# Record of Decision

## Former Fire Training Area and DAACG Chlorinated Solvents Area (HAA-01)
## Hunter Army Airfield, Georgia

**October 2021**
**Version: Final**

*Prepared for*

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**And**

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# Record of Decision

## Former Fire Training Area and DAACG Chlorinated Solvents Area (HAA-01)

## Hunter Army Airfield, Georgia

Acknowledgment and Concurrence for remedial actions to be implemented at HAA-01:

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|---|---|
| ______________________ | 11 MAY 2022 |
| MANUEL F. RAMIREZ<br>Colonel, MI<br>Commanding | Date |

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## Acronyms

| Acronym | Definition |
|---|---|
| µg/L | Micrograms per Liter |
| AWQC | Ambient Water Quality Criteria |
| ARAR | Applicable or Relevant and Appropriate Requirement |
| AST | Aboveground Storage Tank |
| bgs | Below ground surface |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CSM | Conceptual Site Model |
| COC | Contaminant of Concern |
| COPC | Contaminant of Potential Concern |
| COPEC | Contaminant of Potential Ecological Concern |
| CVOC | Chlorinated Volatile Organic Compound |
| DAACG | Departures/Arrivals Airfield Control Group |
| DCE | Dichloroethene |
| DERP | Defense Environmental Restoration Program |
| DPT | Direct Push Technology |
| ERA | Ecological Risk Assessment |
| ERD | Enhanced Reductive Dechlorination |
| EVO | Emulsified Vegetable Oil |
| ft | Foot or Feet |
| FTA | Fire Training Area |
| g/L | Grams per Liter |
| GAEPD | Georgia Environmental Protection Division |
| HAAF | Hunter Army Airfield |
| HHRA | Human Health Risk Assessment |
| HQ | Hazard Quotient |
| ISCO | In Situ Chemical Oxidation |
| IWQS | Instream Water Quality Standards |
| LNAPL | Light Non-Aqueous Phase Liquid |
| LUC | Land Use Controls |
| MCL | Maximum Contaminant Level |
| mg/kg | Milligrams per kilogram |
| MNA | Monitored Natural Attenuation |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NFA | No Further Action |
| O&M | Operation and Maintenance |
| OU | Operable Unit |
| PAH | Polyaromatic Hydrocarbon |
| PRG | Preliminary Remediation Goals |
| PVC | Poly Vinyl Chloride |
| RA | Risk Assessment |
| RAO | Remedial Action Objective |
| RCRA | Resource Conservation and Recovery Act |
| RI/FS | Remedial Investigation/Feasibility Study |
| RME | Reasonable Maximum Exposure |
| ROD | Record of Decision |
| RSLs | Regional Screening Levels |
| SARA | Superfund Amendments and Reauthorization Act |
| SSL | Soil Screening Level |

| Acronym | Definition |
|---|---|
| SVOC | Semi Volatile Organic Compound |
| TCE | Trichloroethene |
| TMV | Toxicity, Mobility, or Volume |
| TOC | Total Organic Carbon |
| TRV | Toxicity Reference Values |
| USEPA | U.S. Environmental Protection Agency |
| UU/UE | Unrestricted Use/ Unrestricted Exposure |
| VC | Vinyl Chloride |
| VISL | Vapor Intrusion Screening Levels |
| VOC | Volatile Organic Compound |

# 1 DECLARATION

## 1.1 Site Name and Location

Site Name: Former Fire Training Area (FTA) and Departure/Arrival Airfield Control Group (DAACG) Chlorinated Solvents Area at Hunter Army Airfield (HAAF). Collectively, the FTA and DAACG Chlorinated Solvents Area comprise HAA-01 and are considered one site for investigation and remediation purposes.

Site Location: Hunter Army Airfield, Georgia.

## 1.2 Statement of Basis and Purpose

This decision document presents the Selected Remedy for HAA-01, at HAA, Georgia, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this Site, which is available for review at the Department of Public Works Prevention and Compliance Branch, 1550 Veterans Parkway Building 1137, Fort Stewart, Georgia 31314. The State of Georgia supports the Selected Remedy without comment; regulatory approval is included in Appendix A.

## 1.3 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect public health, welfare, or the environment from actual or threatened releases of hazardous substances from this site which may present an imminent and substantial endangerment to public health or welfare. Investigations at the site from 1987 through 2014 have found the FTA to be the primary source of petroleum hydrocarbon impacts at HAA-01. Chlorinated Volatile Organic Compounds (CVOCs) are mainly located in the DAACG area, although a specific source has not been identified. Primary Contaminants of Concern (COCs) in groundwater are cis-1,2-dichlorethene (DCE), vinyl chloride (VC), and benzene. The COC in soil is benzo(a)pyrene, a polyaromatic hydrocarbon (PAH).

## 1.4 Description of Selected Remedy

HAAF is the responsible party for activities at the site and the Georgia Environmental Protection Division (GAEPD) oversees regulatory actions at the Site. The overall cleanup strategy at HAA-01 is to reduce the concentrations of the primary COCs in groundwater at the Site, to allow COCs at lower concentrations in groundwater to naturally attenuate, and to prevent human exposure to COCs in soil by way of a vegetative cap. This strategy is a balance of overall protection of human health and the environment; regulatory compliance; long-term and short-term effectiveness; effective reduction of toxicity, mobility, volume, and/or mass of contaminants; cost effectiveness; implementation; and state/support agency and community acceptance. This strategy of balancing these criteria is consistent with the strategies employed at other sites across HAA (e.g., HAA-15, HAA-17). Performance standards for this remediation include Remedial Action Objectives (RAOs) and Applicable or Relevant and Appropriate Requirements (ARARs).

RAOs for this site include:

*Groundwater:*

1. Reduce potential cancer risk and potential non-cancer health hazards for people (i.e., site workers and construction workers) exposed to cis-1-2DCE and VC in contaminated groundwater by reducing the concentrations of or controlling exposure to these COCs in groundwater.

2. Reduce potential exposure of ecological receptors to COCs in groundwater.
3. Prevent potential for migration of unacceptable levels (in excess of Regional Screening Levels [RSLs] and Maximum Contaminant Levels [MCLs]) of cis-1,2-DCE and VC to off-site locations.
4. Return useable groundwaters to their beneficial use whenever practicable.

*Soil*

1. Reduce potential exposure of construction and site workers to soil in the FTA.

ARARs are divided into three categories: chemical-specific, action-specific, and location-specific requirements.

**Chemical-specific:** Chemical-specific ARARs establish health-based concentration limits, risk-based concentration limits, or ranges for specific hazardous substances in different environmental media that provide media cleanup levels or a basis for calculating cleanup levels for COCs. Chemical-specific ARARs identified for remedial action at the site include USEPA RSLs for soil and USEPA MCLs, and Region 4 Tapwater RSLs for groundwater.

**Location-specific:** Location-specific ARARs set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location (e.g., proximity to wetlands, historic buildings, etc.). The Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil, pond sediment, and surface water, so no location specific ARARs were proposed. HAA-01 will remain a commercial/industrial use property requiring that all remedial alternatives address potential residential exposure to COCs in soil and groundwater through the application of institutional controls.

**Action-specific:** Action-specific ARARs set controls or restrictions on the design, implementation, and performance of actions. These provide a basis for assessing the feasibility and effectiveness of the remedial alternatives by specifying performance levels, actions, or technologies and specific levels for discharge of residual chemicals. Action-specific ARARs identified include air emission standards for any air discharge and compliance with National Pollutant Discharge Elimination System (NPDES) and base requirements for any treated water discharged to proximate canals.

The proposed action will reduce the risk associated with exposure to contaminated groundwater above Preliminary Remediation Goals (PRGs). For site groundwater, HAAF has established the following PRGs in accordance with calculated Health Based Goals and United States Environmental Protection Agency (USEPA) MCLs:

*Groundwater*
VOCs
Benzene – 5 micrograms per Liter (µg/L)
cis-1,2-DCE – 70 µg/L
VC – 2 µg/L

For Site soil, HAAF has established the following PRGs based on calculated Health Based Goals:

*Soil*
Benzo(a)pyrene – 2.11 milligrams per kilogram (mg/kg).

The selected remedy includes Enhanced Reductive Dechlorination (ERD) to enhance reduction of CVOCs in groundwater in the DAACG area. Injections of emulsified vegetable oil (EVO) will provide a long-lived source of organic carbon to promote of degradation of CVOCs. Injections will target the area with elevated

CVOC concentrations (1,000 µg/L of cis-1,2-DCE, 10-100 µg/L of VC) to address the primary source in groundwater. A vegetative cover will be maintained to prevent direct contact with contaminants in soils around the former FTA.

The selected remedy for groundwater includes:

- ERD
    - Enhances mass removal of CVOC-impacted groundwater
    - Involves injections of EVO via a network of injection wells
    - Promotes degradation of CVOCs
- Monitored Natural Attenuation (MNA)
    - Some residual COCs will naturally degrade or attenuate
    - Natural attenuation of residual VOCs and environmental characteristics that enhance degradation are monitored to ensure attenuation continues or to determine if additional intervention is required.
    - MNA will be utilized in areas other than those with elevated CVOC concentrations.
- Land Use Controls (LUCs)
    - Onsite LUCs enforced by HAAF will prohibit installation of water wells within or downgradient to the source area.
- Long Term Monitoring
    - Controls the remaining risk/hazards associated with any COCs that remain in excess of unrestricted use.
    - Included in the HAA Base Master Plan

The selected remedy for soil includes:

- Vegetative cover.
    - Compacted soil with grassy cover to prevent direct contact with impacted soils.
- LUCs
    - LUCs will ensure the site will not be used for residential purposes until it can be demonstrated that soil concentrations have declined below applicable PRGs.

## 1.5 Statutory Determinations

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

The remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment), in that the selected remedy for groundwater utilizes treatment as a principal element.

Because it is anticipated to take more than five years to attain RAO and cleanup levels, a policy review may be conducted within five years of construction completion for the site to ensure that the remedy is, or will be, protective of human health and the environment.

## 1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD.
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy (i.e., description of how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision.)

## 1.7 Authorizing Signatures and Support Agency Acceptance of Remedy

The State of Georgia supports the Selected Remedy without comment; regulatory approval is included in Appendix A.

# 2 DECISION SUMMARY

## 2.1 Site Name, Location, and Description

The Site is located at HAAF in Savannah, Georgia. The FTA and DAACG Chlorinated Solvents Area at Hunter Army Airfield comprise the Site, HAA-01, and are considered one site for investigation and remediation purposes. HAA is the responsible party for site activities, and the GAEPD oversees regulatory actions for this site. HAA-01 is an Operable Unit (OU) within HAAF, managed under CERCLA by the Army with regulatory oversite by the GAEPD.

HAAF is an active military installation located in Savannah, Georgia that contains areas of industrial, commercial, and temporary residential properties. HAA-01 is located in the northwestern portion of HAAF, west of the flight line. A Site Location map is shown on **Figure 2-1**, and a Site Features map is shown on **Figure 2-2**.

The Former FTA comprised a gravel covered concrete fire training pad (approximately 6,400 square foot [ft] area enclosed with a concrete curb), a steel structure that served as a mock aircraft, a 17,000-gallon aboveground storage tank (AST) that stored fuel, a 1,100-gallon AST for storing fuel and solvent contaminated water, and associated underground piping. Typical fire training activities included spraying water contaminated fuels on the mock aircraft, igniting the structure, and extinguishing the burning aircraft. Fire training activities were discontinued at the FTA in 1991 and all components of the FTA were removed in 1998 as part of the soil remediation activities conducted at that time (Pika/Arcadis 2019).

The DAACG is located north of the FTA. During investigation activities into the former FTA in 2000, CVOCs were discovered in a monitoring well in this area. Further investigations in the area and associated historical record searches have not identified a potential source for these CVOCs.

## 2.2 Site History and Enforcement Activities

The Former FTA contained a concrete pad on which fire training exercises were conducted, including dousing a mock aircraft with water contaminated fuels, igniting the aircraft, and extinguishing the burning aircraft. Fire training activities ceased in 1991 and components of the FTA were removed in 1998 as part of the soil remediation activities at the time. Soils and groundwater in the FTA were found to be impacted with metals, petroleum-based Volatile Organic Compounds (VOCs) and semi-volatile organic compounds (SVOCs).

Preliminary assessments of the FTA began in 1987, and metals, PAHs, and phthalates were identified as potential COCs in soil. Investigations at the site continued from 1990 through 2014, and included soil, groundwater, surface water, and sediment sampling. Free product was identified at the FTA in one monitoring well in 1995. Source removals including soil excavation and free product removal were conducted in 1995, 1997-2000, and 2003. The simulated aircraft structure, ASTs, underground piping, and the fire training pad were removed from 1997 to 2000. A free product belt skimmer was installed on HMW-07 and ran until the well was removed in December 2003. The remainder of the soil identified as impacted by free product was removed in 2003. Free product has not been observed at the site since 2003. Groundwater monitoring continued at the Site through 2009, with additional Remedial Investigation/Feasibility Study (RI/FS) sampling events in 2011, 2012 and 2014 (Pika/Arcadis 2019).

These investigations determined the former FTA was likely the primary source of petroleum hydrocarbon impacts in the investigation area. Soil impacts were observed up to 10.4 ft below ground surface (bgs). Groundwater impacts were observed in the shallow surficial aquifer zone at depths up to 15 ft bgs. The highest petroleum-related concentrations were observed in the northern portion of the FTA. Benzo(a)pyrene remains as the driving COC in soil at the FTA, and benzene remains as the driving COC in groundwater, though at relatively low concentrations compared to the DAACG.

During field investigations at the former FTA in 2000, CVOCs were identified in groundwater north of the FTA. This became designated as the DAACG area. CVOCs, primarily cis-1,2-DCE and VC, have been observed in the shallow surficial aquifer zone at depths up to 20 ft bgs. Additional investigations and historical record review have not been successful in identifying the source of the CVOCs in the DAACG area; however, the impacts are fully contained within the DAACG area. Groundwater monitoring at the DAACG was conducted from 2002 through 2009 and again in 2011, 2012, and 2014. Benzene, VC, and cis-1,2-DCE remain as the driving COCs in groundwater at the DAACG (Pika/Arcadis 2019).

## 2.3 Community Participation

The Proposed Plans for HAA-01 were made available to the public in July 2021. They were in the Administrative Record at Fort Stewart, online at the Department of Public Works Prevention and Compliance Branch's webpage, and in the Southern Chatham County Public Library. Notice of availability of the plans was published in the Savannah Morning News and The Frontline prior to the public comment period on June 24 and July 1, 2021, respectively. A public comment period was held from July 14 to August 14, 2021. A public meeting was to be scheduled if requested during the public comment period, but no public meeting was requested. No comments were received during the public comment period.

