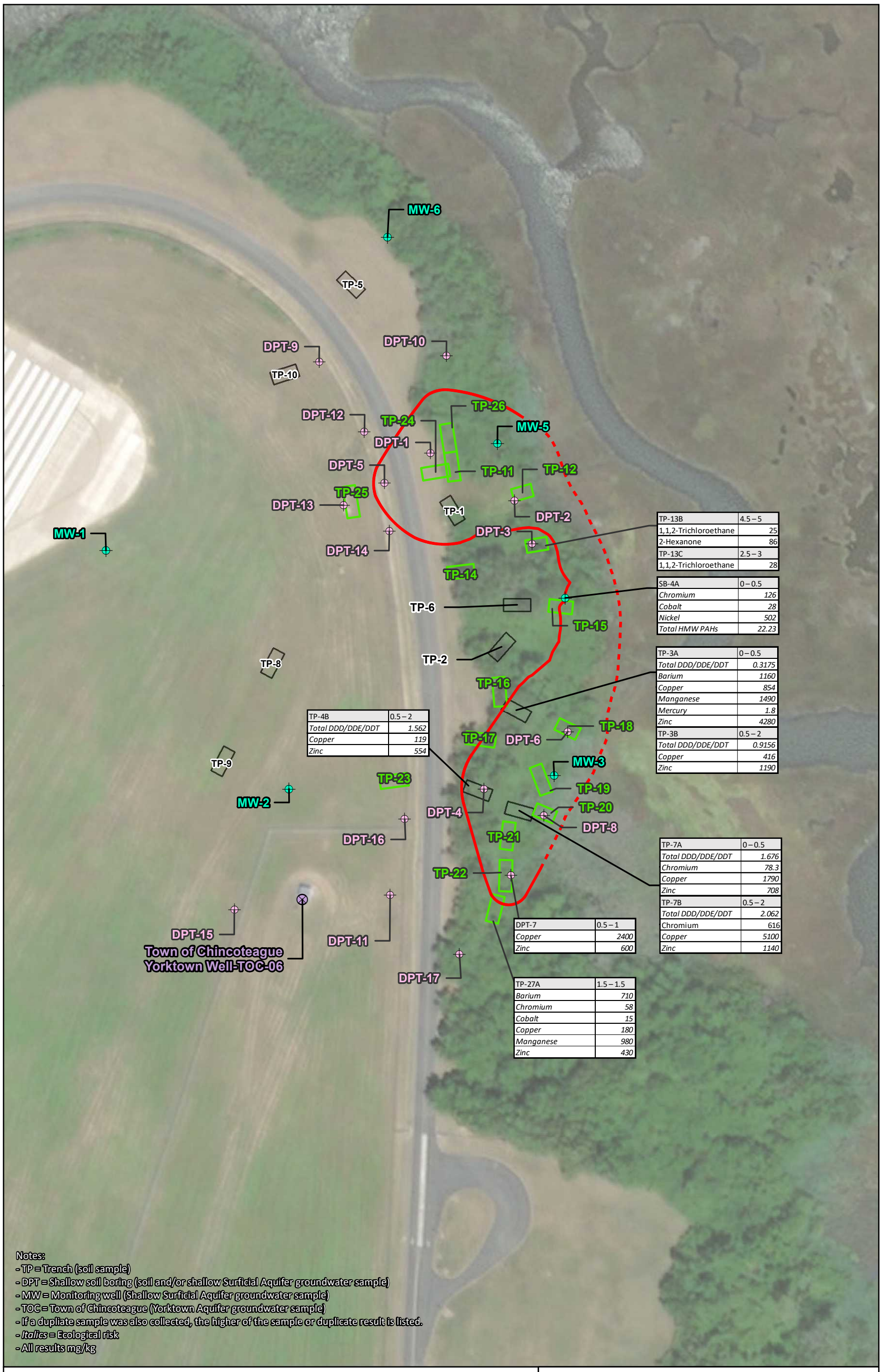


TP-13B	4.5 – 5
1,1,2-Trichloroethane	25
2-Hexanone	86
TP-13C	2.5 – 3
1,1,2-Trichloroethane	28

SB-4A	0 – 0.5
Chromium	*126*
Cobalt	*28*
Nickel	*502*
Total HMW PAHs	*22.23*

TP-3A	0 – 0.5
Total DDD/DDE/DDT	*0.3175*
Barium	*1160*
Copper	*854*
Manganese	*1490*
Mercury	*1.8*
Zinc	*4280*
TP-3B	0.5 – 2
Total DDD/DDE/DDT	*0.9156*
Copper	*416*
Zinc	*1190*

TP-4B	0.5 – 2
Total DDD/DDE/DDT	*1.562*
Copper	*119*
Zinc	*554*

TP-7A	0 – 0.5
Total DDD/DDE/DDT	*1.676*
Chromium	*78.3*
Copper	*1790*
Zinc	*708*
TP-7B	0.5 – 2
Total DDD/DDE/DDT	*2.062*
Chromium	616
Copper	*5100*
Zinc	*1140*

DPT-7	0.5 – 1
Copper	*2400*
Zinc	*600*

TP-27A	1.5 – 1.5
Barium	*710*
Chromium	*58*
Cobalt	*15*
Copper	*180*
Manganese	*980*
Zinc	*430*

Notes:
- TP = Trench (soil sample)
- DPT = Shallow soil boring (soil and/or shallow Surficial Aquifer groundwater sample)
- MW = Monitoring well (Shallow Surficial Aquifer groundwater sample)
- TOC = Town of Chincoteague (Yorktown Aquifer groundwater sample)
- If a dupliate sample was also collected, the higher of the sample or duplicate result is listed.
- *Italics* = Ecological risk
- All results mg/kg

Legend

- Groundwater Monitoring Well
- Public Supply Well
- Shallow DPT Boring
- Supplemental Field Investigation Trench
- Previous Investigation Trench
- Extent of Waste (dashed where estimated)