## 2.4 Scope and Role of OU or Response Action

HAA-01 is an OU covering groundwater and soil impacts at the Site. The planned sequence of actions for HAA-01 is to implement ERD, MNA, and LUCs to manage impacts to groundwater and meet established RAOs. The installation of a vegetative cap over impacted soil is planned to manage exposure risks to impacted soils. HAAF is responsible for implementing remediation at the Site, with regulatory oversite from the GAEPD.

## 2.5 Site Characteristics

The Former FTA contained a concrete pad on which fire training exercises were conducted, including dousing a mock aircraft with water contaminated fuels, igniting the aircraft, and extinguishing the burning aircraft. Fire training activities ceased in 1991 and components of the FTA were removed in 1998 as part of the soil remediation activities at the time. Soils and groundwater in the FTA were found to be impacted with metals, petroleum-based VOCs and SVOCs. The DAACG area was discovered to have CVOC impacted groundwater during investigations of the FTA. While previous investigations and historical record review has not identified the source of the CVOCs observed at the DAACG, the CVOC impacts have been delineated and do not extend beyond HAA-01. The Site with the former FTA, DAACG, and the groundwater monitoring well network is shown on **Figure 2-2**.

### 2.5.1 Conceptual Site Model

The Conceptual Site Model (CSM) identifies the primary sources, primary release mechanism, secondary sources, potential pathways, and receptors. The CSM also identifies potentially complete pathways, wherein there exists a pathway to exposure and known potential receptor present or potentially present at the Site. The CSM is summarized in **Figure 2-3**.

#### 2.5.1.1 Primary Sources and Release Mechanisms

Previous investigations have concluded that historical fire training activities are the most likely source of petroleum related hydrocarbon compounds in soil and groundwater near the former FTA. Releases have potentially occurred from components (e.g., underground pipelines) of the former FTA fuel application system. Excess water and foam generated during fire training exercises involving fuel-soaked aircraft may also have contributed to constituents detected in soils, groundwater, and surface water and sediment through surface runoff and infiltration. PAHs commonly form from incomplete combustion of organic matter. Previous investigations and historical record review have not identified the source of the CVOCs observed at the DAACG, however CVOC impacts are limited to the DAACG.

#### 2.5.1.2 Secondary Sources and Release Mechanisms

*Groundwater*

The highest petroleum-related concentrations in groundwater are in the northern portion of the FTA, with petroleum related impacts in groundwater observed above MCLs in the shallow surficial aquifer zone at depths up to 15 ft bgs. Benzene concentrations in groundwater observed in December 2014 are shown on **Figure 2-4**.

CVOC impacts in groundwater, primarily cis-1,2-DCE and VC, are observed in the shallow surficial aquifer zone beneath the DAACG Area at depths up to 20 ft bgs. Observed CVOC concentrations are most elevated near the center of the DAACG area and are fully contained within the DAACG area. Observed concentrations of cis-1,2-DCE, the primary COC in groundwater at the DAACG, from December 2014 are shown on **Figure 2-5**.

Groundwater may release contaminants through groundwater discharge to other units of groundwater, surface waters, or sediment.

*Soils*

Concentrations of PAHs in exceedance of applicable screening levels have been observed in soils across the former FTA. Surface soils may release contaminants via surface runoff and dust/volatile emissions to air, surface waters, or sediments. Subsurface soils may release contaminants through infiltration/percolation to subsurface soils and groundwater.

#### 2.5.1.3 Pathway - Exposure Medium and Routes

*Groundwater*

Pathway exposure media for groundwater include groundwater (direct), surface water, and sediment. Potential exposure routes for these media include ingestion, direct contact/uptake, or food chain exposure to groundwater; ingestion, dermal contact, inhalation of vapors, direct contact/uptake, and food chain exposure for surface water; and ingestion, dermal contact, direct contact/uptake, and food chain exposure for sediment.

*Soil*

Pathway exposure media for soil contamination in surface soil include surface soil (direct), air, surface water, and sediment. Potential exposure routes for these media include ingestion, dermal contact, direct contact/uptake, and food chain exposure for surface soil; inhalation for air; ingestion, dermal contact, inhalation of vapors, direct contact/update, and food chain exposure for surface water; and ingestion, dermal contact, direct contact/update, and food chain exposure for sediment. Potential exposure routes for subsurface soil include ingestion, dermal contact, direct contact/update, or food chain exposure to subsurface soils.

#### 2.5.1.4 Receptors

Receptors are people, plants, or animals that may be exposed to contaminants at the Site. HAA-01 is currently an industrial-use location at HAAF that is not used for residential purposes. Receptors at HAA-01 include site workers, construction workers, hypothetical future residents, trespassers, terrestrial wildlife, soil dwelling invertebrates, and terrestrial plants.

#### 2.5.1.5 Potentially Complete Exposure Pathways

Exposure pathways include the source, route, and mechanisms through which a contaminant might reach a receptor. Complete exposure pathways, or potentially complete exposure pathways, exist when a continuous link exists between the contaminant source, release mechanism, transport medium, exposure route, and potential receptor. There are no currently complete exposure pathways identified at HAA-01, however there are potentially complete pathways that include:

*Groundwater*
Groundwater at HAA-01 is not recommended for use as a potable water source, and none of the receptors are anticipated to interact directly with groundwater at the Site. The only potentially complete pathways identified in the CSM for groundwater contaminants was for trespassers by ingestion of, dermal contact with, or inhalation of vapors in surface water, and by ingestion of or dermal contact with sediment.

*Soil*
Contaminants in surface soils may reach site workers, construction workers, hypothetical residents, trespassers, terrestrial wildlife, and invertebrates through ingestion and dermal contact. A potentially complete pathway also exists for trespassers, wildlife, invertebrates, and plants through direct contact/uptake; and for terrestrial wildlife through the food chain. The inhalation pathway is potentially complete through inhalation of contaminants by site workers, construction workers, hypothetical future residents, and trespassers. Contaminants in surface soil released to surface water and sediment could potentially reach trespassers through ingestion, dermal contact, or inhalation of vapors (surface water).

Contaminants in subsurface soils could potentially reach site workers, construction workers, hypothetical residents, and terrestrial wildlife through ingestion, dermal contact, direct contact/uptake, and food chain exposure. Soil invertebrates could potentially be exposed to subsurface soil through ingestion, dermal contact, and direct contact/uptake. A potentially complete pathway also exists for terrestrial plants through direct contact/uptake of subsurface soils.

### 2.5.2 Contamination

COCs at HAA-01 include benzo(a)pyrene in soil, and benzene, cis-1,2-DCE, and VC in groundwater. Light Non-Aqueous Phase Liquid (LNAPL) has not been observed at the Site since 2003. These COCs are discussed in further in this section and summarized in **Table 2-1**.

*Groundwater*
**Benzene** is a natural constituent of crude oil and is therefore a common constituent in hydrocarbon products. Physiological effects of exposure to benzene include neurological and immunological damage. Benzene is a known human carcinogen. Benzene concentrations in 2014 are shown on **Figure 2-4**.

**Cis-1-2-DCE** is commonly used in chemical mixtures, to produce solvents, and is a daughter product- or produced during breakdown of- trichloroethene (TCE). Physiological effects of exposure to cis-1,2-DCE include liver and kidney damage, drowsiness, nausea, and cardiovascular complications. Cis-1,2-DCE is reasonably projected to be a human carcinogen. Cis-1,2-DCE impacts are entirely contained within the DAACG, as shown on **Figure 2-5**.

**VC** is used to manufacture polyvinyl chloride (PVC), a very common synthetic plastic polymer. Like cis-1,2-DCE, VC is also a daughter product of TCE. Physiological effects of exposure to VC include central nervous system depression, ataxia, tingling of the extremities, visual disturbances, coma, and death. VC can aggravate the eyes, mucous membranes, and the respiratory tract. VC is a known human carcinogen. VC impacts are entirely contained within the DAACG area.

*Soil*

**Benzo(a)pyrene** is formed during the burning of solid waste, oil, coal, and other organic materials. Physiological effects of exposure to benzo(a)pyrene include darkening of the skin, rash, and eye irritation. Benzo(a)pyrene has been identified as a carcinogen. Benzo(a)pyrene impacts are isolated to the soils in/around the former FTA.

### 2.5.3 Hydrogeology and Hydrology

The geology at HAA-01 consists primarily of sands with interbedded silty sand and lesser clayey sand deposits to a depth of at least 100 ft bgs. Shallow soils from the surface to approximately 35 ft bgs are grey to brown, medium to coarse grained, loose to medium-dense silty sand, with interbedded clays, sands, and poorly graded sand. Deeper zone soils are primarily poorly graded sand that transition to silty clay and clay around 60 ft bgs.

Groundwater flow beneath the site occurs within two hydrostratigraphic units, a shallow and a deep surficial aquifer. The water table occurs within the shallow unconsolidated unit at depths ranging from 5.55 ft bgs to 16.45 ft bgs (based on December 2014 measurements). Groundwater in both units primarily flows to the northwest, and flow is considered likely controlled by higher permeability sand lenses interbedded in an aquifer matrix of lower hydraulic conductivity. Paired wells in the former FTA exhibit a downward vertical component of groundwater flow, while paired wells in the DAACG area exhibit an upward vertical gradient. Potentiometric Maps for the shallow surficial aquifer and deep surficial aquifer are shown in **Figure 2-6** and **Figure 2-7**, respectively.

Monitoring wells in both the shallow and deep surficial aquifer have been installed for use in characterizing hydrology at HAA-01. Shallow wells range from 11.5 to 20.5 ft bgs, and deep wells range from 48 to 65 ft bgs. Groundwater generally flows to the northwest at HAA-01, with a horizontal hydraulic gradient of approximately 0.042 ft/ft at the former FTA and approximately 0.017 ft/ft at the DAACG. The average hydraulic conductivity measured through slug tests at the site range from 1.8 x $10^{-3}$ ft/min (HMW-03) to 8 x $10^{-4}$ ft/min (HMW-11) with an average hydraulic conductivity of 1.25 x $10^{-3}$ ft/min (Law 2002). The average horizontal groundwater velocity was calculated to be 56 ft/yr at the DAACG and 138 ft/yr at the former FTA (Pika/Arcadis 2019).

## 2.6 Current and Potential Future Site Resources Uses

### 2.6.1 Land use

HAAF is an active military installation and access to the Site is restricted. HAA-01 is located in the northwestern portion of HAAF, west of the flight line, and approximately 800 ft northwest of the flight control tower. The site itself has been inactive since 1991, with no buildings at the site, and is maintained as a grassy meadow with areas of mature hardwood and evergreen forest to the north and south. HAA-01 will remain a commercial/industrial use property requiring that all remedial alternatives address potential residential exposure to COCs in soil and groundwater through the application of institutional controls. According to the Base Master Plan (US Army 2017), there are no current plans for future conversion of the site for permanent residential use.

### 2.6.2 Groundwater

There are no potable wells at HAA-01. The surficial aquifers, in which contamination at HAA-01 is observed, are not recommended for use as drinking water. Only when potable use of the groundwater at the Site was considered for either site workers or residents did the calculated risks and hazardous during the Human Health Risk Assessment (HHRA) exceed the benchmarks.

There are two potable wells approximately 1.14 miles northeast of the Site that provide the public water supply for HAAF. These wells are considered upgradient to the Site and are installed in the Floridan Aquifer with an open interval from approximately 260 to 504-555 ft bgs. There is a thick confining unit from 60 to 285 ft bgs separating the surficial aquifers from the underlying potable aquifer. VOC sampling on the public supply wells performed in March 2017 indicated there were no COCs present in the potable wells (Pika/Arcadis 2019).

## 2.7 Summary of Site Risks

Based on the land and groundwater uses described in Section 2.6, the current primary risk of exposure to humans or ecological receptors consists of direct exposure to soils or shallow groundwater by site workers and construction workers. While there is no current risk to residential receptors, nor known plans for future residential use of the Site, remedies are expected to consider potential exposure to hypothetical future residents. The ERA, summarized in Section 2.7.2, found potential ecological exposure risks at the site were considered negligible and no further evaluation or consideration was required.

The primary basis for taking action at this Site is the threat of direct exposure to soils or shallow groundwater by site workers and construction workers.

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances to the environment.

### 2.7.1 Summary of Human Health Risk Assessment

The baseline HHRA estimates what risks HAA-01 poses if no action were taken. This provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section summarizes the HHRA for the Site.

#### 2.7.1.1 COCs

The first step of the HHRA process is compiling and evaluating data to select the Contaminants of Potential Concern (COPCs). The objective is to identify the most toxic, persistent, and prevalent COPCs at the site that are expected to contribute the majority of the potential exposure risk. COPC selection involves a conservative, risk-based screening evaluation, and can be based on criteria including toxicity, frequency of detection, comparison to background concentration, or whether a constituent can be considered a common laboratory contaminant (e.g., acetone).

COCs in this HHRA were identified for retention by comparing maximum detected concentrations of COPCs with health-based screening levels, including:

- USEPA Regional Screening Levels (RSLs): assuming a Hazard Quotient (HQ) of 0.1 and a target cancer risk of $1x10^{-6}$. (USEPA 2018a)
- USEPA MCL-based Soil Screening Levels (SSLs), or in the absence of MCL-based SSLs, the tap water-based SSLs (USEPA 2018a)
- USEPA Vapor Intrusion Screening Levels (VISLs) based on a target HQ of 0.1 and a target cancer risk of $1x10^{-6}$ (USEPA 2018b)
- Georgia Instream Water Quality Standards (IWQS; GAEPD 2015) were used to identify surface water COPCs, or in the absence of Georgia IWQS, the USEPA National Recommended Ambient Water Quality Criteria (AWQC) were used (USEPA 2015).

COCs are summarized in **Table 2-1.**

#### 2.7.1.2 Exposure Assessment

The exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to substances present in the environment. The purpose of the assessment is to evaluate the ways the receptors might be exposed to COPCs at HAA-01. Exposure can only occur when the potential exists for a receptor to contact COPCs or when there is a mechanism for COPCs to be transported to a receptor. With no exposure, there is no risk. The exposure assessment includes characterization of the physical environment; identification of exposure pathways, including migration pathways, exposure points, and exposure routes; and identification of receptors- potentially exposed individuals and populations.