Sample Number	Depth

0 50 100 200 Feet

N

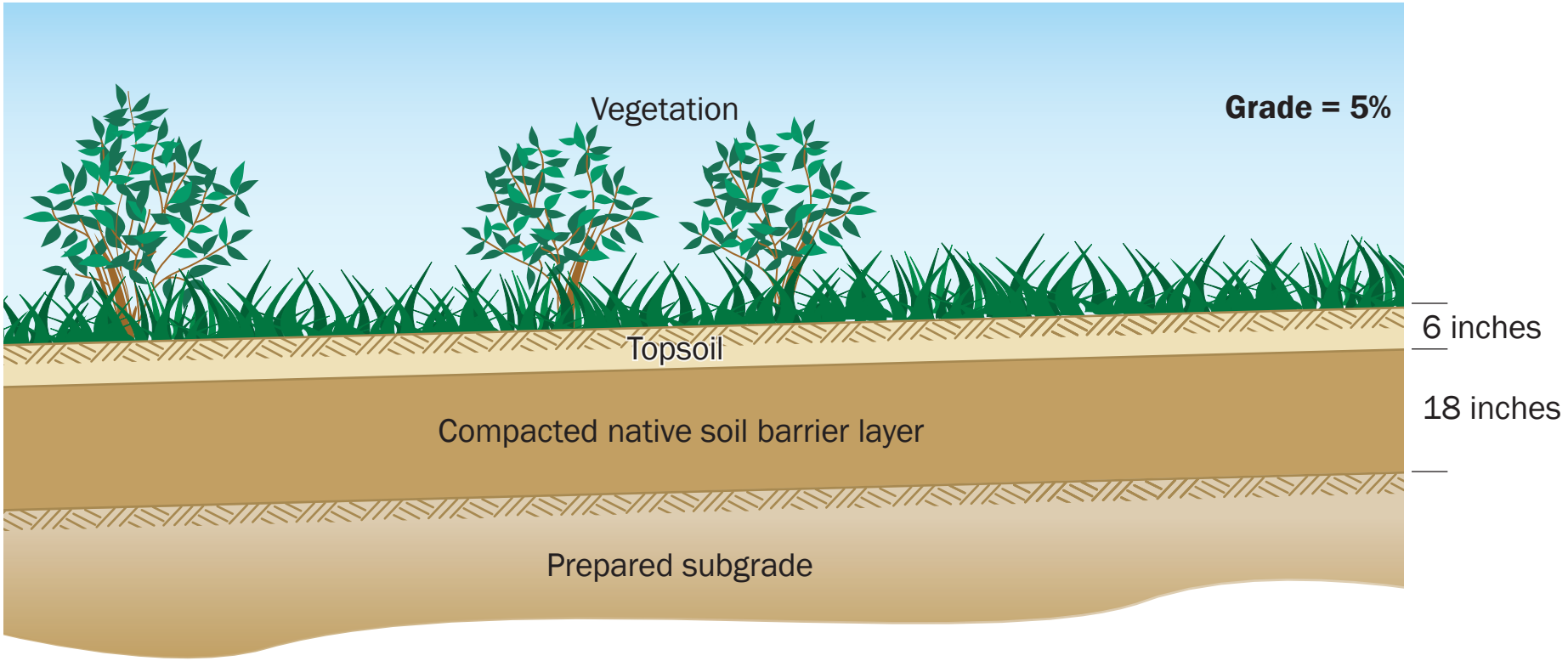
Soil Above PRGs and ESVs

CLIENT	NASA WFF CDL SFI & NTCRA			
PROJECT	Supplemental Field Investigation			
REVISED	5/13/2022	GIS BY	MS	5/13/2022
SCALE	1:1,200	CHK BY	JK	5/13/2022
Base Map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community		PM	JK	5/13/2022

AECOM
12420 Milestone Center Drive4
Germantown, MD 20876

Figure 4-1

L:\DCS\Projects\ENV\GEARS\GEO\NASA\WFF CDL SFI\GIS\MXD\AECOM_Figures\May_2022\Fig_9-3_Wallops_Island_Soil_Above_PRGs_and_ESVs.mxd



CLIENT NASA				TITLE **Cross Section of a Subtitle D Landfill Cap**	
PROJ Wallops Island					
REVISION NO	DES BY			AECOM	PROJ NO 60642834
SCALE	DR BY	BR			FIGURE **4-2**
	CHK BY	JK			

Tables

Table 3-1
Refined Direct Contact Evaluation (Central AOC; Surface Soil, 0 - 2 feet)
Ecological Risk Assessment
Construction Debris Landfill, Wallops Island, Virginia

Scenario Timeframe:	Current and Future
Site:	Central AOC
Exposure Medium:	Soil
Exposure Point:	Soil (0 – 2 ft)

COPEC	CASRN	Frequency of Detection	Refined EPC (mg/kg)		Refined ESV (mg/kg)	Study Endpoint	Source	Refined HQ	Refined COPEC?	Rationale
Semi-Volatile Organic Compounds (SVOCs)										
Benzaldehyde	100-52-7	1/1	0.0542	MDC	2.3	see text; modeled using acute aquatic effects (via ECOSAR Class Program)	USEPA (2018)	<1	No	Refined EPC less than refined ESV
Total HMW PAHs	HMW-PAH	2/9	19.58	MDC	18	invertebrate (geometric mean MATC and EC10)	USEPA (2008)	1	Yes	Refined EPC exceeds refined ESV
Total Metals										
Chromium	7440-47-3	9/9	79.29	UCL	57	invertebrate (minimum MATC)	USEPA (2008)	1	Yes	Refined EPC exceeds refined ESV
Cobalt	7440-48-4	9/9	17.8	UCL	13	plant (geometric mean EC20)	USEPA (2008)	1	Yes	Refined EPC exceeds refined ESV
Lead	7439-92-1	9/9	65.53	UCL	1700	invertebrate (geometric mean MATC)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Manganese	7439-96-5	9/9	244.9	UCL	450	invertebrate (geometric mean EC20)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Mercury	7439-97-6	9/9	0.183	UCL	0.5	earthworm (LOEC)	LANL (2017)	<1	No	Refined EPC less than refined ESV
Nickel	7440-02-0	9/9	502	MDC	280	invertebrate (geometric mean MATC)	USEPA (2008)	2	Yes	Refined EPC exceeds refined ESV
Selenium	7782-49-2	1/9	1.5	MDC	4.1	invertebrate (geometric mean EC20)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Thallium	7440-28-0	9/9	0.115	UCL	0.5	generic plant (LOEC)	LANL (2017)	<1	No	Refined EPC less than refined ESV
Zinc	7440-66-6	9/9	110.2	UCL	153	invertebrate (geometric mean EC10)	USEPA (2008)	<1	No	Refined EPC less than refined ESV

Notes:

CASRN = Chemical Abstract Services Registry Number
COPEC = Constituent of Potential Ecological Concern
EC10 = Effects Concentration for 10 percent of test population
EC20 = Effects Concentration for 20 percent of test population
ECOSAR = Ecological Structure Activity Relationships
EPC = Exposure Point Concentration
ESV = Ecological Screening Value
HQ = Hazard Quotient
LOEC = Lowest Observed Effects Concentration
MATC = Maximum Allowable Toxicant Concentration
mg/kg = milligram per kilogram
UCL = Upper Confidence Limit
USEPA = United States Environmental Protection Agency

References:

Los Alamos National Laboratory (LANL). 2017. ECORISK Database Release 4.1 (September 2017).
USEPA. 2008. Ecological Soil Screening Level (Eco-SSL) Guidance and Documents. Office of Solid Waste and Emergency Response, Washington, D.C. Published and revised from 2003-2008.

Table 3-2
Refined Direct Contact Evaluation (Southern AOC; Surface Soil, 0 - 2 feet)
Ecological Risk Assessment
Construction Debris Landfill, Wallops Island, Virginia

Scenario Timeframe:	Current and Future
Site:	Southern AOC
Exposure Medium:	Soil
Exposure Point:	Soil (0 – 2 ft)

COPEC	CASRN	Frequency of Detection	Refined EPC (mg/kg)		Refined ESV (mg/kg)	Study Endpoint	Source	Refined HQ	Refined COPEC?	Rationale
Pesticides										
alpha-Chlordane	5103-71-9	1/10	0.0267	MDC	22	generic plant (LOEC)	LANL (2017)	<1	No	Refined EPC less than refined ESV
gamma-Chlordane	5103-74-2	1/10	0.0346	MDC	22	generic plant (LOEC)	LANL (2017)	<1	No	Refined EPC less than refined ESV
Total Metals										
Barium	7440-39-3	14/14	601.1	UCL	330	invertebrate (geometric mean EC20)	USEPA (2008)	2	Yes	Refined EPC exceeds refined ESV
Chromium	7440-47-3	14/14	255.4	UCL	57	invertebrate (minimum MATC)	USEPA (2008)	4	Yes	Refined EPC exceeds refined ESV
Cobalt	7440-48-4	14/14	6.175	UCL	13	plant (geometric mean EC20)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Copper	7440-50-8	14/14	2419	UCL	80	invertebrate (geometric mean MATC and EC10)	USEPA (2008)	30	Yes	Refined EPC exceeds refined ESV
Lead	7439-92-1	14/14	826.6	UCL	1700	invertebrate (geometric mean MATC)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Manganese	7439-96-5	14/14	837.1	UCL	450	invertebrate (geometric mean EC20)	USEPA (2008)	2	Yes	Refined EPC exceeds refined ESV
Mercury	7439-97-6	14/14	0.785	UCL	0.5	earthworm (LOEC)	LANL (2017)	2	Yes	Refined EPC exceeds refined ESV
Nickel	7440-02-0	14/14	52.71	UCL	280	invertebrate (geometric mean MATC)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Selenium	7782-49-2	2/14	2.576	UCL	4.1	invertebrate (geometric mean EC20)	USEPA (2008)	<1	No	Refined EPC less than refined ESV
Thallium	7440-28-0	5/14	0.0793	UCL	0.5	generic plant (LOEC)	LANL (2017)	<1	No	Refined EPC less than refined ESV
Zinc	7440-66-6	14/14	1695	UCL	153	invertebrate (geometric mean EC10)	USEPA (2008)	11	Yes	Refined EPC exceeds refined ESV

Notes:

CASRN = Chemical Abstract Services Registry Number
COPEC = Constituent of Potential Ecological Concern
EC10 = Effects Concentration for 10 percent of test population
EC20 = Effects Concentration for 20 percent of test population
ECOSAR = Ecological Structure Activity Relationships
EPC = Exposure Point Concentration
ESV = Ecological Screening Value
HQ = Hazard Quotient
LOEC = Lowest Observed Effects Concentration
MATC = Maximum Allowable Toxicant Concentration
mg/kg = milligram per kilogram
UCL = Upper Confidence Limit
USEPA = United States Environmental Protection Agency

References:

Los Alamos National Laboratory (LANL). 2017. ECORISK Database Release 4.1 (September 2017).
USEPA. 2008. Ecological Soil Screening Level (Eco-SSL) Guidance and Documents. Office of Solid Waste and Emergency Response, Washington, D.C. Published and revised from 2003-2008.