Exposure pathways are defined by four elements:

1. A source and mechanism of constituent release to the environment.
2. An environmental transport medium for the released constituent.
3. A point of potential contact by the receptor with the medium containing the constituent (exposure point).
4. A route of exposure to the receptor at the exposure point (e.g., dermal contact, ingestion, inhalation).

To identify and evaluate the ways a population may be exposed to COPCs, the assessment includes estimating concentrations along potential pathways using site-specific data and, when necessary, mathematical modeling. In this assessment, doses and risks were calculated for the reasonable maximum exposure scenarios.

**Receptors**

Receptors were identified to include site workers (e.g., those who periodically mow and maintain the site) and construction/utility workers. While there are no plans to use the site for residential purposes, hypothetical future residents were included in the assessment. Trespassers are considered unlikely based on the nature of restricted access to the military installation but were nevertheless evaluated as potential receptors. HAA-01 is inactive, and soldiers do not typically spend extended time at the Site.

Receptors at the Site were identified to include site workers, construction workers, and hypothetical future residents.

**Exposure Pathways**

Surface water features are unlikely to be accessed from HAA-01. The ditches present at the site have steeply sloped and heavily vegetated banks that are unlikely to be accessed, limiting exposure to sediments and surface water, but were evaluated for a potential adolescent trespasser scenario. Shallow groundwater may be encountered during intrusive activities at the Site, and though shallow groundwater at the site is not considered a potable water source, potential exposure of hypothetical future residents and site workers to constituents in groundwater through potable use was evaluated. Should the site be redeveloped in the future, the potential for constituents in shallow groundwater to migrate into buildings though the vapor intrusion pathway was also evaluated.

Potentially complete exposure pathways were identified to include:

- Hypothetical future adult and child residents potentially exposed to surface and subsurface soil through direct contact, groundwater used as a potable water supply, and if appropriate, inhalation of vapors migrating to indoor air.

- Hypothetical future commercial/industrial workers potentially exposed to surface and subsurface soil through direct contact, ingestion of groundwater used as a potable water supply, and if appropriate, inhalation of vapors migrating to indoor air.
- Hypothetical future construction/utility workers potentially contacting soil and shallow groundwater.
- Hypothetical adolescent trespassers contacting soil, surface water, and sediments.

**Exposure Evaluation**

Exposure point concentrations were estimated using site-specific data and a statistical approach consistent with USEPA methodology. Receptor exposure assumptions including body weight and ingestion rates and scenario specific assumptions including the total period of receptor is exposed and the frequency of exposure were obtained based on USEPA guidance. Receptor exposure assumptions were selected such that the risk calculated would be for the Reasonable Maximum Exposure (RME) scenario. Potential risk from exposure to constituents in each medium were calculated considering the fate and transport of COPCs, which is dependent on their physical and chemical properties, the environmental transformation processes affecting them, and the media through which they migrate. Calculations, assumptions, and chemical properties (e.g., molecular weight, solubility, diffusivity in air and water) are all included in the HHRA within the RI/FS (Pika/Arcadis 2019).

#### 2.7.1.3 Toxicity Assessment

The toxicity assessment describes the relationship between the administered and/or the absorbed dose of a constituent and the magnitude or likelihood of adverse health effects. Toxicity values for potential non-carcinogenic and carcinogenic effects were obtained consistent with the recommended USEPA hierarchy and USEPA guidance. Therefore, the following sources were used to obtain toxicity values, in the order in which they are presented below.

- USEPA's Integrated Risk Information System (USEPA 2019a)
- USEPA Provisional Peer Reviewed Toxicity Values (USEPA 2019b)
- The USEPA Superfund Program Health Effects Assessment Summary Tables (USEPA 2011)
- Toxicity values from the agency for Toxic Substances and Disease Registry (2019)
- The California Environmental Protection Agency, Office of Environmental Health Hazard Assessment's Toxicity Criteria Database (CalEPA 2019)

Summaries of Cancer and Non-Cancer Toxicity Data for HAA-01 are provided in **Tables 2-2a** and **2-2b**, respectively.

#### 2.7.1.4 Risk Characterization

Risk characterization is the integration of the results of the data evaluation, exposure assessment, and toxicity assessment to yield a quantitative measure of cancer risk and non-cancer hazard. Potential risks to human health are evaluated quantitatively by combining calculated exposure levels and toxicity data. Risk calculations are presented in the RI/FS (Pika/Arcadis 2019) and summarized in **Table 2-3** of this ROD.

The individual risks and hazards were calculated by medium and receptor to determine the total site risk and hazard by receptor, as shown on **Table 2-3**. The risks and hazards for the hypothetical future construction worker and utility worker are below the regulatory benchmarks of $1 \times 10^{-6}$ and 1, respectively. The calculated risks for the hypothetical future adolescent trespasser were at the low end of the target risk range and the non-cancer hazards were well below the benchmark of 1. For the current or hypothetical future site worker, exposure to soil and inhaling vapors migrating from the groundwater to indoor air were also at the low end of the target risk range and the non-cancer hazards were less than the benchmark of 1.

Similar results for a hypothetical future resident exposed to soil and inhalation of vapors migrating into a home were within the target risk range of $1 \times 10^{-6}$ to $1 \times 10^{-4}$ and less than or equal to the non-cancer hazard of 1. Only when potable use of the groundwater was considered for either site workers or residents did the calculated risks and hazards exceed the benchmarks. Therefore, it is recommended that groundwater not be used as a potable water supply (Pika/Arcadis 2019).

### 2.7.2 Summary of Ecological Risk Assessment

The ERA estimates what risks HAA-01 poses to ecological receptors if no action were taken. This section summarizes the ERA for this Site, as presented in the RI/FS (Pika/Arcadis 2019).

**COPECs**

The refinement of Contaminants of Potential Ecological Concern (COPECs) is necessary to help focus further risk assessment activities on those constituents that pose the greatest potential hazard to ecological receptors. It is intended as an incremental iteration of exposure, effects, and risk characterization. Constituents are either excluded as COPECs or retained for further evaluation in the ERA process. The process to refine COPECs includes:

1. Comparison with background and upgradient concentrations - This is only applicable for inorganic constituents unless organic constituents being considered also occur in background or upgradient media unaffected by the site. Soil background levels for inorganics were identified from the Revised Final CSR (Law 2002) and were incorporated in the ERA.

2. Frequency of Detection – constituents detected in greater than 5% of the samples in a given medium are typically retained as COPECs and considered in the next step of the refinement process.

For HAA-01 COPECs retained through the end of the screening are high molecular weight PAHs and Dieldrin.

**Exposure Assessment**

HAA-01 is maintained as a grassy meadow with areas of mature hardwood and evergreen forest to the north and south. Banks of the two onsite storm water ditches are steeply sloped and heavily vegetated.

Indicator species were chosen to represent a cross-section of feeding guilds for selected assessment endpoints. The American robin (*Turdus migratorius*) was chosen to represent the invertivorous birds, and the short-tailed shrew (*Blarina brevicaudus*) was chosen to represent the invertivorous mammals. The American robin is prolific in the United States with a home range that includes Georgia, tends to forage in open areas and the ecotone between woodlands and open areas (like that at HAA-01), and has sufficient exposure-related and toxicological information available to be used in assessments. The short-tailed shrew is one of the most common mammals in North America and may be present at the Site. The short-tailed shrew also has a high ingestion rate and as such may be used as a conservative species in an ERA. With a relatively high consumption of earthworms, and if hazards are not expected for this species, then hazards should not be expected for species with lesser exposures to bio accumulative constituents (e.g., herbivorous mammals).

Risks were characterized for ecological receptors by considering direct contact with constituents of potential ecological concern (COPECs) in surface soil (0 to 4 feet below ground surface) and through ingestion of prey tissue through a food web model to upper-trophic level wildlife. Pathways of concern are summarized in **Table 2-4**.

**Ecological Effects Assessment**

Toxicity Reference Values (TRVs) were obtained from the toxicological database presented in USEPA's EcoSSL documents (USEPA 2007a,b) or, when unavailable in the EcoSSL documents, from the open literature. Toxicological benchmarks were used in food chain modeling such that a range of predicted food chain impacts could be evaluated. Food chain ingestion- based exposure calculations were used to identify potential adverse effects for wildlife at the site via wildlife dose models. Estimated ingestion intakes were divided by TRVs to obtain HQs for bioaccumulative COPECs. A HQ value of 1 or less is considered to indicate that adverse effects are not expected. An HQ above 1 indicates the need for further investigation. COPEC Concentrations Expected to Provide Adequate Protection of Ecological Receptors are summarized in **Table 2-5**.

**Eco Risk Characterization**

Overall, the potential ecological risks are considered negligible for exposure to site surface soil. Most COPECs have HQs below 1. While the HQs for exposure to some COPECs in soil (i.e., xylene, high-molecular weight-PAHs and dieldrin) were above 1, population-level effects for terrestrial receptors are not expected because those COPECs are present in areas of the site with low-quality habitat, which is not attractive as a foraging or resting area for mammals and birds. Risks to terrestrial wildlife from exposure to sediment evaluated as soil are also unlikely. The area of the drainage ditches represents a small percentage of the shrew and American robin's average foraging range and less than the de minimis (i.e., ecologically insignificant) areal extent typically used in an ERA of 1 to 2 acres (Suter et al. 1995; Henning and Shear 1998; Efroymson et al. 2003). Based on the ERA, potential ecological risks at the site are considered negligible, and no further evaluation is required.

## 2.8 Remedial Action Objectives

Cleanup at HAA-01 will afford protection of human and environmental health for the current and reasonably anticipated future land use at HAA-01. For HAA-01, this will entail limiting potential contact with contaminated soils, and reducing concentrations of COCs in groundwater to acceptable levels (i.e., PRGs established in accordance with calculated health-based goals and USEPA MCLs).

RAOs are site-specific, initial clean-up objectives that are established on the basis of the nature and extent of contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. HAA-01 does not currently house any administrative, industrial, or residential buildings, and family housing is not provided at the Site. Military and civilian workers may be present for short term intervals during the work week. Access to the site is restricted, and trespassers are not expected at the site. It is unlikely that that the site will be used for permanent residential housing based on the HAAF Master Plan not including plans for family housing in the area (US Army 2017).

Based on the current site use, potential human receptors are limited to workers periodically mowing/maintaining the site, and potential construction workers. Banks of the two onsite storm water ditches are steeply sloped and heavily vegetated, precluding contact with surface water and sediments. Groundwater at the site is not used as a potable water supply. The nearest potable water supply wells are over a mile from the site, are not down gradient to the site, and are screened in the much deeper Floridan Aquifer, which is separated from the surficial aquifers by thick clay confining units. Groundwater at HAA-01 is typically two to 10 ft bgs and may be encountered by workers during intrusive activities. Response actions will primarily focus on groundwater at the Site but will also include measures to reduce potential exposure of workers to site soils.

The Defense Environmental Restoration Program (DERP) Manual states, "if remedial action for groundwater is necessary to protect human health or the environment, the DoD Component should consider the NCP expectation that useable groundwater will be returned to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site, when establishing RAOs in accordance with the NCP (300.430[a][1][iii][F]).” The cited section of the NCP states “EPA expects to return useable groundwaters to their to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction.”

The RAOs for the remediation of groundwater at the Site include:

1. Reduce potential cancer risk and potential non-cancer health hazards for people (i.e., site workers and construction workers) exposed to cis-1,2-DCE and VC in contaminated groundwater by reducing the concentrations of or controlling exposure to these COCs in groundwater.
2. Reduce potential exposure of ecological receptors to COCs in groundwater.
3. Prevent potential for migration of unacceptable levels of cis-1,2-DCE and VC to offsite locations.
4. Return useable groundwaters to their beneficial use whenever practicable.

The RAOs for the remediation of soil at the Site include:

1. Reduce the potential exposure of construction and site workers to soil in the former FTA.

The risk assessment identified concentrations of various contaminants as presenting potential risks to site workers and construction workers in site soil and groundwater. No risks to site workers were identified in sediment or surface waters. No unacceptable risks were identified for other potential receptors.

ARARs are divided into three categories: chemical-specific, action-specific, and location-specific requirements.

**Chemical-specific:** Chemical-specific ARARs establish health-based concentration limits, risk-based concentration limits, or ranges for specific hazardous substances in different environmental media that provide media cleanup levels or a basis for calculating cleanup levels for COCs. Chemical-specific ARARs identified for remedial action at the site include USEPA RSLs for soil and USEPA MCLs, and Region 4 Tapwater RSLs for groundwater.

**Location-specific:** Location-specific ARARs set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location (e.g., proximity to wetlands, historic buildings, etc.). The Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil, pond sediment, and surface water, so no location specific ARARs were proposed. HAA-01 will remain a commercial/industrial use property requiring that all remedial alternatives address potential residential exposure to COCs in soil and groundwater through the application of institutional controls.

**Action-specific:** Action-specific ARARs set controls or restrictions on the design, implementation, and performance of actions. These provide a basis for assessing the feasibility and effectiveness of the remedial alternatives by specifying performance levels, actions, or technologies and specific levels for discharge of residual chemicals. Action-specific ARARs identified include air emission standards for any air discharge and compliance with NPDES and base requirements for any treated water discharged to proximate canals.

Preliminary Remediation Goals (PRGs) were established based on USEPA RSLs, USEPA MCLs, and Georgia IWQS Criteria. PRGs for the site COCs include:

*Groundwater:*
VOCs
Benzene – 5.00 µg/L

Cis-1,2-DCE – 70 µg/L
VC – 2.00 µg/L

*Soils*
PAHs
Benzo(a)pyrene – 2.11 mg/kg

The RAOs address risks identified in the RA by reducing or limiting potential exposure of site workers and construction workers to COCs in groundwater and soils, reducing concentrations of COCs in groundwater, and preventing potential for migration of COCs to offsite locations.

## 2.9 Description of Alternatives

Remedial alternatives are discussed in this section. Alternatives are presented in consecutive order corresponding to their order in the RI/FS report. Alternatives are evaluated based on effectiveness (overall protectiveness of human health and the environment; compliance with RAOs; long-term and short-term effectiveness; and reduction of toxicity, mobility, or volume [TMV] of contaminants), implementability, cost effectiveness, and state and community acceptance.

The alternatives are:

*Groundwater*
Alternative 1: No Action
Alternative 2: LTM and LUCs
Alternative 3: ERD, MNA, and LUCs
Alternative 4: In situ chemical oxidation (ISCO) via injection wells, monitoring, and LUCs

*Soil*
Alternative 1: No Action
Alternative 2: Capping with vegetative cover
Alternative 3: Excavation and Disposal

These alternatives are summarized below.