Table 3-3: Summary of Preliminary Remediation Goals for Soil in the Central/Southern Exposure Area

Chemical of Concern (COC)	CASRN	Cancer and Non-Cancer Toxicity Values Used to Derive PRGs (a)									Calculated Industrial Worker Soil PRGs (b)		Apportioned Soil PRGs (c, d)		Site-Specific PRG Thresholds		Selected Risk-Based Site-Specific PRG (g)	Basis for Selection
		Cancer Slope Factor (SFo) $(mg/kg\text{-}day)^{-1}$	SF_o Source	Inhalation Unit Risk (IUR) $(\mu g/m^3)^{-1}$	IUR Source	Oral Chronic Reference Dose (RfD) (mg/kg-day)	RfDo Source	Inhalation Chronic Reference Dose (RfD) (mg/kg-day)	RfDI Source	Chronic Target Organ System	Cancer Industrial Worker Soil EPA PRG TR= 1E-04 (mg/kg)	NC Industrial Worker Soil EPA PRG THQ=1 (mg/kg)	Cancer Industrial Worker Soil PRG TR= 3E-05 (mg/kg)	NC Industrial Worker Soil PRG Target Organ HI ≤ 1 (mg/kg)	Site-Specific Cancer TR (e)	Site-Specific Non-Cancer THQ (f)		
1,1,2-Trichloroethane	79-00-5	5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	RS; HM; IM	5.0E+02	6.3E+00	125.0	2.1	3.E-05	0.33	2.1	Protective of THQ of 0.33 (cumulative exposure to 3 noncarcinogenic COCs - RS Target Organ HI)
2-Hexanone	591-78-6					5.0E-03	I	3.0E-02	I	NV	--	1.3E+03	--	433	3.E-05	0.33	433	Protective of THQ of 0.33 (cumulative exposure to 3 noncarcinogenic COCs - NV Target Organ HI)
Benzo(a)pyrene	50-32-8	1.0E+00	I	6.0E-04	I	3.0E-04	I	2.0E-06	I	DV	2.1E+02	2.2E+02	53	110	3.E-05	0.50	53	Protective of TR of 3E-05 (cumulative exposure to 4 carcinogenic COCs)
Arsenic	7440-38-2	1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C	CV; DM; DV; NV; RP; RS	3.0E+02	4.8E+02	75	160	3.E-05	0.33	75	Protective of TR of 3E-05 (cumulative exposure to 4 carcinogenic COCs)
Chromium	7440-47-3	5.0E-01	C	8.4E-02	G	3.0E-03	I	1.0E-04	I	OT; RS	6.3E+02	3.5E+03	158	1167	3.E-05	0.33	158	Protective of TR of 3E-05 (cumulative exposure to 4 carcinogenic COCs)
Manganese	7439-96-5					2.4E-02	G	5.0E-05	I	NV	--	2.6E+04	--	8667	3.E-05	0.33	8667	Protective of THQ of 0.33 (cumulative exposure to 3 noncarcinogenic COCs - NV Target Organ HI)
										Cumulative Cancer Risk/Hazard Index =			1.E-04	1				

Notes:

- = no value or not applicable
CALEPA = California Environmental Protection Agency
CASRN = CAS registry number
COC = chemical of concern
HI = hazard index
HM = hematological system
HP = hepatic system
IM = immune system
IRIS = Integrated Risk Information System
µg/L = micrograms per liter
$\mu g/m^3$ = micrograms per meters cubed
mg/kg-day = milligrams per kilogram-day
NC = non-carcinogenic
NV = nervous system
RfD = reference dose
RDX = royal demolition explosive, Hexahydro-1,3,5-trinitro-1,3,5-triazine
PPRTV = provisional peer-reviewed toxicity value; Screen values do not meet all the requirements for deriving a provisional toxicity value and therefore have a higher level of uncertainty.
PRG = preliminary remediation goal
THQ = target hazard quotient
TR = target cancer risk

	Soil
Total Cardiovascular (CV) HI across All Media =	0.3
Total Dermal (DM) HI across All Media =	0.3
Total Developmental (DV) HI across All Media =	0.8
Total Endocrine (EN) HI across All Media =	0.0
Total Gastrointestinal (GI) HI across All Media =	0.0
Total Hematological (HM) HI across All Media =	0.3
Total Immune (IM) HI across All Media =	0.3
Total Nervous (NV) HI across All Media =	1.0
Total Other (OT) HI across All Media =	0.3
Total Reproductive (RP) HI across All Media =	0.3
Total Respiratory (RS) HI across All Media =	1.0
Total Urinary (UR) HI across All Media =	0.0
Total Hepatic (HP) HI across All Media =	0.0

T.O.	Target Organ Counts
CV	1
DM	1
DV	2
EN	0
GI	0
HM	1
IM	1
NV	3
OT	1
RP	1
RS	3
UR	0
HP	0

(a) No inhalation reference concentrations were available for the chemicals listed in THQs table.

(b) EPA Industrial Worker Preliminary Remediation Goals (PRGs) were derived using May 2022 toxicity data and are protective of a TR of 1E-04 and a THQ of 1.

(c) The apportioned site-specific cancer PRGs were derived using the following equation:

$$Apportioned\ Cancer\ PRG = Calculated\ Cancer\ PRG \times \left(\frac{Site - Specific\ Cancer\ TR}{EPA\ PRG\ TR}\right)$$

(d) The apportioned site-specific non-cancer PRG was derived using the following equation:

$$Apportioned\ Non - Cancer\ PRG = Calculated\ Non - Cancer\ PRG \times \left(\frac{Site - Specific\ THQ}{EPA\ PRG\ THQ}\right)$$

(e) The site-specific PRG target risk (TR) was derived using the following equation:

$$Site - Specific\ PRG\ TR = \frac{Cumulative\ Cancer\ Risk\ Threshold\ (1E-04)}{Number\ of\ Cancer\ COCs\ (5)}$$

(f) The site-specific PRG target hazard quotient (THQ) was derived using the following equation:

$$Site - Specific\ PRG\ THQ = \frac{Cumulative\ Non - Cancer\ Hazard\ Threshold\ (1)}{Maximum\ Number\ of\ Non - Cancer\ COCs\ Contributing\ to\ Target\ Organ}$$

(g) The selected risk-based site-specific PRG is the minimum PRG of the apportioned cancer risk and non-cancer PRGs.

Table 3-4: Summary of PRGs and ESVs for Soil

	Residential					
Compound (values are in mg/kg)	**PRG Surface Soil**	**PRG Subsurface Soil**	**PRG for Total Soil**	**Industrial Soil PRGs**	**ESV Surface Soil**	**Value used to determine excavation and offsite disposal**
1,1,2-Trichloroethane	0.12	0.12	0.12	2.1		2.1
2,3,7,8-TCDD TEQ	2.60E-05	2.60E-05	2.60E-05			
2-Hexanone	29	29	29	433.3		433.3
Benzo(a)pyrene	1	1	1	52.5		52.5
bis(2-Ethylhexyl)phthalate						
Aluminum	13900	22400	13900			
Antimony	2.4	2.4	2.4			
Arsenic	13.72	5.3	5.3	75		75
Barium					330	330
Cadmium	24	24	24			
Chromium	18.4	21	18.4	157.5	57	57
Cobalt	7.3	8.8	7.3		13	13
Copper	1033.333	1033.3333	1033		80	80
Iron	18333	24200	18333			
Lead						
Manganese	781	257	257	8667	450	450
Mercury					0.5	0.5
Nickel	125	125	125		280	280
Thallium	0.76	0.26	0.26			
Vanadium	32.5	42	33			
Zinc					153	153
Total DDD/DDE/DDT					0.044	0.044
Total HMW PAHs					18	18

Legend:
All values in mg/kg
mg/kg = milligrams per kilogram
PRG = Preliminary Remediation Goal from Table 3-1 of the EE/CA (AECOM, 2022)
Total DDD/DDE/DDT is the summation of BTVs for the individual compounds

Table 3-5: Chemical-Specific ARARs and TBC Guidance for the NTCRA at the Construction Debris Landfill, Wallops Flight Facility, Virginia

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Federal Requirements			
USEPA Ecological Soil Screening Level (Eco-SSL)	USEPA	Eco-SSLs are guidance values used to evaluate ecological risk caused by exposure to contaminants. These are not ARARs because they are not promulgated regulations. Eco-SSLs are the geometric mean of eligible toxicity values protective of growth and reproduction; in cases where a geometric mean could not be calculated, the minimum eligible toxicity value was used as a refined ESV.	To be considered
USEPA Region 4 Ecological Risk Assessment Supplemental Guidance.	Scientific Support Section, Superfund Division, USEPA Region 4.	EPA Region 4 ESVs are guidance values used to evaluate ecological risk caused by exposure to contaminants. These are not ARARs because they are not promulgated regulations.	To be considered

Acronyms:
ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations.
E&SC - Erosion and Sediment Control
TBC - To Be Considered
U.S.C. - United States Code
USEPA - United States Environmental Protection Agency
VAC - Virginia Administrative Code

Table 3-6: Location-Specific ARARs and TBC Guidance for the NTCRA at the Construction Debris Landfill, Wallops Flight Facility, Virginia

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
		Federal Requirements	
Resource Conservation and Recovery Act (RCRA) Flood Plain Regulations	40 Code of Federal Regulations (CFR) 264.18(b)	Requires that any treatment, storage, and disposal (TSO) facility be designed, constructed, operated, and maintained to avoid washout. For existing surface impoundments, waste piles, land treatment units, landfills, and miscellaneous units, no adverse effects on human health and the environment will result if washout occurs. Relevant and appropriate to a remedial action that leaves waste in place to protect against washout because the site is an existing landfill that is at least partially located within a 100-year floodplain.	Relevant and Appropriate
Executive Order (EO) on Floodplain Management	EO 11988, 40 CFR 6 Appendix A, excluding Sections 6(a)(2), 6(a)(4) and 6(a)(6); 40 CFR 6.302[a]	Requires federal agencies to evaluate the potential effect of actions taken in a floodplain and to avoid long- and short-term adverse Impacts associated with direct and indirect development of a floodplain. Part of the CDL Site ls located within a floodplain on a federal facility, and remediation will be federally financed. Potentially applicable to capping and excavation activities. Capping would likely require work in the floodplain to achieve a proper grade. In addition, capping would require identification of impacts of the proposed action, an evaluation of whether those actions can be avoided, and development of measures to minimize the impacts and restore and preserve the floodplain. Appendix A public notification requirements are excluded because they are not substantive requirements	Applicable

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Executive Order on Protection of Wetlands	EO 11990, 40 CFR Part 6, Appendix A. excluding Sections 6(a)(2), 6(a)(4) and 6(a)(6); 40 CFR 6.302[a]	Sets forth direction for avoidance of adverse impacts associated with the distinction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. The CDL Site ls located partially within a wetland and on a federal facility. Potentially applicable to capping and excavation activities. Capping would likely require some filling of the wetlands to achieve a proper grade. Capping also would require the identification of impacts of proposed action, an evaluation of whether those actions can be avoided, and development of measures to minimize the impacts and restore and preserve the wetland. Appendix A public notification requirements are excluded because they are not substantive requirements. Nationwide Permit no. 38 will be used for any activities undertaken in the wetland areas of the CDL Site and incorporates coordination with natural resource and historical resource trustees regarding the potential to adversely impact threatened and endangered species and/or sites protected under the National Historical Preservation Act.	Applicable

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
National Historic Preservation Act (NHPA)	36 CFR Part 62 and 65; 16 U.S. Code (U.S.C.) 469-470; 36 CFR 800	Requires federal agencies to consider the effects of their actions on historic properties before undertaking a project. Federal agencies are required to initiate consultation with the State Historic Preservation Office (SHPO), informing them of the planned action and requesting their submittal of any comments or concerns. The U.S. Army Corps of Engineers, Baltimore District, conducted archaeological monitoring of trenches conducted as part of a remedial investigation of the Central AOC and Southern AOC in May and June 2015. The Virginia Department of Historic Resources (VDHR), in a letter dated April 29, 2016, determined that archaeological monitoring for additional investigative trenching and borings was not warranted. Under Section 106 of the National Historic Preservation Act and Title 36, Part 800 of the Code of Federal Regulations, NASA WFF has determined the proposed NTCRA of waste and soil removal, as well as future remedial actions for groundwater, sediment, and surface water at the CDL, will not affect historic resources. NASA WFF submitted the determination to the Virginia Department of Historic Resources (VDHR) on May 25,2022, and has requested their concurrence. On June 22, 2022, VDHR concurred that no further identification efforts are warranted. VDHR and appropriate Native American tribes will be notified of any artifacts and/or human remains encountered during ground disturbance activities.	Applicable
Clean water Act (CWA)	40 CFR 230.2(b), .10-.12, .20-.32, .41-42,.53, 60l-.77; 33CFR 320.4, 328.2, 330.l(c),330.4	Regulates discharge of dredged or fill material into wetlands. During the identification. screening, and evaluation of alternatives, the effects on wetlands must be evaluated, and adverse impacts on wetlands are to be avoided. No activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available. If there is no other practicable alternative, impacts must be mitigated. Substantive aspects of the Section 404 regulations are applicable. Potentially applicable to sediment remediation (excavation, removal, and stream restoration) and capping alternatives that require placement of materials into the wetland areas to achieve a proper grade for the cap.	Applicable

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Coastal Zone Management Act	Section 307(c) of 16 U.S.C.1456(c); 15 CFR 930.30 to 34; .36(c), and .39(b-d)	Requires adequate provision for protection of fish and wildlife resources when any modification of any stream, wetland, or other water body is proposed. Applicable to sediment remediation if treatment or excavation is selected. Under Section 301(c)(l)(A), a federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner that is consistent to the maximum extent practicable with the enforceable policies of approved state management programs.	Not Applicable
Endangered Species Act	16 U.S.C.1531 50 CFR 200 and 402	Protects endangered species and threatened species and preserves their habitat. Requires coordination with federal agencies for migration of impacts. These requirements are not applicable because threatened and endangered species or critical habitats have not been found at the CDL Site, but threatened and endangered species (e.g., Delmarva Peninsula Fox Squirrel and piping plover) are known to exist nearby. The CDL site is also overflown by numerous migratory birds that may temporarily use this area. The coordination aspects of this act are relevant and appropriate.	To be considered
Fish and Wildlife Coordination Act	16 U.S.C. 661-663; 40 CFR Part 6, Appendix A. excluding Sections 6(a)(2), 6(a)(4), and 6(a)(6); 40 CFR 6.302[a]	Establishes provisions for protection of fish and wildlife resources and requires consultation with federal authorities if modifications of streams or other water bodies are required. Activities conducted for the CDL Site, including capping, may impact fish or wildlife resources or modify streams or other water bodies. This regulation is directly applicable to potential sediment remedies for the CDL Site. Excavation or treatment of sediment will have temporary impacts, and construction of a cap/cover for the CDL site will require fill to be placed over some parts of the wetland to achieve a proper grade. This regulation is not applicable to excavation of the landfill and soil activities.	To be considered
Migratory Bird Treaty Act	16 U.S.C. 703	Provides protection for migratory bird species, including many passerines. Prohibits killing or taking of any bird or any part, nest, or egg of any such bird. Protects almost all species of native birds in the United States from unregulated taking, which can include poisoning at hazardous waste sites. Migratory birds are known to frequent the area surrounding the CDL Site, and the CDL Site is located within the Atlantic Migratory Flyway. Destruction of habitat can be viewed as taking, and any site area undergoing construction activities must be determined to be free of the nest of the applicable species.	To be considered