### 2.9.1 Groundwater

#### 2.9.1.1 Groundwater Alternative 1: No Action

Under this alternative, HAAF would take no action at the site to prevent exposure to groundwater contamination or to reduce TMV of contaminants. There are no technological barriers to implementation of the No Action alternative, however the potential risks identified in the Risk Assessment (RA) would not be mitigated by this response. This response is evaluated as required based USEPA guidance.

#### 2.9.1.2 Groundwater Alternative 2: Long Term Monitoring and LUCs.

A statistical analysis of historical groundwater analytical data conducted as part of the RI/FS indicated that groundwater COC concentrations are declining in some areas over time and do not represent a risk to receptors under current conditions. However, calculations of trends in CVOC concentrations in the DAACG area indicate an extended timeframe to achieve PRGs. Groundwater Alternative 2 will utilize:

- MNA via a long-term monitoring program to demonstrate continued reduction in COC concentrations.
- LUCs will be implemented to maintain protection of human health and the environment:

  - Prohibition of potable water well installation and groundwater consumption until site groundwater concentrations are at levels that allow unrestricted use and unlimited exposure (UU/UE).

Implementation of the groundwater monitoring program involves continued monitoring of COC concentrations to quantify attenuation rates and demonstrate transformation of the COCs. The infrastructure required to implement monitoring is an adequate monitoring network, which is already in place at the site, translating to relatively low capital costs and moderate O&M costs for sampling, analysis, and monitoring. Because the site is characterized, groundwater monitoring would be relatively infrequent (i.e., semi-annually).

This remedy will also include CERCLA five-year reviews until the RAOs are achieved. Under CERCLA 121(c), any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use must be reviewed as least once every 5 years.

*Estimated Capital Cost: $30,000*
*Estimated Present Worth Cost: $320,616*
*Estimated Construction Timeframe: Not Required*
*Estimated Time to Achieve RAOs: >100 years*

#### 2.9.1.3 Groundwater Alternative 3: ERD, MNA, and LUCs

Groundwater Alternative 3 will actively reduce concentrations of CVOCs in groundwater at the DAACG by mass removal. Groundwater Alternative 3 will utilize:

- ERD system for mass removal of CVOCs
  - Injections of EVO to establish a long-lived source of organic carbon to promote degradation of CVOCs.
  - Will target the area with elevated CVOC concentrations
- MNA to treat residual COCs in the other areas
- Onsite LUCs prohibiting potable water well installation and groundwater consumption until site groundwater concentrations are at levels that allow UU/UE.

Exact location and quantity of injection wells are pending the results of baseline sampling. Continued monitoring in the form of performance sampling events and long term MNA monitoring for VOCs will be conducted for several years after injections. These groundwater monitoring programs will track progress of remediation, ensure that conditions remain favorable for continued natural attenuation, and determine when the RAOs have been achieved. This remedy will also include CERCLA five-year reviews, during which the effectiveness of the implemented remedy will be assessed and whether the implementation of additional remedial action is appropriate.

*Estimated Capital Cost: $158,727*
*Estimated Present Worth Cost: $702,242*
*Estimated Construction Timeframe: 1 year*
*Estimated Time to Achieve RAOs: 5 years*

#### 2.9.1.4 Groundwater Alternative 4: ISCO, MNA, and LUCs.

Groundwater Alternative 4 will actively reduce concentrations of CVOCs in groundwater at the DAACG by mass removal. Groundwater Alternative 4 will utilize:

- ISCO for mass removal of CVOCs
  - Injections of oxidizing compounds to the aquifer to chemically destroy contaminants

    - Will target the area with elevated CVOC concentrations
    - Performance sampling events will be conducted for two years after injections
- MNA to treat residual COCs in the other areas
- Onsite LUCs prohibiting potable water well installation and groundwater consumption within or downgradient of the source area.

ISCO injections would be implemented via a network of 11 permanent injection wells installed in three transects. The oxidizing chemistry that is mostly likely to be optimal is sodium persulfate (oxidizer) and an activator such as sodium hydroxide. The injection program will include two biennial injections of approximately 4,500 gallons of 60 grams per liter (g/L) sodium persulfate and 40 g/L sodium hydroxide.

Quarterly (4 wells), semi-annual (5 wells), and annual (18 wells) performance sampling events will be conducted for two years after injections. Once the injection and initial performance monitoring events are complete, 5 years of semi-annual MNA monitoring of 18 wells for VOCs will be implemented, then frequency will decrease to annual MNA monitoring for 18 wells for VOCs for 25 years. These groundwater monitoring programs will track progress of remediation, to ensure that conditions remain favorable for continued natural attenuation, and to determine when the RAOs have been achieved. This remedy will also include CERCLA five-year reviews until the RAOs are achieved, during which the effectiveness of the implemented remedy will be assessed and whether the implementation of additional remedial action is appropriate

*Estimated Capital Cost: $183,431*
*Estimated Present Worth Cost: $771,510*
*Estimated Construction Timeframe: 1 year*
*Estimated Time to Achieve RAOs: 5 years*

### 2.9.2 Soil

#### 2.9.2.1 Soil Alternative 1: No Action

Under this alternative, HAAF would take no action at the site to prevent exposure to soil contamination or to reduce TMV of contaminants. There are no technological barriers to implementation of the No Action alternative, however the potential risks identified in the RA would not be mitigated by this response. This response is evaluated as required based USEPA guidance.

#### 2.9.2.2 Soil Alternative 2: Capping- Vegetative Cover

Soil Alternative 2 will limit potential contact with impacted soils. Soil Alternative 2 will utilize:

- Vegetative Cover
    - Features a minimum of 1.5 ft of compacted soil and 6 inches of topsoil
    - Eliminates direct contact with impacted soils.
    - Annual inspection of the vegetative cover to ensure continued integrity.
- LUCs will be implemented to ensure the site will not be used for residential purposes.
    - Implemented in the Base Master Plan

Installation of a vegetative cover is a proven and effective method of providing an exposure barrier, erosion control, and some long-term enhancement of ecological habitat. Vegetative covers minimize infiltration of rainwater and subsequent dissolution of contaminants and are commonly used, easy to construct, and relatively inexpensive. Implementation of the vegetative cover would be relatively simple at HAA-01, as the former FTA is grassy and level and, as such, would require minimal to no installation of a new vegetative cover. This remedy will include CERCLA five-year reviews, and these restrictions will remain in place until it could be demonstrated that soil concentrations have declined below applicable PRGs.

*Estimated Capital Cost: $13,438*
*Estimated Present Worth Cost: $40,193*
*Estimated Construction Timeframe: 1 year*
*Estimated Time to Achieve RAOs: 10 years*

#### 2.9.2.3 Soil Alternative 3: Excavation and Disposal

Soil Alternative 3 will actively reduce TMV of contaminants in soil at HAA-01. Soil Alternative 3 will utilize:

- Excavation and off-site disposal of impacted soils at an approved landfill
    - Sampling will be conducted to ensure attainment of RAOs
    - Excavation will be backfilled with clean soil, graded, and revegetated

Excavation of impacted soils would be conducted using typical construction equipment (e.g., backhoes, drag lines, clamshells, vacuum trucks, and front-end loaders).

Materials handling is a concern that affects the implementability of excavation. Staging areas would be used to prepare wastes for disposal or treatment; the staging areas would be graded to reduce ponding, lined to prevent groundwater contamination, and bermed to prevent runoff. The offsite transportation of wastes resulting from excavation must meet Federal and the State of Georgia shipping and manifesting regulations. Characterization of the material would be required to ensure proper disposal, treatment requirements, and to ensure compliance of material left in place.

Excavation and removal of impacted soil eliminates the environmental and health concerns associated with direct contact of contaminated soil. However, consideration must be given to the health and safety of remedial workers. On-site air monitoring and dust and vapor control provisions would be necessary during excavation operations. Excavation activities can result in the release of fugitive dusts and runoff from disturbed soil. Dust controls could include water sprays or application of chemical dust suppressants. Surface water controls may also be required.

*Estimated Capital Cost: $880,044*
*Estimated Present Worth Cost: $956,812*
*Estimated Construction Timeframe: 1 year*
*Estimated Time to Achieve RAOs: 5 years*

## 2.10 Comparative Analysis of Alternatives

Alternatives are evaluated relative to 9 evaluation criteria listed in the NCP:

- *Overall protectiveness of human health and the environment*- whether the alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
- *Compliance with ARARs* – whether the alternative meets Federal and State environmental statutes, regulations, and other requirements pertaining to the site, or whether a waiver is justified.
- *Long-term effectiveness and permanence* – the ability of an alternative to maintain protection of human health and the environment over time.
- *Reduction of toxicity, mobility, volume, or mass of contaminants* - an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environments, and the amount of contamination present.

- *Short-term effectiveness* – the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
- *Implementability* – the technical and administrative feasibility of implementing an alternative, including factors such as the relative availability of goods and services.
- *Cost* – includes estimated capital and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
- *State/support agency acceptance* – whether the State agrees with HAAF's analyses and recommendations, as described in the RI/FS and Proposed Plan.
- *Community acceptance* – whether the local community agrees with the analysis and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

A comparative analysis of the alternatives is provided below and summarized in **Tables 2-6a, b and 2-7a, b.**

### 2.10.1 Protection of Human Health and the Environment

Each remedial alternative except the "no action" alternative would provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, and/or institutional controls.

**Groundwater Alternative 3** would provide ERD of impacted groundwater and would enhance natural biological degradation by stimulating naturally occurring bacterial populations that can break down CVOCs. The in situ reactive zone created by EVO injections further enhances the protection of human health and environment by degrading COCs that exceed the PRGs within the mass flux portion of the contaminant plume.

**Groundwater Alternative 4** would degrade CVOCs through introduction of an oxidizer and activator solution into the aqueous environment. ISCO further enhances the protection of human health and environment by oxidizing COCs that exceed the PRGs within the mass flux portion of the contamination plume.

**Groundwater Alternative 2** would implement an MNA program to quantify attenuation rates and demonstrate continued degradation of site COCs in groundwater.

**Soil Alternative 3** would include physical removal and off-site disposal of impacted soil. While this remedy would preclude direct exposure with impacted soil, consideration must be given to the health and safety of remedial workers including the need for mitigating dust and vapor impacts.

**Soil Alternative 2** would implement a vegetative cover to prevent direct exposure with impacted soil.

LUCs instituted as part of the groundwater and soil alternatives will further protect human health and the environment by limiting the types of construction that can occur at the site (e.g., no water supply wells, restrictions of residential buildings).

### 2.10.2 Compliance with ARARs

With the exception of the two "no action" alternatives, all soil and groundwater alternatives would meet their respective ARARs. The "No Action" alternatives will not be discussed further in this comparison. Each alternative applies MNA or source reduction technologies to reduce contamination below chemical-specific ARARs including USEPA RSLs/MCLs, and Region 4 Tapwater RSLs for groundwater. Each alternative addresses potential residential exposure to COCs through institutional controls. Action-specific ARARs include air emission standards for any air discharge and compliance with NPDES and installation requirements for any treated water discharged to proximate canals. These are addressed in any alternative that includes air emissions (e.g., air monitoring during excavations).

### 2.10.3 Long-Term Effectiveness and Permanence

All Groundwater and Soil Alternatives would achieve long- term effectiveness and permanence of maintaining protection to human health and the environment. Under Groundwater Alternatives 3 and 4, in situ technologies (ERD and ISCO, respectively) would target the elevated CVOC concentration zones through up to 2 injections, while natural attenuation will reduce concentrations in areas of lower concentrations. Under Groundwater Alternative 2, long-term monitoring will ensure COC concentrations continue to decline, though RAOs may not be achieved in an acceptable timeframe.

For Soil Alternative 2, the vegetative cap is an existing permanent cap. For Soil Alternative 3, excavation and removal of impacted soil would achieve long-term effectiveness and permanence.

### 2.10.4 Reduction of Toxicity, Mobility, Volume, and Mass

Reduction of the mobility, toxicity, volume, and mass of COCs in groundwater would be confirmed through regular groundwater monitoring for each proposed groundwater alternative. In addition, Groundwater Alternatives 3 and 4 would utilize in situ technologies to accelerate the reduction in volume and mass of the elevated CVOC concentration zones.

Soil Alternative 3 would eliminate toxicity, mobility, volume, and mass by removing impacted soil from the site. Soil Alternative 2 would reduce the mobility of COCs through a well-maintained vegetative cover, while the toxicity, volume, and mass would be reduced through natural attenuation.

### 2.10.5 Short-Term Effectiveness

Groundwater Alternative 2 would result in minimal risks to the community, site workers, and the environment through LUCs and long-term monitoring. Groundwater Alternative 3 would result in minimal risks to the community, workers, and the environment. Degradable carbon that would be used to create the in situ reactive zone would be in the form of molasses, corn syrup, whey, or other similar products that would not result in additional risks to the community, workers, and the environment. Groundwater Alternative 4 requires the use of strong oxidizers and would result in moderate risks to the community, site workers, and the environment. Groundwater Alternatives 2, 3, and 4 would handle purge water from monitoring well sampling using approved methods.

Under Soil Alternative 2, an existing vegetative cover currently provides protection and implementation with LUCs would result in minimal risks to the community, site workers, and the environment. Soil Alternative 3 would provide short-term effectiveness by removing impacted soil from the site but may result in temporary air quality effects during excavation activities and hazards or potential exposure risk to the community and workers during excavation and transport of impacted soils.

### 2.10.6 Implementability

Groundwater Alternatives 2, 3, and 4 are technically and administratively feasible. A site-wide groundwater monitoring network currently exists. Groundwater Alternative 2 is the most readily implementable of these alternatives as it does not require installation of any additional wells. Groundwater Alternatives 3 and 4 would require installation of permanent injection wells to implement ERD and ISCO, respectively. Injection points would be installed using standard direct push technology (DPT) or drilling methods and materials. These services are readily available, as are the services and materials necessary for the collection and analysis of groundwater samples.

Soil Alternative 2 is both technically and administratively feasible as the vegetative cover currently exists and only requires routine lawn maintenance. Soil Alternative 3 is readily implementable but may result in temporary air quality effects during excavation activities and hazards to the community and workers from excavation and transport of the impacted soil.

### 2.10.7 Cost

The estimated present worth cost of Groundwater Alternative 2 is less than Groundwater Alternatives 3 and 4. However, concentration trend data indicate that the time to achieve remedial goals could be extensive and could potentially increase the overall cost.

The estimated present worth cost of Soil Alternative 2 is less than Soil Alternative 3, though Soil Alternative 3 is expected to achieve RAOs in a shorter time frame.