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
		State Requirements	
Wetlands Management Program/ Wetlands Mitigation-Compensation Policy	Virginia Administrative Code 28.1-1300 to 1320; 4VAC20-390-10 to 50	This policy encourages, where appropriate, the compensation of all permitted tidal wetland losses, especially vegetative losses, provided that all mitigative measures have been considered to avoid any impact. Requires preservation of tidal wetlands, prevention of their destruction, and accommodation of necessary economic development in a manner consistent with wetlands preservation goals. The capping alternative has the potential for sediment disturbance. To mitigate ecological risk would include restoration strategies so there is no net loss of wetlands. This regulation is not applicable to excavation of the landfill and soil.	Not Applicable
Wetlands Policy	9VAC25-380	These regulations contain procedures and restrictions for siting wastewater treatment plants, controlling construction activities, and controlling nonpoint sources to prevent discharges that impair the quality of a wetland area. Alteration in quantity or quality of the natural flow of water, which nourishes the ecosystem, should be minimized. Portions of 9VAC25-380 pertaining to wastewater treatment siting and operations are not applicable. Portions pertaining to impacts from construction and restoration activities in or near wetlands are potentially applicable. Direct discharges are not part of any of the considered remedial alternatives. This regulation is not applicable to excavation of the landfill and soil.	Not Applicable
Water Resources Policy	9VAC25-390	This policy restricts construction in floodplains and requires minimizing the destruction, loss, or degradation of wetlands and surface water resources to assure water quality and quantity (i.e., Virginia's water resources) needs are met at all times. Portions of 9VAC25-390 pertaining to groundwater, navigable waters, and potable use reservoirs and surface water bodies are not applicable. Portions pertaining to impacts on wetlands from remedial action construction and restoration activities are potentially applicable. Also see evaluation of Virginia’s Wetland Policy, above. This regulation is not applicable to excavation of the landfill and soil.	Not Applicable

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Endangered Species Act Regulations	4VAC15-20-130 to 140	These regulations from the Department of Game and Inland Fisheries prohibit the taking of endangered species. The cited regulations provide listings of endangered species and definitions of actions that constitute taking. If remediation could potentially affect an endangered species, these regulations would apply. However, threatened and endangered species or critical habitats have not been found at the CDL Site, but threatened and endangered species (e.g., Delmarva Peninsula fox squirrel and piping plover) are known to exist nearby. The CDL Site is also overflown by numerous migratory birds that may temporarily use this area. Requirements to coordinate with state agencies to confirm that these species are not impacted are applicable and relevant. Virginia regulates more species than do federal regulations.	To be considered
Endangered Plant and Insect Species Act Regulations	2VAC5-320-10	These regulations from the Department of Game and Inland Fisheries prohibit the taking of endangered plant and insect species. If a site investigation or remediation could potentially affect an endangered species, these regulations would apply. However, threatened and endangered species or critical habitats have not been found at the CDL Site, and no endangered plants or insects have been recognized nearby (except Seabeach Amaranth Plant, which only occurs as a barrier island plant). Requirements to coordinate with state agencies to confirm that these species are not impacted are applicable and relevant. Virginia regulates more species than do federal regulations.	To be considered

Acronyms:
ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations.
E&SC - Erosion and Sediment Control
TBC - To Be Considered
U.S.C. - United States Code
USEPA - United States Environmental Protection Agency
VAC - Virginia Administrative Code

Table 3-7: Action-Specific ARARs and TBC Guidance for the NTCRA at the Construction Debris Landfill, Wallops Flight Facility, Virginia

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
		Federal Requirements	
National Ambient Air Quality Standards	40 Code of Federal Regulations (CFR) 50.4-50.12	Establishes standards for ambient air quality to protect public health and welfare (Including particulate matter and lead). Not applicable because only "major sources" are subject to requirements related to attainment of National Ambient Air Quality Standards (NAAQS). Emissions from Comprehensive Environmental Response, Compensation. and Liability Act (CERCLA) activities are not expected to qualify as "major." Each state has the primary responsibility for assuring that NAAQS are attained and maintained through the state implementation plan (SIP). State SIP requirements become federal requirements by means of the SIP approval process. Therefore, federal NAAQS are not relevant and appropriate. State requirements approved through the SIP process are potentially applicable or relevant and appropriate requirements (ARARs). Moreover, states may delegate authority to regional or local air programs for SIP requirements. Any regional or local air program requirements that are a part of a SIP under the Clean Air Act (CAA) are considered potential ARARs.	Not Applicable, Relevant or Appropriate
National Pollutant Discharge Elimination System (NPDES)	40 CFR 122	Establishes permitting requirements for the discharge of pollutants from any point source into waters of the United States and establishes criteria and standards for technology-based treatment of discharges. Potentially applicable for on-site remedies that use treatment and discharge because these types of cleanup activities could be considered “direct discharges" from a point source under the Clean Water Act (U.S. Environmental Protection Agency [EPA) 1988, pp. 3-6 to 3-7). Also, man-made drainage ditches at the CDL Site (e.g., SD-2 to SD-9) are point sources, and site run-off following remedial action would trigger the requirements. The compliance point is at the mouth of the drainage ditch where it leaves the site; substantive NPDES requirements include discharge limitations, monitoring requirements, and best management practices.	To be Considered

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Technology-based effluent limitations	Clean Water Act (CWA) part 301(b)	Establishes guidelines to determine effluent standards based on the best available technology (BAT) that is economically achievable. Potentially applicable for on-site remedies that use treatment and discharge because these types of cleanup activities could be considered "direct discharges" from a point source under the Clean Water Act (EPA 1988, pp. 3-6 to 3-7).	To be Considered
Ocean Discharge Regulations	40 CFR Part 227, Subpart G	Establishes limiting permissible concentrations for solid, liquid, and suspended particulate phase of a discharge at the mixing zone boundary. Potentially applicable for on-site remedies that use treatment and discharge because these types of cleanup activities could be considered "direct discharges" from a point source under the Clean Water Act (EPA 1918, pp. 3-6 to 3-7).	To be Considered
Resource Conservation and Recovery Act (RCRA) Flood Plain Regulations	40 Code of Federal Regulations (CFR) 260-264	Regulates the operation, transportation, and the treatment, storage, and disposal of hazardous material. Also regulates construction, design, monitoring, operation, and closure of hazardous waste facilities. The regulations restrict these activites from occurring on floodplains. Remedial activities will not constitute operation of a treatment, storage, and disposal (TSD) facility. There is no potential for hazardous wastes to be generated as a result of implementing a remedy for the site and so is not applicable. Site activities for remedial alternatives are not expected to generate hazardous materials requiring transportation or require the operation of a TSD facility and no hazardous wastes were identified during the remedial investigation.	Not Applicable
RCRA Regulations, Land Disposal Restrictions (LDRs)	40 CFR Part 268	This regulation prohibits the land disposal of untreated hazardous wastes and provides criteria for treatment of hazardous waste prior to land disposal. Applicable to off-site disposal of soil or sediment that meets the definition of a hazardous waste. Remedial actions that involve treating and re-depositing hazardous soils and sediment or by-product of treatment process must comply with LDRs.	To be considered
Municipal Solid Waste Landfill Regulations	40 CFR 258	Establishes design and operating criteria for solid waste (nonhazardous) landfills. These criteria do not apply to municipal solid waste landfill units that do not receive waste after October 9, 1991. These requirements would be relevant and appropriate for landfill closure and post-closure care.	To be considered

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Occupational Safety and Health Administration (OSHA)	29 USC Sect. 651-678	Regulates worker health and safety. Requirements of the act apply to response actions under the National 0il and Hazardous Substances Pollution Contingency Plan (NCP). OSHA exposure limits are developed for 8-hour worker exposures. OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) requirements also apply to field crews conducting remedial action activities. This regulation is applicable for the site activities during implementation of remedial alternatives.	Applicable
		State Requirements	
Erosion and Sediment Control	Section 4VAC50-30-40 of the Virginia Erosion and Sediment Control Regulations	This regulation is applicable when excavation, backfilling, and regrading of soil is contemplated. It establishes procedures to prevent erosion through runoff and discharge of sediment in water bodies. Construction projects that disturb in excess of 10,000 square feet or more than 100 cubic yards of earth must prepare (and apply controls in accordance with) an erosion and sediment control (E&SC) plan and retain a copy of the E&SC plan at the construction site (Section 4VAC50-30-40 of the Virginia Erosion and Sediment Control Regulations).	Relevant and Appropriate
Particulate Matter from Materials Handling and Construction	9VAC5-40-90	This regulation mandates that reasonable precautions (e.g., dust control measures) to prevent particulate matter from becoming airborne must be undertaken during construction.	Relevant and Appropriate
Virginia Waste Management Act and Solid Waste Management Regulation	9VAC20-81	These regulations establish standards and procedures pertaining to the management of solid wastes by providing the requirements for siting, design, construction, operation, maintenance, closure, and post-closure care of solid waste management facilities. These regulations would apply if waste on-site needed to be stored, transported, or disposed of.	To be considered

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Virginia Open Dump Regulations	9VAC20-81-45, 160 and 170	Prohibits operation of an open dump on which any solid waste is placed, discharged, deposited, injected, dumped, or spilled so as to create a nuisance or present a threat of a release of harmful substances into the environment or present a hazard to human health. These criteria do not apply to waste sites that are undergoing a CERDA or RCRA remediation under Virginia Department of Environmental Quality (VDEQ) supervision per 9VAC20-81-45B, 2 (f). Closure and post-closure requirements are relevant and appropriate. Because the waste material is located at the groundwater discharge area to surface water, there is no further potential for migration of the contaminants to the uppermost aquifer, groundwater monitoring requirements under 9VAC20-81-250 are not ARARs.	To be considered
State Water Control Law	Va. Code Ann. §62.1- 44-2 to 62.1-44.34:28	Prohibits discharges of waste to the waters of the state and excavation of a wetland or new activities that cause significant alteration or degradation of existing wetland acreage or functions, except as authorized by permit. Only applicable to potential sediment removal within wetlands and discharge of impacted groundwater to surface water.	Not Applicable
Virginia Pollutant Discharge Elimination System Permit Regulation	9VAC25-31	This regulation governs the discharge to surface waters that must meet site-specific effluent limits. These regulations would apply to potential remedial activities that involve discharges to surface water. Defines allowable concentrations of contaminant discharges to Little Mosquito Creek. May be relevant to capping the landfill.	To be considered
Virginia Water Quality Standards - Anti-degradation Policy	9VAC25-260-30	Mandates the protection of existing high quality state waters and provides for the restoration of all other state waters to such condition of quality that any such waters will permit all reasonable public uses and will support the propagation and growth of all aquatic life that might reasonably be expected to inhabit them. Remedial actions at the CDL Site address upland soil contamination, not wetland, sediment, or surface water. Engineering controls (e.g., erosion and sediment control, booms and temporary dams/dikes, off-site disposal of liquids from dewatering excavation areas, off-site disposal of decanted sediment water) will be used during any remedial action construction and restoration activities to prevent or minimize wetland surface water quality issues	Relevant and Appropriate

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Virginia Storm Water Management Act Regulation	Va. Code Ann §10.1- 603.1 to 603.15 4VAC50-60-10 to 240	Establishes requirements for discharges of storm water that will protect surface water of the state. These regulations are applicable because NASA has a formal storm water management program under these regulations and the CDL Site is not exempt. Remedial actions would consider the impact of the discharge of storm water (e.g., runoff from a capped area).	Relevant and Appropriate
Virginia Erosion and Sediment Control Act Regulations	Va. Code Ann.§10.1- 560 to 571 4VAC50-30-10 to 110	Establishes requirements for erosion control to protect surface water of the state. These regulations are applicable because NASA has a formal erosion and sediment control management program under these regulations, and the CDL Site is not exempt. Remedial actions would consider the impact of soil erosion and sediment control during implementation of the remedy and afterwards.	Relevant and Appropriate
Virginia Water Protection Permit Regulation	9VAC25-210 to 260	This regulation delineates the requirements applicable to activities such as dredging, filling or discharging pollutants into, or adjacent to, surface waters (the Commonwealth's definition of surface waters includes wetlands). The requirements of the regulation are in addition to those that may be found In a U.S. Army Corps of Engineers§ 404 permit. These regulations would apply to remedial activities that involve dredging or discharges, which will not occur during the removal of the waste at the CDL and do not apply.	Not Applicable
Virginia Wastewater Treatment Requirements	9VAC25-260-5 to 550	Establishes basic wastewater treatment requirements of effluent discharge on a site-by-site basis. Potentially applicable if the remedial actions involved point source discharges.	Not Applicable
Virginia Pollution Abatement (VPA) Discharge of Pollutants Requirements	9VAC25-32-10 to 300	Establishes standards for the discharge of pollutants adjacent to state waters including underground waters. Applicable to surface run-off, which is collected or channeled by man; discharges through pipes, sewers, or other conveyances, such as culverts passing below the National Oceanic and Atmospheric Administration access road; and man-made drainages at the CDL Site.	Relevant and Appropriate

Standards, Requirements, Criteria, or Limitations	Citation	Synopsis	Status
Virginia Ambient Air Quality Standards	9VAC5-30-10 to 80	These rules establish ambient air quality standards and air emission standards from disturbance of soil at a site or from treatment of soil or water or from other pollutant management activities. Although these regulations are only directly applicable to industrial polluters, these requirements are relevant and appropriate for a remedial action that could result in release of regulated contaminants to the atmosphere, such as may occur during air stripping or excavation.	Relevant and Appropriate
Virginia Fugitive Dust Regulations	9VAC5-50-90	These regulations require precautions to be taken to prevent particulate matter from becoming airborne during disturbance of soil or treatment activities. Applicable to excavation, grading, or other construction activities on-site.	Relevant and Appropriate

Acronyms:
ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations.
E&SC - Erosion and Sediment Control
TBC - To Be Considered
U.S.C. - United States Code
USEPA - United States Environmental Protection Agency
VAC - Virginia Administrative Code

Table 4-1: Present Value Cost Estimate for Alternative 2

Alternative 2: Excavation of Waste and Affected Soil with Offsite Disposal

Summary: This alternative consists of excavation and offsite disposal of all accessible waste and affected soil and backfilling with clean fill

Approximate Timeframe : 3 months for plan approval, 5 months for implementation.

Site : Wallops Flight Facility (WFF) Construction Debris Landfill (CDL)

*Phase: Engineering Evaluation / Cost Analysis (*EE/CA)

Date : March 2022

1. Existing vegetation would be removed along with the waste and affected soil and imported general fill would be placed to backfill to the current grade and provide a minimum slope of 4% for drainage.
2. Disturbed areas would be restored with vegetative cover.
3. An access road for NOAA traverses this area. The bituminous concrete roadway will need to be supported, and utilities that are located on either side of the roadway will need to be maintained during excavation. Power and communication lines run parallel to the access road east and west of the road. The contractor will be required to identify the exact location and elevation of utility lines, expose the lines, and employ engineering controls (shoring) to minimize the risk of damaging the utility lines and disrupting electrical and/or data service to NOAA and/or posing a hazard to workers.