### 2.10.8 State/Support Agency Acceptance

The State of Georgia supports the Preferred Alternatives, Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 2 (vegetative cover) without comment. The GAEPD acceptance letter of the Proposed Plans is included in Appendix A.

### 2.10.9 Community Acceptance

The Proposed Plans for HAA-01 were made available to the public in July 2021 in the Administrative Record at Fort Stewart, online, and in the Southern Chatham County Public Library. Notice of availability of the plans was published in the Savannah Morning News and The Frontline prior to the public comment period on June 24 and July 1, 2021, respectively. A public comment period was held from July 14 to August 14, 2021. The public accepted the Preferred Alternatives without comment.

## 2.11 Principal Threat Waste

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. The “principal threat” concept applies to the characterization of “source materials.” A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, surface water, air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material, however LNAPL in groundwater may be viewed as a source material. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. There are no principal threat wastes present at HAA-01.

## 2.12 Selected Remedy

The preferred alternatives selected for remediating the HAA- 01 Former FTA and DAACG Chlorinated Solvents Area is Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 2 (vegetative cover). These alternatives are implementable, effective in meeting the RAOs, and reasonable with respect to present-worth cost.

### 2.12.1 Summary of Rationale for the Selected Remedies

All of the groundwater alternatives are implementable, but Groundwater Alternative 3 was rated the most favorable. Groundwater Alternative 3 is more likely to meet the RAOs in an acceptable timeframe, is effective in mitigating and controlling risks at the site, and results in the reduction of the volume and mobility of onsite waste. Furthermore, Alternative 3 eliminates the risks and costs associated with handling hazardous chemicals (i.e., chemical oxidants). Monitoring will ensure continued degradation of the dilute plume, and LUCs will prohibit the installation of potable wells.

All of the soil alternatives are implementable, but Soil Alternative 2 was rated the most favorable. Due to the low risk factors, low level COC concentrations, the existing vegetative cover, and with LUCs precluding future residential use, Soil Alternative 2 will be effective in meeting RAOs, is implementable, and is reasonable with respect to present- worth cost.

### 2.12.2 Description of the Selected Remedies

**Groundwater Alternative 3**

This alternative includes an ERD system to enhance mass removal associated with CVOCs near the DAACG area, MNA for contaminants that are already decreasing around the former FTA, onsite LUCs preventing installation of potable wells within or downgradient to the source areas, and CERCLA five-year reviews.

An ERD system will enhance the mass removal associated with the chlorinated VOC impacted groundwater near the DAACG Area. A statistical analysis of historical groundwater analytical data for select monitoring wells indicates that COC concentrations are stable to increasing over time, therefore, mass removal is warranted. The conceptual design assumptions for the ERD installation associated with Alternative 3 are as follows:

- Eleven injection wells would be installed in three injection lines located in the chlorinated VOC source zone near the DAACG Area targeting the plume core, as shown on **Figure 2-8**.
- The well barriers would include rows of three wells, five wells, and three wells, respectively, to achieve coverage and would be positioned perpendicular to plume flow.
- Well locations would be advanced using DPT and screened between 5 and 20 feet bgs and completed with flush mount well vaults.
- Biennial EVO injections of up to 4,500 gallons of a 2% EVO solution per well would be required until routine performance monitoring determines when a reductive zone has been established, such that the geochemistry is adequate for in-situ enhanced bioremediation and VOC degradation end products ethene and/or ethane are being produced.
- Performance monitoring includes quarterly sampling of 4 wells for total organic carbon (TOC), semi-annual monitoring of 5 wells for VOCs and 4 wells for VOCs, light gases (methane, ethane, and ethene), and TOC, and annual sampling of 18 additional wells for VOCs.
- Two injection events are assumed for effective treatment, with 2-year duration between events.

Implementation of ERD would reduce the higher concentration zone within two years of operation, allowing for the residual mass to attenuate naturally. Long-term monitoring of downgradient monitoring wells and any necessary new monitoring well installations at the site would also be conducted to ensure that the selected remedy continues to be effective.

The remedy would also include five-year reviews until RAOs are achieved, per CERCLA 121(c), which requires any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use must be reviewed at least once every five years. During five-year reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate.

Additionally, MNA and onsite LUCs would also be implemented to control the remaining risk/hazards associated with COCs that remain in excess of unrestricted use. Monitoring is a potentially applicable technology for the aqueous groundwater contamination associated with the former FTA groundwater plume. Historical groundwater analytical data for the former FTA indicate that the residual COC concentrations are decreasing over time and do not represent a risk to receptors under the current site conditions. MNA will include:

- Monitoring performance monitoring wells following completion of ERD injections
- Analyze for VOCs, light gases, and field parameters
- Assume 30 years for costing based on USEPA guidance (1988), though this may not reflect actual time to cleanup
  - Semi-annual sampling for 5 years and annual sampling for 25 years.

A statistical analysis of historical groundwater analytical data for select monitoring wells indicates that COC concentrations are decreasing over time; benzene concentrations in HMW-13, for example, are estimated to reach cleanup goals in approximately two years (Pika/Arcadis 2019). Implementation of monitoring for former FTA groundwater involves continued monitoring of COC concentrations to quantify attenuation rates and demonstrate transformation of the COCs.

The infrastructure required to implement monitoring is an adequate monitoring network, which is already in place at the former FTA, translating to relatively low capital costs and moderate O&M costs for sampling, analysis, and monitoring. Because the site is characterized, monitoring would be relatively infrequent for former FTA groundwater (i.e., semi-annually). Monitoring would be performed in conjunction with LUCs to maintain protection of human health and the environment until site groundwater contaminant concentrations are at levels that allow UU/UE.

LUCs will be put in place so that protection to human health and the environment is maintained and land and groundwater use is restricted until site groundwater contaminant concentrations are at levels that allow unrestricted use and unlimited exposure. The USEPA requires LUCs when site levels do not allow unrestricted use and unlimited exposure. They can also serve to notify current and future users about the environmental conditions of the property. LUCs are expected to remain in place until site groundwater contaminant concentrations are at levels that allow UU/UE.

ERD and MNA address the chemical specific ARARs of USEPA MCLs, and Region 4 Tapwater RSLs by source reduction of contamination until concentrations meet these requirements. LUCs address location-specific ARARs by restricting potential residential exposure to COCs in groundwater through application of institutional controls. Action-specific ARARs including adherence to air emission standards or NPDES requirements do not apply to this alternative as no air emissions or discharges of water to surface water/canals are anticipated.

**Soil Alternative 2**

Soil Alternative 2 includes a vegetative cover as a containment technology for limiting contact with impacted soils. Installation of a vegetative cover is a proven and effective method of providing an exposure barrier, erosion control, and some long-term enhancement of ecological habitat. Vegetative covers minimize infiltration of rainwater and subsequent dissolution of contaminants and are commonly used, easy to construct, and relatively inexpensive.

The vegetative cover will feature a minimum of 1.5 feet of compacted soil and 6 inches of topsoil to eliminate potential direct contact with impacted soils. Implementation of the vegetative cover would be relatively simple at HAA-01, as the former FTA is grassy and level and, as such, would require minimal to no installation of a new vegetative cover. O&M costs associated with this alternative would include annual inspection of the vegetative cover to ensure its integrity.

In addition, LUCs will be implemented to ensure the site will not be used for residential purposes. The remedy will include CERCLA five-year reviews until RAOs are achieved, any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use must be reviewed as least once every 5 years. These restrictions would remain in place until it could be demonstrated that soil concentrations have declined below applicable PRGs.

A vegetative cover addresses chemical-specific ARARs of USEPA RSLs by preventing potential contact between receptors and soils exhibiting concentrations in excess of RSLs. Implementation of LUCs addresses location-specific ARARs by restricting potential residential exposure to COCs in soil through institutional controls, in addition to the installation of a physical barrier. Action-specific ARARs including adherence to air emission standards or NPDES requirements are not anticipated to apply to this alternative.

### 2.12.3 Summary of Estimated Remedy Costs

The information in the following cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file and/or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

**Selected Remedy Cost Estimates**

| Alternative | Total Cost | Present Worth Total Cost | Capital Cost | Total Annual O&M and Periodic Costs | Present Worth of Total Annual O&M and Periodic Costs | Estimated Timeframe of Alternative |
|---|---|---|---|---|---|---|
| Groundwater Alternative 3 | $1,176,160 | $702,242 | $158,727 | $1,017,433 | $543,515 | 30 Years |
| Soil Alternative 2 | $51,681 | $40,193 | $13,438 | $38,244 | $26,755 | 10 years |

Notes:
1. The estimated timeframe of each alternative assumed for costing may not reflect the actual time to cleanup.
2. Estimations based off USEPA Guidance (1988).

### 2.12.4 Expected Outcomes of Selected Remedy

The selected remedies are expected to result in restricted use of the site with exposure controlled through use of treatment and institutional controls. Long-term attenuation of CVOCs in groundwater and restriction of access (without removal) of impacted soils will require onsite LUCs prohibiting residential use of the site and prohibition of use of the shallow surficial aquifer as a potable water source.

## 2.13 Statutory Determinations

Under CERCLA and the NCP, selected remedies must be protective of human health and the environment, comply with ARARs (unless a waiver is justified), be cost effective, and use permanent solutions and treatment or resource recovery technologies to the extent practicable. The following sections discuss how the selected remedy meets these statutory requirements and explains the Five-Year Review requirements.

### 2.13.1 Protection of Human Health and the Environment

The selected remedies (Groundwater Alternative 3: ERD, MNA, and LUCs and Soil Alternative 2-Vegetative Cover and LUCs) are protective of human health and the environment.

Groundwater Alternative 3 will reduce the mass/volume of contaminants present in groundwater through ERD and MNA. This remedy will prevent direct exposure to contaminants through the use of onsite LUCs preventing use of groundwater as a potable source while COCs are still present above applicable screening levels.

Soil Alternative 2 will prevent direct exposure to contaminants in soil through the installation and maintenance of a vegetative cover and prevent unacceptable future risk by prohibiting residential use of the Site while COCs still exist at the site over PRGs.

### 2.13.2 Compliance with ARARs

Remedial actions selected must comply with all ARARs. ARARs for this project include:

- Chemical specific ARARs include USEPA RSLs for soil, USEPA MCLs and USEPA Region 4 Tapwater RSLs for groundwater.
- Location-specific ARARs include institutional controls such that HAA-01 remains a commercial/industrial use property to prevent residential exposure to COCs in soil and groundwater.
    - Residential PRGs and eco based PRGs have not been developed for the property. Remediation goals for COCs based on human health endpoints will also address marginal hazards to eco receptors.
- Action-specific ARARs identified include air emission standards for any air discharge and compliance with NPDES and base requirements for any treated water discharged to proximate canals.

The remedies will comply with all ARARs. ERD and MNA address the chemical specific ARARs of USEPA MCLs, and Region 4 Tapwater RSLs by source reduction of contamination until concentrations meet these requirements. LUCs address location-specific ARARs by restricting potential residential exposure to COCs in groundwater through application of institutional controls. Action-specific ARARs including adherence to air emission standards or NPDES requirements do not apply to this alternative as no air emissions or surface water discharges are anticipated.

### 2.13.3 Cost-Effectiveness

The cost-effectiveness of the proposed remedy must be considered. Cost effective remedies are considered those for which the costs are proportional to its overall effectiveness. While more than one cleanup alternative can be cost-effective, the NCP does not mandate that the selection of the most cost-effective cleanup alternative. The most cost-effective remedy may not necessarily be the remedy that provides the best tradeoff with respect to the remedy selection criteria.

Cost effectiveness is considered by evaluating the long-term effectiveness and permanence, reduction in TMV through treatment, and short-term effectiveness.

The selected remedies are cost effective. Groundwater Alternative 3 is more expensive than Groundwater Alternative 2 but is more effective in the long and short term, and in reduction of TMV. Alternative 3 is less expensive than Alternative 4 but is comparably effective in the long and short term, and in the reduction of TMV. Soil Alternative 2 is much less expensive than Alternative 3, while not quite as effective in the reduction of TMV. Soil Alternative 2 does prevent direct exposure to the contaminants in soil and is considered effective enough that the cost effectiveness is acceptable.

### 2.13.4 Utilization of Permanent Solutions and Alternative Treatment

The selected remedies provide the best balance of trade offs among the alternatives with respect to the balancing criteria such that it represents the maximum extent to which permanence and treatment can be practicably utilized at this time. Emphasis is placed on long term effectiveness and reduction of TMV through treatment, with a bias against off-site disposal. The selected groundwater remedy includes use of

ERD to actively reduce TMV of COCs in the DAACG with MNA for already decreasing COCs around the former FTA. This alternative was equally as effective in the long term and in reduction of TMV as Alternative 4 and more effective in both criteria than Alternative 2.

The selected soil remedy is effective in the long term by preventing potential contact with COCs in soil and provides the best balance of trade-offs. Alternative 2 limits the mobility of contaminants in soil with a vegetative cap. While Alternative 3 is more effective in the long term with removal of impacted soil, there is an NCP bias against off-site disposal. Alternative 2 is sufficiently effective in the long and short term, and sufficiently cost effective to outweigh the relatively greater long-term effectiveness/permanence of Alternative 3 (which also carries some negative aspects with risk to workers implementing the remedy).

### 2.13.5 Preference for Treatment as a Principal Element

This remedial action satisfies the statutory preference for treatment as a principal element in that the selected remedy for Groundwater utilizes treatment as a principal element. Treatment includes ERD to reduce TMV of COCs present. The selected remedy for soil does not involve treatment as a principal element, but there is no principal threat waste in soil at HAA-01 that would necessitate treatment over any other approach.

### 2.13.6 Five Year Review Requirements

CERCLA five-year reviews are required in any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use. These will be required for HAA-01 until it is demonstrated that soil and groundwater concentrations have declined below applicable PRGs. The review will evaluate whether the implemented remedies currently are or will be protective of human health and the environment, and whether additional action is required.

## 2.14 Documentation of Significant Changes

The Proposed Plans for HAA-01 were released for public comment in July 2021. The Proposed Plans identified Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 2 (vegetative cover) as the Preferred Alternatives. No comments were received during the public comment period, and no significant changes to the remedy as originally identified in the Proposed Plans were necessary or appropriate.

# 3 RESPONSIVENESS SUMMARY

## 3.1 Stakeholder Issues and Lead Agency Responses

The Proposed Plans for HAA-01 were released for public comment in July 2021. The Proposed Plans identified Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 2 (vegetative cover) as the Preferred Alternatives. No comments were received during the public comment period, and the State of Georgia supports the Preferred Alternatives without comment.