Assumptions:

1. Area of CDL waste and affected soil = 72,925 sq. ft = 2,701 sq. yd. = 1.7 acres.
2. Estimated volume of CDL waste and affected soil = 7,450 yds3
3. Swelling factor for soils is assumed to be 30%
4. Assumes 1 week to install E&SC measures, 3 months to complete the excavation, 1 month to backfill, and 1 month for site restoration

DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL COST	ESTIMATE/SOURCE NOTES
CAPITAL COSTS					
Pre-Excavation Characterization Soil Sampling					
Drill Rig Mobilization	1	Lump Sum	$3,000.00	$3,000.00	Driller to mobilize equipment and personnel to the site.
Drill Rig Day Rate	3	Day	$2,000.00	$6,000.00	Collect 12 samples from different portions of the CDL in order to characterize the waste and soil for disposal.
Site geologist	38	Hour	$100.00	$3,800.00	Assume 3 10-hr days plus prep time
Waste Characterization Sampling (for disposal facility	15	Each	$1,800.00	$27,000.00	Assume 12 samples for full suite plus 1 dupe, 2 equipment blanks, 1 MS/MSD
Subtotal				$39,800.00	
Planning, Surveying, and Mobilization					
Construction documents	1	Lump Sum	$42,000.00	$42,000.00	
Topographic survey	2	Day	$1,500.00	$3,000.00	Assumes detailed field survey to determine current grades and conditions, based on professional experience of similar projects
Mobilization (10% of cost for field tasks)	10%	Percent	$1,778,173.15	$177,817.32	
Subtotal				$222,817.32	
Site Preparation					
Utility Locate Mob/Demob to clear site prior to field work	1	Each	$1,200.00	$1,200.00	Professional experience and accumulation of cost for similar projects. projects.
Utility Locate to clear site prior to field work	2	Day	$1,550.00	$3,100.00	Vendor Rate; utility locate necessary to break ground and begin work at site.
Establish Staging and Laydown Area	1	Lump Sum	$5,000.00	$5,000.00	Professional experience and accumulation of cost for similar projects.
Silt fence	500	LF	$5.00	$2,500.00	Perimeter super silt fence installed as E&S control
Stabilized construction entrance	1	Each	$5,000.00	$5,000.00	Professional experience and accumulation of cost for similar
Clear and Grub	0.25	Acre	$5,000.00	$1,250.00	Unusable vegetation/stumps will be disposed of offsite at a C&D landfill. R.S. Means (2018)
Clean Fill Sampling	4	Each	$750.00	$3,000.00	1 sample per 2000 CY import soil
Subtotal				$21,050.00	
Excavation					
Dust Control and Air Monitoring	100	Day	$1,200.00	$120,000.00	Equip, labor, shipping, office support. Assume 5 months air monitoring for excavation work to post-confirmatory sampling.
Excavation	9685	Cubic Yard	$8.45	$81,838.25	Professional experience and accumulation of cost for similar projects.
Backfill	11622	Cubic Yard	$8.45	$98,205.90	Professional experience and accumulation of cost for similar projects.
Topsoil	450	Cubic Yard	$35.00	$15,750.00	Based on an 6-inch-thick layer over the cover surface area. Account for swell factor and assumes procurement and installation.
Subtotal				$315,794.15	
Soil Disposal					
Transportation and Offsite Disposal (RCRA C non-haz)	14528	Ton	$98.00	$1,423,744.00	Professional experience and accumulation of cost for similar projects.
Site Restoration					
Hydroseed	72925	Square Foot	$0.20	$14,585.00	The entire site would be restored with permanent grass seed within the growing season.
Survey	2	Day	$1,500.00	$3,000.00	Final survey for as-built.
Roadway, power, and communication line	0			$0.00	Be aware of location.
Subtotal				$1,441,329.00	
Subtotal of Field Tasks				$2,000,990.47	
Contingency	25%	Percent	$2,040,790.47	$510,197.62	
Subtotal				$510,197.62	
Project Management	10%	Percent	$2,550,988.08	$255,098.81	
Construction Management	8%	Percent	$2,550,988.08	$204,079.05	
Information/Database Management	3%	Percent	$2,550,988.08	$76,529.64	
Land Use Controls					
Institutional Controls Plan	1	Each	$5,000.00	$5,000.00	
Groundwater use restrictions	1	Each	$5,000.00	$5,000.00	
Subtotal				$10,000.00	

Table 4-1: Present Value Cost Estimate for Alternative 2

Post Construction					
After Action Report	1	Lump Sum	$25,000.00	$25,000.00	Professional experience for similar projects.
Subtotal				$25,000.00	
TOTAL CAPITAL COSTS				$3,121,695.58	
ANNUAL OPERATION AND MAINTENANCE COSTS					
		Year 1-5			
		Year 6-30			
PERIODIC COSTS					
Five Year Review	1	Each	$8,000.00	$8,000.00	Inspection, reporting, minor maintenance. Assume an event every 5 yrs. over 30 years.
Repair	1	Each	$3,000.00	$3,000.00	Repair of minor erosion to consist of importing fill, reseeding. Assume an event every 5 years over 30 years
TOTAL PERIODIC ANNUAL COSTS				$11,000.00	
PRESENT VALUE ANALYSIS	Year	Total Cost	Total Cost per Year	Discount Factor at 1.5%	Present Value
Cost Type					
Capital Cost	0	$3,121,696	$3,121,695.58	0.9965	$3,110,885.25
Annual O&M Cost	1-5	$0.00	$0.00	4.9483	$0
Annual O&M Cost	5-30	$0.00	$0.00	23.4940	$0
Periodic Cost	5	$11,000	$11,000.00	0.9828	$10,810.85
Periodic Cost	10	$11,000	$11,000.00	0.9659	$10,624.96
Periodic Cost	15	$11,000	$11,000.00	0.9493	$10,442.26
Periodic Cost	20	$11,000	$11,000.00	0.9330	$10,262.70
Periodic Cost	25	$11,000	$11,000.00	0.9169	$10,086.23
Periodic Cost	30	$11,000	$11,000.00	0.9012	$9,912.79
Total Present Value of Alternative					$3,173,025.03

Notes:

Lump Sum Unit Costs are based on AECOM project experience of similar size and nature and engineering judgment. Additional costs associated with specific project location and working calendar were Individual Unit Costs (i.e. each, tons, cubic yards) based on executed construction bid documents (for other AECOM recent projects), vendor quotes and costing tools (e.g., RS Means). Thirty-Year Real Discount Rate obtained from OMB Circular No. A-94, Last Revision November 2016.

Acronyms:

% - percent
CY - cubic yard
LF - linear feet
O&M = operation and maintenance
SF = square feet
SY = square yard

Table 4-2: Present Value Cost Estimate for Alternative 3

Alternative 3: Impermeable Cover with LUCs, LTMgt, and LTM

Summary : This alternative consists of an impermeable cover with long term management (LTMgt), land use controls (LUCs), and long term monitoring (LTM).

Approximate Timeframe : 12 months for plan approval, 2 months for implementation, and 30 years of long-term monitoring

Site : CDL

Phase : EE/CA

Date : March 2022

1. This alternative assumes a Subtitle D compliant cap within the CDL Limits.
2. Existing vegetation would be removed and imported general fill would be placed to achieve a uniform subgrade for the soil cover and provide a minimum slope of 4%.
3. The cap would consist of a geomembrane cushion layer, a geomembrane liner system, a 6-inch-thick granular drainage layer, and a 2-foot-thick vegetated soil layer.
4. Disturbed areas would be restored with vegetative cover.
5. Following construction completion, a groundwater and soil gas LTM regimen would be initiated.
6. Periodic inspections and landfill cover maintenance would be conducted to ensure the integrity of the landfill cover and surrounding side slopes.

Assumptions:

1. Area of CDL = 72,925 sq. ft = 2,701 sq. yd. = 1.7 acres; cover perimeter = 1,000 linear feet.
2. Swelling factor for soils is assumed to be 30%
3. Geomembrane and geotextile quantity determined by area of CDL times a contingency of 15%.