## 3.2 Technical and Legal Issues

There are no known technical or legal issues at this time.

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# Tables

**Table 2-1**

**Summary of Chemicals of Concern and Medium-Specific Exposure Pont Concentrations**

| Scenario Timeframe: Current | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Exposure Point | Chemical of Concern | Media | Exposure Media | Concentration Detected | | Units | Frequency of Detection | Exposure Point Concentration | Exposure Point Concentration Units | Statistical Measure |
| | | | | Min | Max | | | | | |
| Soil On-Site - Direct Contact | Benzo(a)pyrene | Soil (0-2ft) | Soil | 1.60E-01 | 2.6+01 | mg/kg | 18/44 | 5.28E+00 | mg/kg | UCL |
| Soil On-Site - Direct Contact | Benzo(a)pyrene | Soil (0-10ft) | Soil | 8.10E-02 | 2.60E+01 | mg/kg | 28/104 | 2.27E+00 | mg/kg | UCL |
| Groundwater - Drinking Water | Benzene | Groundwater | Drinking Water | 1.60E-04 | 1.40E-01 | mg/L | 41/95 | 5.10E-03 | mg/L | UCL |
| | Cis-1,2-dichloroethene | | | 2.20E-04 | 9.00E+00 | mg/L | 41/95 | 9.27E-01 | mg/L | UCL |
| | Vinyl Chloride | | | 1.30E-04 | 1.00E+00 | mg/L | 26/95 | 1.06E-01 | mg/L | UCL |

Notes:
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
UCL - Upper Confidence Limit

**Table 2-2a**
**Cancer Toxicity Data Summary**

| Pathway: Oral, Dermal | | | | | |
|---|---|---|---|---|---|
| Chemical of Concern | Oral Cancer Slope Factor | Dermal Cancer Slope Factor | Slope Factor Units | Weight of Evidence/Cancer Guideline Description | Source |
| Benzene | 5.50E-02 | 5.50E-02 | $(mg/kg/day)^{-1}$ | A | I |
| Benzo(a)pyrene | 1.00E+00 | 1.00E+00 | $(mg/kg/day)^{-1}$ | A | I |
| Cis-1,2-dichloroethene | NA | NA | $(mg/kg/day)^{-1}$ | B | NA |
| Vinyl Chloride | 7.20E-01 | 7.20E-01 | $(mg/kg/day)^{-1}$ | A | I |

| Pathway: Inhalation | | | | |
|---|---|---|---|---|
| Chemical of Concern | Inhalation Unit Risk | Slope Factor Units | Weight of Evidence/Cancer Guideline Description | Source |
| Benzene | 7.80E-06 | $(\mu g/m^3)^{-1}$ | A | I |
| Benzo(a)pyrene | 6.00E-04 | $(\mu g/m^3)^{-1}$ | B2 | I |
| Cis-1,2-dichloroethene | NA | $(\mu g/m^3)^{-1}$ | D | NA |
| Vinyl Chloride | 4.40E-06 | $(\mu g/m^3)^{-1}$ | A | I |

Notes:
$(mg/kg/day)^{-1}$ - Inverse miligram per kilogram per day (risk per unit dose)
$(\mu g/m^3)^{-1}$ - Inverse microgram per cubic meter (risk per unit does)
A - Human Carcinogen (sufficient evidence of carcinogenicity in humans) (USEPA, 2019a)
B - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
D - Not classifiable as to Human Carcinogenicity (inadequate or no evidence)
I - USEPA, Integrated Risk Information System (IRIS) (USEPA 2019a)
NA - Not available or applicable

**Table 2-2b**
**Non-Cancer Toxicity Data Summary**

| Pathway: Oral, Dermal | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chemical of Concern | Oral RfD Value (mg/kg/day) [a] | | | | Dermal RfD (mg/kg/day) [b] | | Primary Target Organ | Combined Uncertainty/Modifying Factors |
| | Subchronic | [ref] | Chronic | [ref] | Subchronic | Chronic | | |
| Benzene | 1.00E-02 | P | 4.00E-03 | I | 1.00E-02 | 4.00E-03 | Blood | medium/300 |
| Benzo(a)pyrene | NA | NA | 3.00E-04 | I | NA | 3.00E-04 | Developmental | medium/300 |
| Cis-1,2-dichloroethene | 2.00E-02 | P | 2.00E-03 | I | 2.00E-02 | 2.00E-03 | Kidney | low/3000 |
| Vinyl Chloride | 3.00E-03 | c | 3.00E-03 | I | 3.00E-03 | 3.00E-03 | Liver | medium/300 |

| Pathway: Inhalation | | | | | | |
|---|---|---|---|---|---|---|
| Chemical of Concern | Oral RfD Value (mg/kg/day) [a] | | | | Primary Target Organ | Combined Uncertainty/Modifying |
| | Subchronic | [ref] | Chronic | [ref] | | |
| Benzene | 8.00E-02 | P | 3.00E-02 | I | Blood | medium/300 |
| Benzo(a)pyrene | NA | NA | 2.00E-06 | I | Developmental | low to medium/3000 |
| Cis-1,2-dichloroethene | NA | NA | NA | NA | NA | NA |
| Vinyl Chloride | 7.67E-02 | A | 1.00E-01 | I | Liver | medium/300 |

Notes:
A - Agency for Toxic Substances Disease Registry (ATSDR 2017)
c - The chronic value is used if available
I - USEPA, Integrated Risk Information System (IRIS) (USEPA 2019a)
P - Provisional Peer Reviewed Toxicity Values (PPRTV) (USEPA 2019b)
NA - Not Applicable
mg/kg/day - Milligram per kilogram per day
[a] - Toxicity values were obtained following USEPA recommended hierarchy (USEPA 2003a)
[b] - The oral-to-dermal adjustment factor (oral absorption efficiency) as used to calculate the dermal RfD values (USEPA 2004b)

**Table 2-3**

**Risk Characterization Summary - Carcinogens and Non-Carcinogens**

**Scenario Timeframe: Current**
**Receptor Population: Current or Hypothetical Future Site Worker**
**Receptor Age: Adult**

| Medium | Exposure Medium | Exposure Point | Chemcial of Concern | Carcinogenic Risk | | | | Primary Target Organ/Critical Effect | Non-Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Oral | Dermal | Inhalation | Exposure Routes Total | | Oral | Dermal | Ingestion | Exposure Routes Total |
| Soil | Surface Soil (0-2ft) | Soil On-site - Direct Contact | Benzo(a)pyrene | 1.60E-06 | 8.90E-07 | 7.00E-12 | 2.49E-06 | Developmental | 1.50E-02 | 8.30E-03 | 1.60E-05 | 2.33E-02 |
| Soil | Surface Soil (0-10ft) | Soil On-site - Direct Contact | Benzo(a)pyrene | 6.90E-07 | 3.80E-07 | 3.00E-12 | 1.07E-06 | Developmental | 6.50E-03 | 3.60E-03 | 7.00E-06 | 1.01E-02 |
| Groundwater | Drinking Water | Shallow Aquifer - Tap Water | Benzene | 8.60E-07 | 9.30E-09 | 1.60E-06 | 2.47E-06 | Blood | 1.10E-02 | 1.20E-04 | 1.90E-02 | 3.01E-02 |
| | | | Cis-1,2-dichloroethene | NA | NA | NA | 0.00E+00 | Kidney | 4.00E+00 | 3.60E-02 | NA | 4.04E+00 |
| | | | Vinyl Chloride | 2.30E-04 | 1.30E-06 | 1.90E-05 | 2.50E-04 | Liver | 3.00E-01 | 1.70E-03 | 1.20E-01 | 4.22E-01 |
| | | | | | | **Soil Risk Total =** | **2.56E-04** | | | | **Soil Hazard Index Total =** | **4.52E+00** |
| | | | | | | **Groundwater Risk Total =** | **2.53E-04** | | | | **Groundwater Risk Total =** | **4.49E+00** |

**Scenario Timeframe: Current**
**Receptor Population: Hypothetical Future Construction Worker**
**Receptor Age: Adult**

| Medium | Exposure Medium | Exposure Point | Chemcial of Concern | Carcinogenic Risk | | | | Primary Target Organ/Critical Effect | Non-Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Oral | Dermal | Inhalation | Exposure Routes Total | | Oral | Dermal | Ingestion | Exposure Routes Total |
| Soil | Surface Soil (0-2ft) | Soil On-site - Direct Contact | Benzo(a)pyrene | NA | NA | NA | 0.00E+00 | Developmental | NA | NA | NA | 0.00E+00 |
| Soil | Surface Soil (0-10ft) | Soil On-site - Direct Contact | Benzo(a)pyrene | 4.80E-08 | 2.00E-08 | 2.80E-10 | 6.83E-08 | Developmental | NA | NA | NA | 0.00E+00 |
| Groundwater | Drinking Water | Shallow Aquifer - Tap Water | Benzene | NA | NA | NA | 0.00E+00 | Blood | NA | NA | NA | 0.00E+00 |
| | | | Cis-1,2-dichloroethene | NA | NA | NA | 0 | Kidney | NA | NA | NA | 0.00E+00 |
| | | | Vinyl Chloride | NA | NA | NA | 0.00E+00 | Liver | NA | NA | NA | 0.00E+00 |
| | | | | | | **Soil Risk Total =** | **6.83E-08** | | | | **Soil Hazard Index Total =** | **0.00E+00** |
| | | | | | | **Groundwater Risk Total =** | **0.00E+00** | | | | **Groundwater Risk Total =** | **0.00E+00** |

**Scenario Timeframe: Current**
**Receptor Population: Hypothetical Future Trench Worker**
**Receptor Age: Adult**

| Medium | Exposure Medium | Exposure Point | Chemcial of Concern | Carcinogenic Risk | | | | Primary Target Organ/Critical Effect | Non-Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Oral | Dermal | Inhalation | Exposure Routes Total | | Oral | Dermal | Ingestion | Exposure Routes Total |
| Soil | Surface Soil (0-2ft) | Soil On-site - Direct Contact | Benzo(a)pyrene | NA | NA | NA | 0.00E+00 | Developmental | NA | NA | NA | 0.00E+00 |
| Soil | Surface Soil (0-10ft) | Soil On-site - Direct Contact | Benzo(a)pyrene | 4.80E-08 | 2.00E-08 | 2.80E-10 | 6.83E-08 | Developmental | NA | NA | NA | 0.00E+00 |
| Groundwater | Drinking Water | Shallow Aquifer - Tap Water | Benzene | NA | NA | NA | 0.00E+00 | Blood | NA | NA | NA | 0.00E+00 |
| | | | Cis-1,2-dichloroethene | NA | NA | NA | 0.00E+00 | Kidney | NA | NA | NA | 0.00E+00 |
| | | | Vinyl Chloride | NA | NA | NA | 0.00E+00 | Liver | NA | NA | NA | 0.00E+00 |
| | | | | | | **Soil Risk Total =** | **6.83E-08** | | | | **Soil Hazard Index Total =** | **0.00E+00** |
| | | | | | | **Groundwater Risk Total =** | **0.00E+00** | | | | **Groundwater Risk Total =** | **0.00E+00** |

**Table 2-4**
**Ecological Exposure Pathways of Concern**

<table>
<tr><th>Exposure Medium</th><th>Sensitive Environment Flag (Y or N)</th><th>Receptor</th><th>Endangered/Threatened Species Flag</th><th>Exposure Routes</th><th>Assessment Endpoints</th><th>Measurement Endpoints</th></tr>
<tr><td rowspan="3">Surface Soil (0-2ft)</td><td>N</td><td>Terrestiral Wildlife</td><td>N</td><td>Incidental ingestion of soil, direct contact of surface soil, ingestion of prey tissue</td><td rowspan="6">• Sustainability of mammal populations;<br>• Sustainability of avian populations;<br>• Sustainability of terrestrial plant communities;<br>• Sustainability ofsoil invertebrate communities</td><td rowspan="6">•HQ is the measurment endpoint. The HQ is the ratio of the EPC of a given constituent to it's ecological screening value.</td></tr>
<tr><td>N</td><td>Terrestrial Soil Invertebrates</td><td>N</td><td>Direct contact of surface soil and ingestion of surface soil</td></tr>
<tr><td>N</td><td>Terrestrial Plants</td><td>N</td><td>Direct contact of surface soil</td></tr>
<tr><td rowspan="3">Soil (0-10ft)</td><td>N</td><td>Terrestiral Wildlife</td><td>N</td><td>Direct contact of surface soil and ingestion of subsurface soil</td></tr>
<tr><td>N</td><td>Terrestrial Soil Invertebrates</td><td>N</td><td>Direct contact of surface soil and ingestion of subsurface soil</td></tr>
<tr><td>N</td><td>Terrestrial Plants</td><td>N</td><td>Direct contact of subsurface soil</td></tr>
</table>

Notes:
HQ - Hazard Quotient
EPC - Exposure Point Concentration, lower of either UCL on the mean or the maximimum concentration

**Table 2-5**
**COPC Concentrations Expected to Provide Adequate Protection of Ecological Receptors**

| Potentially Impacted Species | Exposure Medium | COPC | Protective Level | Units | Basis | Assessment Endpoint |
|---|---|---|---|---|---|---|
| Short-tailed Shrew | Soil (0-2ft) | High Molecular Weight PAHs | 0.615 - 3.07 | mg/kg | Site specific LOAEL - NOAEL | • Sustainability of mammal populations;<br>• Sustainability of avian populations;<br>• Sustainability of terrestrial plant communities;<br>• Sustainability of soil invertebrate communities |
| American Robin | | | 10-100 | | | |
| Short-tailed Shrew | Comined Surface and Subsurface Soil | High Molecular Weight PAHs | 0.615 - 3.07 | | | |
| | | Dieldrin | 0.015 - 0.03 | | | |
| American Robin | | High Molecular Weight PAHs | 10 - 100 | | | |
| | | Dieldrin | 0.0709 - 3.78 | | | |

Notes:
mg/kg: Milligrams per kilogram
PAHs - Polycyclic aromatic hydrocarbons
LOAEL - Lowest observed adverse effect level
NOAEL - No observed adverse effect level