DESCRIPTION	QUANTITY	UNIT	RATE	TOTAL COST	ESTIMATE/SOURCE NOTES
CAPITAL COSTS					
Remedial Design/Plans/Permits					
Remedial Design	1	LS	$52,500.00	$52,500.00	Design of cover, drainage channels, and catch/sediment basins.
Land Use Control Implementation Plan	1	LS	$12,000.00	$12,000.00	Assumes deed restrictions for certain structures on the landfill and for nonpotable use of shallow groundwater.
Long Term Monitoring Plan	1	LS	$12,000.00	$12,000.00	Assumes sampling 10 wells and 4 soil gas points twice a year.
HASP	1	LS	$8,000.00	$8,000.00	Health and Safety Plan to cover the field tasks included below.
Erosion and Sediment Control Plan	1	LS	$25,000.00	$25,000.00	Assumes silt fence and drainage channels to control erosion.
Subtotal				$109,500.00	
Site Preparation					
Utility Locate Mob/Demob	1	Each	$175.00	$175.00	Professional experience and accumulation of cost for similar projects.
Utility Locate to clear site prior to field work	1	Day	$1,550.00	$1,550.00	Vendor Rate; utility locate necessary to break ground and begin work at site.
Topographic survey	2	Day	$1,500.00	$3,000.00	After grade attained, topo survey to determine final elevations, place grade stakes on 50' grids Assumes detailed field survey to determine current grades and conditions, based on professional experience of similar projects.
Establish Staging and Laydown Area	1	Lump Sum	$10,000.00	$10,000.00	Professional experience and accumulation of cost for similar projects.
Silt fence	500	LF	$5.00	$2,500.00	Perimeter super silt fence installed as E&S control
Stabilized construction entrance	1	Each	$5,000.00	$5,000.00	Professional experience and accumulation of cost for similar projects.
Perimeter drainage ditch and sediment basin	500	LF	$25.00	$12,500.00	Professional experience and accumulation of cost for similar projects.
Clear and Grub	0.25	Acre	$5,000.00	$1,250.00	Unusable vegetation/stumps will be disposed of offsite at a C&D landfill
Clean Fill Sampling	2	Each	$750.00	$1,500.00	1 sample per 2000 CY import soil.
Subtotal				$37,475.00	
Installation of Cap					
Geomembrane Liner	83864	Square Foot	$1.00	$83,864.00	Based on 60-mil HDPE, includes 15% additional for waste/trenching/drainage flap. Cost includes procurement, import, and installation.
Cushion Geotextile	83864	Square Foot	$0.60	$50,318.40	16-oz. nonwoven cushion geotextile. Includes 15% additional for waste/trenching/drainage flap. Cost includes procurement, import, and installation.
Granular Drainage Layer	450	Cubic Yard	$30.00	$13,500.00	Based on 60-mil HDPE, includes 15% additional for waste/trenching/drainage flap. Cost includes procurement, import, and installation.
Certified Clean Fill	1351	Cubic Yard	$25.00	$33,775.00	Based on an 18-inch-thick layer over the cover surface area. Account for swell factor and assumes procurement and installation.
Topsoil	450	Cubic Yard	$35.00	$15,750.00	Based on an 6-inch-thick layer over the cover surface area and 0.4 acres of wetlands 6- inches deep. Account for swell factor and assumes procurement and installation.
Hydroseed	72925	Square Foot	$0.20	$14,585.00	Hydroseed impacted areas using native soil mixes as recommended for LF cover
Subtotal				$211,792.40	
Site Restoration					
Survey	2	Day	$1,500.00	$3,000.00	Final survey for as-built.
Roadway, power, and communication line				$0.00	Be aware of location.
Subtotal				$3,000.00	
Subtotal of Field Tasks				$252,267.40	
Contingency	25%	Percent	$361,767.40	$90,441.85	
Subtotal				$90,441.85	
Project Management	10%	Percent	$452,209.25	$45,220.93	
Remedial Design	15%	Percent	$452,209.25	$67,831.39	
Construction Management	8%	Percent	$452,209.25	$36,176.74	
Land Use Controls					
Institutional Controls Plan	1	Each	$5,000.00	$5,000.00	
Groundwater use restrictions	1	Each	$5,000.00	$5,000.00	
Subtotal				$10,000.00	
Post Construction					
Contractor Completion Report	1	LS	$30,000.00	$30,000.00	
Remedial Action Completion Report	1	LS	$25,000.00	$25,000.00	
Subtotal				$55,000.00	
TOTAL CAPITAL COSTS				$666,438.30	

Table 4-2: Present Value Cost Estimate for Alternative 3

OPERATION AND MAINTENANCE (O&M) COSTS (Annual)					
Long Term Soil Gas and Groundwater Monitoring (2 rounds per year)					
Monitoring Well Low Flow Sampling Rental Equipment	2	Days	$425.00	$850.00	Daily rental for 2 units because of 2 field teams.
Sampling Staff	45	Hr	$75.00	$3,375.00	10 wells, assume 5 wells per 2-man crew per day.. 8 soil gas points, assume 8 points per 1-man crew per 1/2 day..
Laboratory Analyses (VOC, metals, SVOCs)	14	Samples	$206.00	$2,884.00	Assume 10 wells each round plus 1 dupe, 2 equipment blanks, 1 MS/MSD.
Purge Water IDW Disposal	2	LS	$200.00	$400.00	Assumes 2 drums of IDW water.
Data Validation	1	LS	$1,000.00	$1,000.00	
Landfill Gas Sampling Equipment Rental	1	LS	$225.00	$225.00	Daily rental for 1 unit.
Sampling Staff	4	Hr	$75.00	$300.00	Assumes 4 soil gas points, 1-man crew per 1/2 day. .
Laboratory Analyses (methane and helium)	5	Samples	$260.00	$1,300.00	Assume 4 soil gas sample points each round plus 1 dupe.
Data Validation	1	LS	$500.00	$500.00	
Subtotal				$10,834.00	
Subtotal per year assuming 2 events per year				$21,668.00	
Landfill Cap Inspections					
Annual Inspection	1	Each	$500.00	$500.00	1 person, site walk to identify areas of erosion, ponding water, exposed trash or violations of the LUCs
Annual Mowing	1	Each	$2,000.00	$2,000.00	Professional experience and accumulation of cost for similar projects.
Removal of Waste along Side Slopes / Repairs	1	Each	$1,000.00	$1,000.00	Professional experience and accumulation of cost for similar projects.
Subtotal				$3,500.00	
Project Management	10%	Percent	$25,168.00	$2,516.80	
Technical Support	8%	Percent	$25,168.00	$2,013.44	
Information/Database Management	3%	Percent	$25,168.00	$755.04	
Annual Reporting	1	LS	$10,000.00	$10,000.00	
Total Annual Operation and Maintenance (O&M) Costs				$29,619	
PERIODIC COSTS					
Five Year Review	1	Each	$15,000	$15,000.00	Inspection, reporting, minor maintenance. Assume an event every 5 yrs. over 30 years.
Erosion Repair	1	Each	$6,000	$6,000.00	Repair of minor erosion to consist of importing fill, reseeding, and also repair of LUCs (e.g., replace signage). Assume an event every 5 yrs. over 30 years.
LUC Sign Repair	1	Each	320	$320.00	Repair of one LUC sign includes costs for a new sign and labor to install it. Assume 1 sign every 5 yrs.
Total Periodic Annual Costs				$21,320	
PRESENT VALUE ANALYSIS (calculated up to year 30)					
	Year	Total Cost	Total Cost per Year or 5 Years	Discount Factor at	Net Present Value
Cost Type				0.4%	
Capital Cost	0	$666,438	$666,438	0.9936	$662,192
Annual O&M Cost	1-5	$29,624.28	$29,619	4.8746	$144,407
Annual O&M Cost	6-30	$740,482.00	$29,619	0.8608	$637,381
Periodic Cost	5	$21,320	$21,320	0.9685	$20,649
Periodic Cost	10	$21,320	$21,320	0.9381	$20,000
Periodic Cost	15	$21,320	$21,320	0.9086	$19,371
Periodic Cost	20	$21,320	$21,320	0.8800	$18,762
Periodic Cost	25	$21,320	$21,320	0.8523	$18,172
Periodic Cost	30	$21,320	$21,320	0.8255	$17,600
TOTAL PRESENT VALUE OF ALTERNATIVE					$1,558,534

Notes:

Lump Sum Unit Costs are based on AECOM project experience of similar size and nature and engineering judgment. Additional costs associated with specific project location and working calendar were accounted for.

Individual Unit Costs (i.e. each, tons, cubic yards) based on executed construction bid documents (for other AECOM recent projects), vendor quotes and costing tools (e.g., RS Means).

Thirty-Year Real Discount Rate obtained from OMB Circular No. A-94, Last Revision November 2016.

Acronyms:

% - percent

CY - cubic yard

LF - linear feet

MS/MSD matrix spike/matrix spike duplicat

O&M = operation and maintenance

SF = square feet

SY = square yard