**Table 2-6a**
**Alternatives Summary and Evaluation – Groundwater**
**HAA-01 (Former Fire Training Area and DAACG Chlorinated Solvents Area) RI/FS**
**Hunter Army Airfield, Georgia**

| Evaluation Criteria | | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|---|---|
| | | No Action | MNA and LUCs | MNA, LUCs, and ERD | MNA, LUCs, and ISCO |
| **Threshold Criteria** | | | | | |
| 1) | Overall protection of human health and the environment | Does not provide overall protection of human health or the environment. Does not minimize, reduce, or control COC impacts or associated exposure risks. Source area RAOs would not be met. | Natural attenuation processes would be monitored while institutional controls would protect against human exposure to impacted groundwater. | ERD will enhance the rate of COC plume degradation while LUCs would protect against human exposure to groundwater impacts. Groundwater monitoring via MNA would be used to assess achievement of RAOs. | ISCO will enhance the rate of COC plume degradation while LUCs would protect against human exposure to groundwater impacts. Groundwater monitoring via MNA would be used to assess achievement of RAOs. |
| 2) | Compliance with ARARs | ARARs are not met with the No Action alternative as no remedy will be implemented | Natural attenuation would occur within an acceptable timeframe to achieve chemical-specific ARARs and would comply with location- and action-specific ARARs. | Natural attenuation and ERD treatment of COCs would occur within an acceptable timeframe to achieve chemical-specific ARARs and would comply with location- and action-specific ARARs | Natural attenuation and ISCO treatment of COCs would occur within an acceptable timeframe to achieve chemical-specific ARARs and would comply with location- and action-specific ARARs |
| **Balancing Criteria** | | | | | |
| 3) | Long-term effectiveness and permanence | Not effective or permanent. Potential exposure risks associated with COCs would remain with no controls or long-term management plan. | MNA and institutional controls would provide adequate and reliable long-term controls to assure exposure does not occur and would quantify the rate of the natural attenuation processes occurring at the site. | Effective in protecting human health and the environment as long as IRZ is well established and LUCs are maintained. | ISCO will treat mass flux of COC plume. As determined by MNA, a second ISCO injection may be necessary to achieve source reduction. |
| 4) | Reduction of mobility, toxicity, or volume | Natural attenuation processes may reduce mobility, toxicity, or volume of source area impacts, although monitoring of these processes would not be performed. | Reduces mobility, toxicity, and volume of VOCs in source area groundwater. | Permanently reduces mobility, toxicity, and volume of COCs via ERD and natural attentuation processes. | Permanently reduces mobility, toxicity, and volume of COCs via ISCO and natural attentuation processes. |
| 5) | Short-term effectiveness | No activities would be implemented that would present potential short-term exposure risks to human health or the environment. | Would result in minimal exposure risks to the community and workers via institutional controls while MNA will track plume migration and ensure that the remedy is protective of potential receptors in the short term. | Substrate injection wells and additional monitoring wells will be needed to monitor IRZ performance. EVO as the substrate injection compound for ERD will not result in additional risks to the community, workers, and the environment. MNA in will track plume migration in the short term. Potential risks are limited to onsite populations. | Requires use of hazardous chemicals that would result in moderate risks to the community, workers, and the environment. This approach would result in rapid oxidation of dissolved phase COCs. |
| 6) | Implementability | This alternative is technically implementable as no action would be taken. | Technically and administratively feasible, as site-wide monitoring well network already exists. | Technically and administratively feasible. Well installation and injection tasks would not interfere with ongoing operations at HAAF. | Technically and administratively feasible. Well installation and injection tasks would not interfere with ongoing operations at HAAF. |
| 7) | Cost | No cost. | $648,813 | $1,176,160 | $1,247,633 |

Notes:
All costs are estimated to an accuracy of +50 percent to -30 percent (per the USEPA Guide to Developing and Documenting Cost Estimates During the Feasibility Study, dated July 2000).

Abbreviations:
ARAR = Applicable or Relevant and Appropriate Requirement
COC = Constituent of Concern
ERD = Enhanced Reductive Dechlorination
EVO = Emulsified Vegetable Oil
IRZ = In-Situ Reactive Zone
ISCO = In-Situ Chemical Oxidation
LUC = Land Use Control
MNA = Monitored Natural Attenuation
RAO = Remedial Action Objective

From Pika/Arcadis 2019

**Table 2-6b**
**Alternatives Summary and Evaluation – Soil**
**HAA-01 (Former Fire Training Area and DAACG Chlorinated Solvents Area) RI/FS**
**Hunter Army Airfield, Georgia**

| Evaluation Criteria | | Alternative 1<br>No Action | Alternative 2<br>Capping - Vegetative Cover | Alternative 3<br>Excavation and Disposal |
|---|---|---|---|---|
| **Threshold Criteria** | | | | |
| 1) | Overall protection of human health and the environment | Does not provide overall protection of human health or the environment. Does not minimize, reduce, or control COC impacts or associated exposure risks. Source area RAOs would not be met. | Maintaining a vegetative cover would maintain RAOs by limiting exposure to impacted soils while LUCs would also be implemented to protect against current and future human exposure to soil impacts. | Excavation and disposal would maintain RAOs by physically eliminating current and future human exposure to soil impacts. |
| 2) | Compliance with ARARs | ARARs are not met, as no remedy will be implemented. | Alternative 2 would comply with chemical-specific, location-, and action-specific ARARs for soil. | Alternative 3 would comply with chemical-specific, location-, and action-specific ARARs for soil. |
| **Balancing Criteria** | | | | |
| 3) | Long-term effectiveness and permanence | Not effective or permanent. Potential exposure risks associated with COCs would remain with no controls or long-term management plan. | Alternative 2 would achieve long-term effectiveness and permanence through the maintenance of existing vegetative cover and implementation of LUCs. | Alternative 3 would achieve long-term effectiveness and permanence through the elimination of soil COCs. |
| 4) | Reduction of mobility, toxicity, or volume | Natural attenuation processes may reduce mobility, toxicity, or volume of source area impacts, although monitoring of these processes would not be performed. | Erosion control provided by a well-maintained vegetative cover will reduce mobility of COCs. Toxicity, volume, and mass of organic COCs may naturally attenuate over time. | Mobility, toxicity, and volume of soil COCs would completely be eliminated by Alternative 3. |
| 5) | Short-term effectiveness | No activities would be implemented that would present potential short-term exposure risks to human health or the environment. | Implementation would result in minimal exposure risks to the community and workers via LUCs while an existing vegetative cover already provides protection. | Alternative 3 would achieve short-term effectiveness and permanence through the elimination of soil COCs. |
| 6) | Implementability | This alternative is technically implementable as no action would be taken. | Vegetative cover already exists and only requires routine lawn maintenance. | While readily implementable, Alternative 3 may result in air quality effects and hazards from excavation and transportation to the community and workers. |
| 7) | Cost | No cost. | $51,681 | $964,561 |

Notes:
All costs are estimated to an accuracy of +50 percent to -30 percent (USEPA, 2000)

Abbreviations:
ARAR = Applicable or Relevant and Appropriate Requirement
COC = Constituent of Concern
LUC = Land Use Control
MNA = Monitored Natural Attenuation
RAO = Remedial Action Objective

From Pika/Arcadis 2019

**Table 2-7a**
**Comparative Analysis Score – Groundwater**
**HAA-01 (Former Fire Training Area and DAACG Chlorinated Solvents Area) RI/FS**
**Hunter Army Airfield, Georgia**

| Alternative No. | | Alternative 1 (DAACG and Former FTA) | Alternative 2 (Former FTA) | Alternative 3 (DAACG Area) | Alternative 4 (DAACG Area) |
|---|---|---|---|---|---|
| **Remedial Timeframes and Lifecycle Costs (1)** | | | | | |
| 1) | Remedy Name | No Action | MNA and LUCs | ERD in source area with downgradient MNA and onsite LUCs | ISCO in source area with downgradient MNA and onsite LUCs |
| 2) | Estimated Remedial Timeframe | 30 years | 10 years | 5 years | 5 years |
| 3) | Estimated Lifecycle Costs | | | | |
| **Remedy Performance Evaluation Ranking (2)** | | | | | |
| 1) | Overall protection of human health and the environment | **4** | **1** | **1** | **1** |
| 2) | Compliance with applicable regulations | **4** | **2** | **2** | **2** |
| 3) | Long-term effectiveness and permanence | **4** | **2** | **1** | **2** |
| 4) | Reduction of toxicity, mobility, and volume | **4** | **2** | **1** | **1** |
| 5) | Short-term effectiveness | **4** | **3** | **2** | **1** |
| 6) | Implementability | **4** | **2** | **2** | **3** |
| 7) | Relative Cost | **1** | **2** | **2** | **3** |
| 8) | Community Acceptance | **4** | **2** | **1** | **1** |
| | Total Ranking Score (Lowest score is the best performing) | **29** | **16** | **12** | **14** |
| | Average Score (Lowest score is the best performing) | **3.6** | **2.0** | **1.5** | **1.8** |

Notes:
(1) Includes an opinion of probable cost for capital expenses related to system installation, operations and maintenance, and management for the project lifecycle.
(2) Performance Ranking Scale:
1 = Most Favorable
4 = Least Favorable

Abbreviations:
DAACG = Departure/Arrival Airfield Control Group
ERD = Enhanced Reductive Dechlorination
FTA = Fire Training Area
ISCO = In Situ Chemical Oxidation
LUC = Land Use Control
MNA = Monitored Natural Attenuation

From Pika/Arcadis 2019

**Table 2-7b**
**Comparative Analysis Score – Soil**
**HAA-01 (Former Fire Training Area and DAACG Chlorinated Solvents Area) RI/FS**
**Hunter Army Airfield, Georgia**

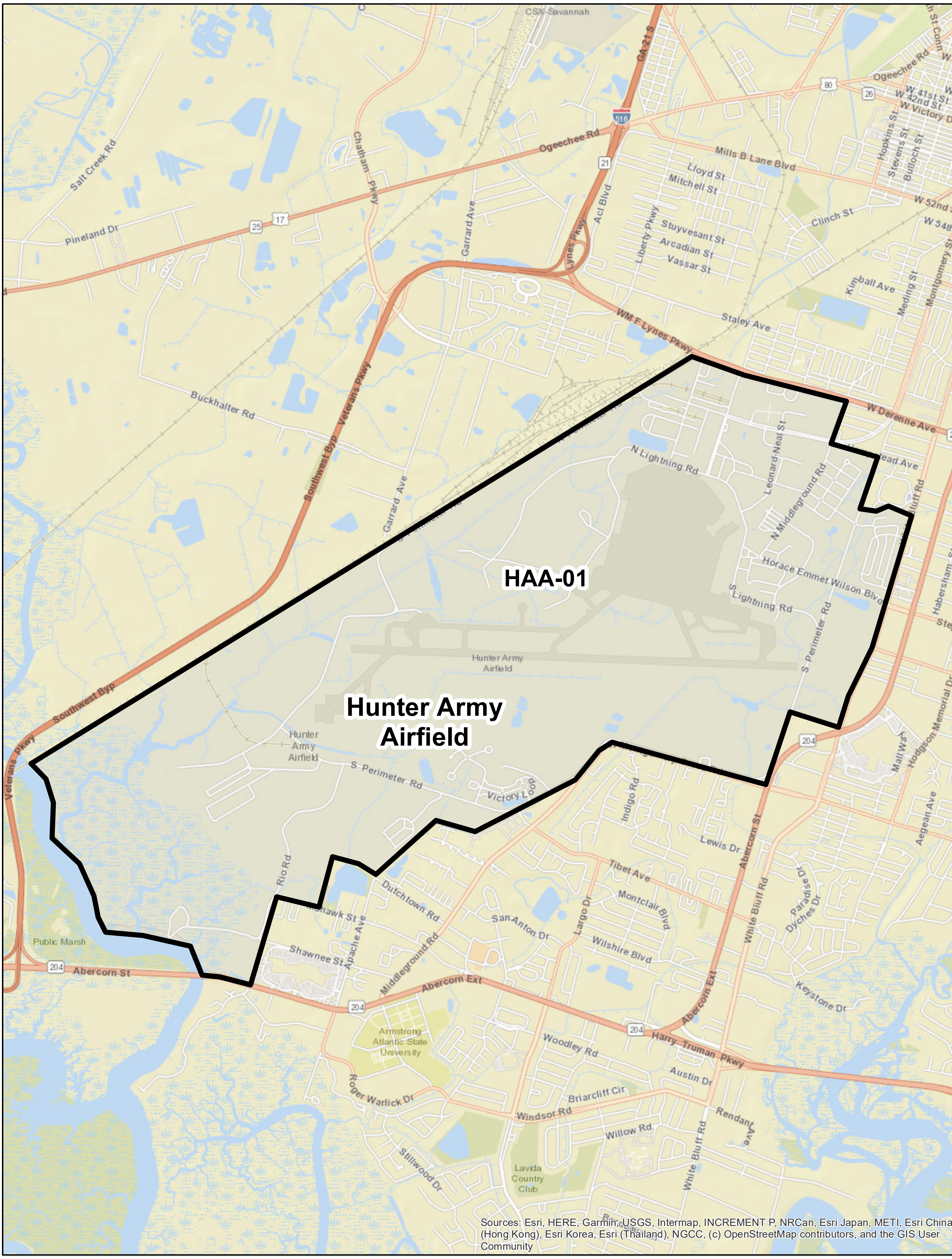
| Alternative No. | | Alternative 1 | Alternative 2 |
|---|---|---|---|
| **Remedial Timeframes and Lifecycle Costs (1)** | | | |
| 1) | Remedy Name | No Action | Vegetative Cover and LUCs |
| 2) | Estimated Remedial Timeframe | 30 years | 30 years |
| 3) | Estimated Lifecycle Costs | | |
| **Remedy Performance Evaluation Ranking (2)** | | | |
| 1) | Overall protection of human health and the environment | **4** | **2** |
| 2) | Compliance with applicable regulations | **4** | **2** |
| 3) | Long-term effectiveness and permanence | **4** | **3** |
| 4) | Reduction of toxicity, mobility, and volume | **4** | **3** |
| 5) | Short-term effectiveness | **4** | **3** |
| 6) | Implementability | **4** | **2** |
| 7) | Relative Cost | **1** | **2** |
| 8) | Community Acceptance | **4** | **3** |
| | Total Ranking Score (Lowest score is the best performing) | **29** | **20** |
| | Average Score (Lowest score is the best performing) | **3.6** | **2.5** |

Notes:
(1) Includes an opinion of probable cost for capital expenses related to system installation, operations and maintenance, and management for the project lifecycle.
(2) Performance Ranking Scale:
1 = Most Favorable
4 = Least Favorable

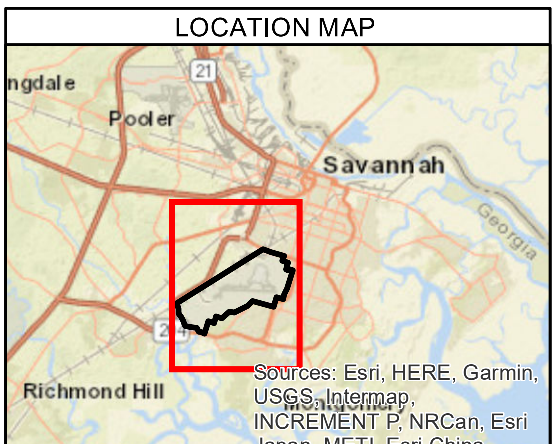
Abbreviations:
LUC = Land Use Control

From Pika/Arcadis 2019

# Figures




LOCATION MAP




0 2,000 4,000

Feet

NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17 N (feet)

LEGEND

Installation Boundary

TITLE

**Hunter Army Airfield**
**FTA/DAACG HAA-01**
**Site Location Map**

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 3/17/2021

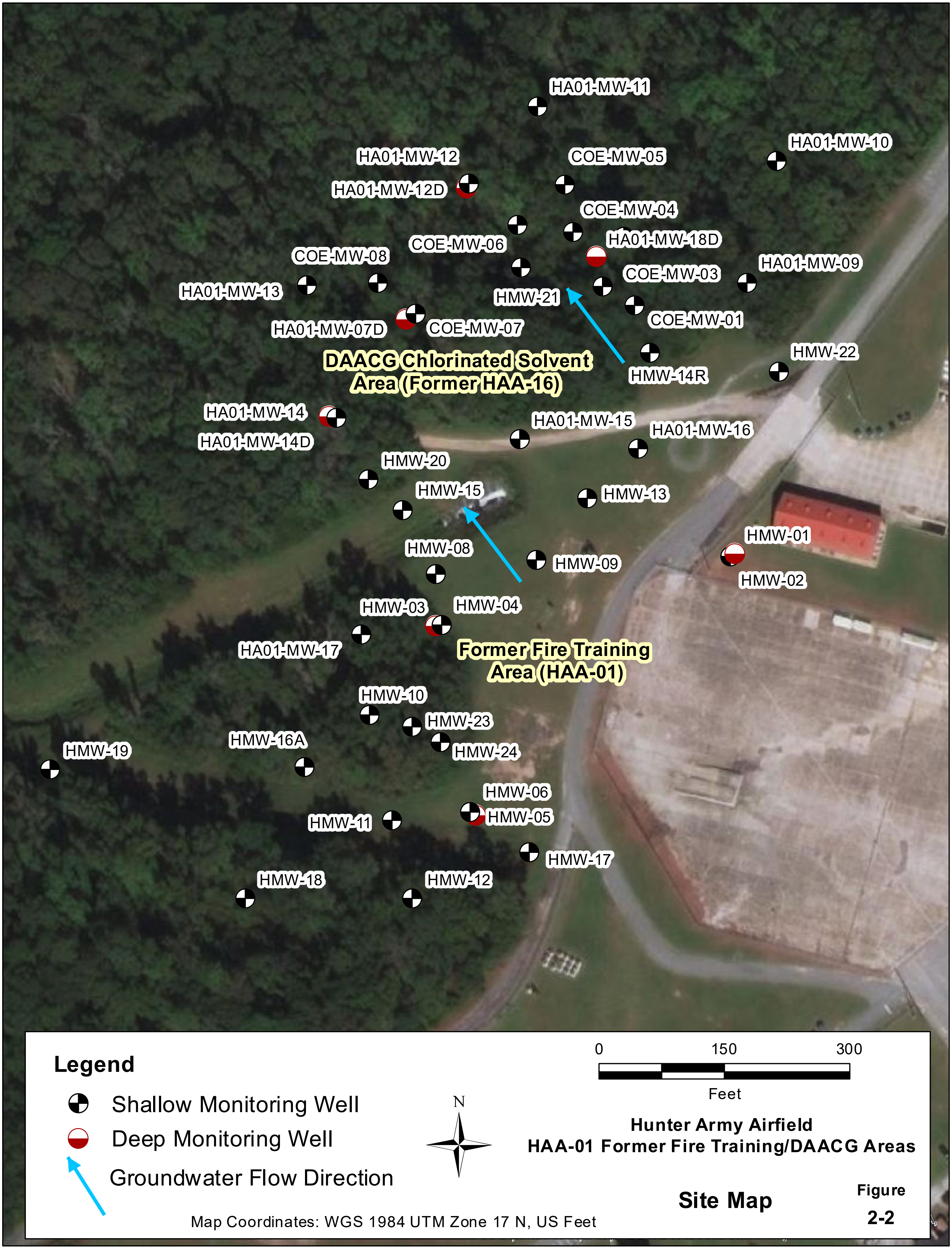
| Drawn by: | Reviewed by: |
|---|---|
| CJ | MSC |

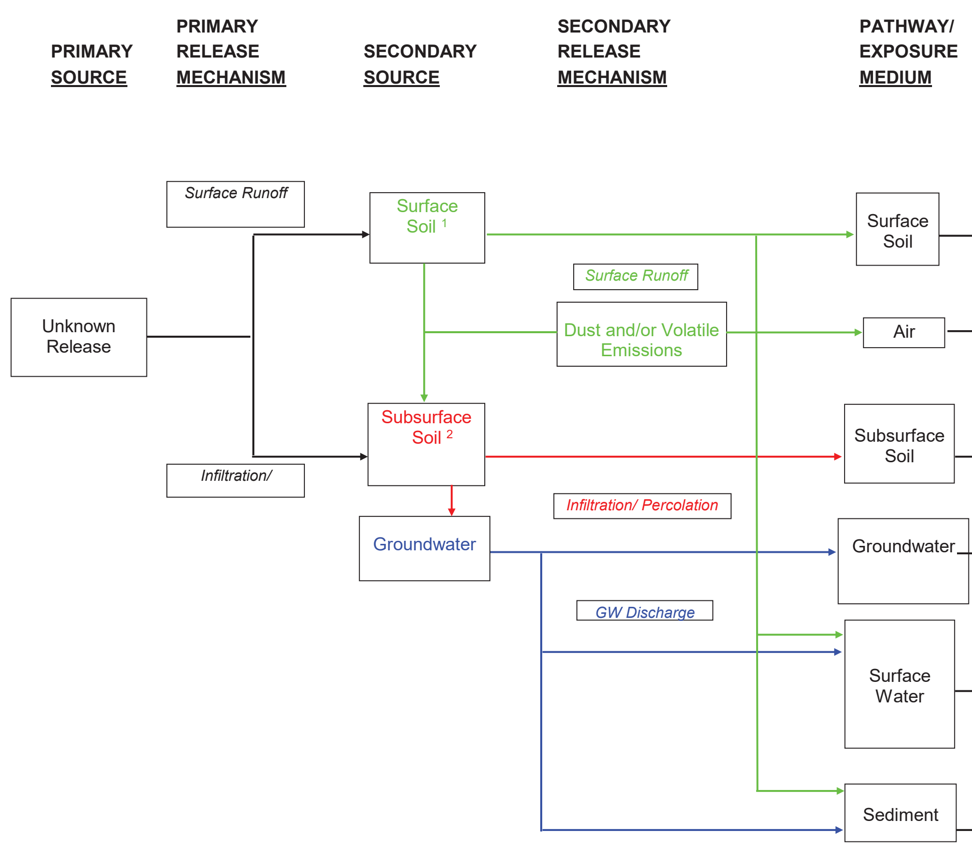
N

FIGURE

2-1

Document Path: L:\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Hunter Army Airfield\MXDs\HAA-01\Site_Location.mxd


HA01-MW-11
HA01-MW-10
HA01-MW-12
COE-MW-05
HA01-MW-12D
COE-MW-04
HA01-MW-18D
COE-MW-06
COE-MW-08
HA01-MW-09
COE-MW-03
HA01-MW-13
HMW-21
COE-MW-01
HA01-MW-07D
COE-MW-07
DAACG Chlorinated Solvent Area (Former HAA-16)
HMW-22
HMW-14R
HA01-MW-14
HA01-MW-15
HA01-MW-16
HA01-MW-14D
HMW-20
HMW-15
HMW-13
HMW-01
HMW-08
HMW-09
HMW-02
HMW-03
HMW-04
HA01-MW-17
Former Fire Training Area (HAA-01)
HMW-10
HMW-23
HMW-19
HMW-16A
HMW-24
HMW-06
HMW-05
HMW-11
HMW-17
HMW-18
HMW-12
Legend
Shallow Monitoring Well
Deep Monitoring Well
Groundwater Flow Direction
0
150
300
Feet
N
Hunter Army Airfield
HAA-01 Former Fire Training/DAACG Areas
Site Map
Figure 2-2
Map Coordinates: WGS 1984 UTM Zone 17 N, US Feet




| Pathway/ Exposure Medium | Exposure Route | Site Worker | Construction Worker | Hypothetical Futre Adult/Child Resident | Adolescent Trespasser | Terrestrial Wildlife | Soil Invertebrates | Terrestrial Plants |
|---|---|---|---|---|---|---|---|---|
| Surface Soil | Ingestion | x | x | x | x | x | x | NA |
| | Dermal Contact | x | x | x | x | x | x | NA |
| | Direct Contact/Uptake | NA | NA | NA | x | x | x | x |
| | Food Chain | NA | NA | NA | NA | x | NA | NA |
| Air | Inhalation | x | x | x | x | NA | NA | NA |
| Subsurface Soil | Ingestion | x | x | x | NA | x | x | NA |
| | Dermal Contact | x | x | x | NA | x | x | NA |
| | Direct Contact/Uptake | x | x | x | NA | x | x | x |
| | Food Chain | x | x | x | NA | x | NA | NA |
| Groundwater | Ingestion | NA | NA | NA | NA | NA | NA | NA |
| | Direct Contact/Uptake | NA | NA | NA | NA | NA | NA | NA |
| | Food Chain | NA | NA | NA | NA | NA | NA | NA |
| Surface Water | Ingestion | NA | NA | NA | x | NA | NA | NA |
| | Dermal Contact | NA | NA | NA | x | NA | NA | NA |
| | Inhalation of vapors | NA | NA | NA | x | NA | NA | NA |
| | Direct Contact/Uptake | NA | NA | NA | NA | NA | NA | NA |
| | Food Chain | NA | NA | NA | NA | NA | NA | NA |
| Sediment | Ingestion | NA | NA | NA | x | NA | NA | NA |
| | Dermal Contact | NA | NA | NA | x | NA | NA | NA |
| | Direct Contact/Uptake | NA | NA | NA | NA | NA | NA | NA |
| | Food Chain | NA | NA | NA | NA | NA | NA | NA |

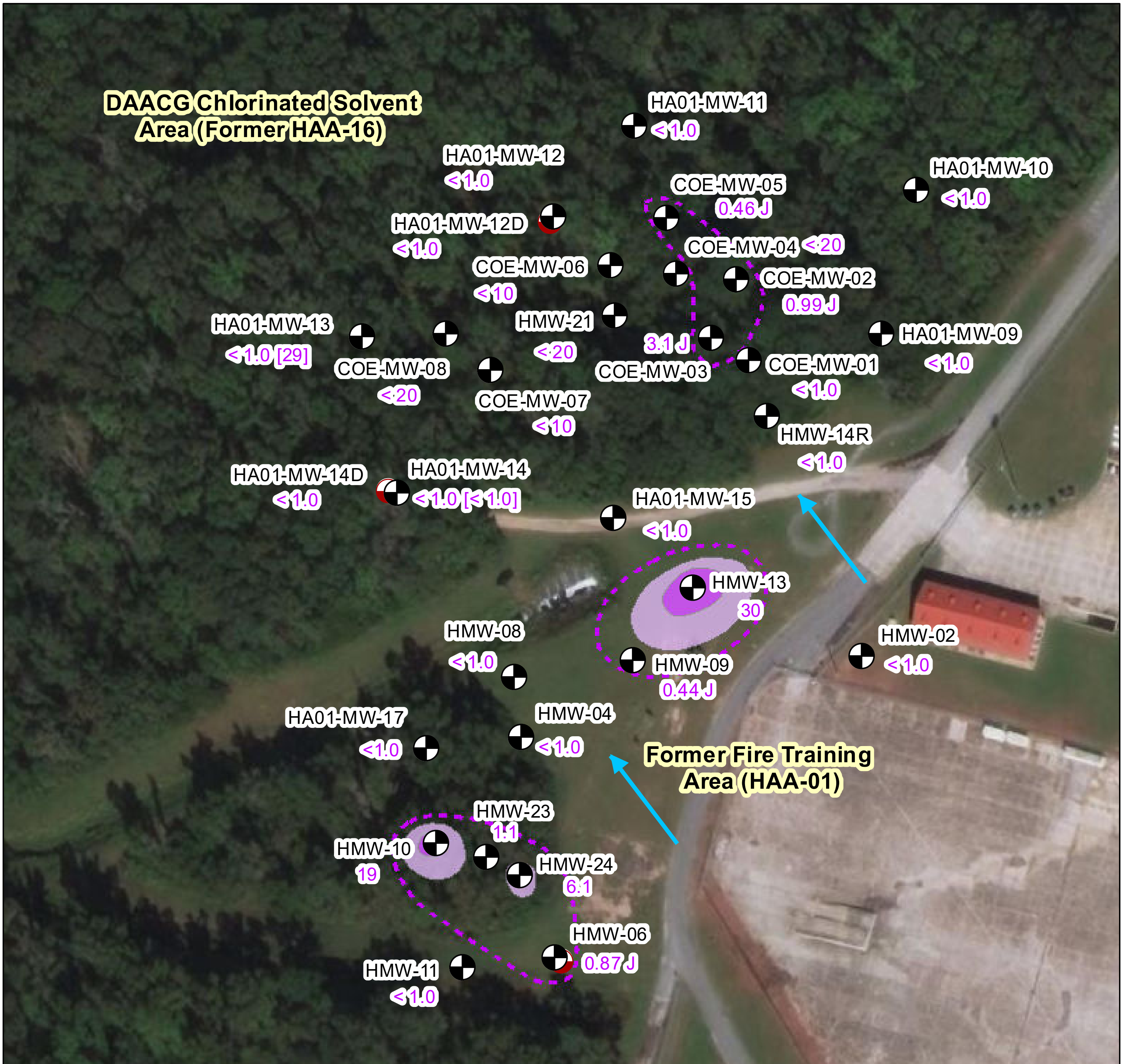
[1] Surface soil is defined as soil in the top 2 feet of the soil column for human receptors and in the top 1 foot of the soil column for non-burrowing ecological receptors.
[2] Combined surface and subsurface soil is defined as 0 to 10 feet for human receptors, while 0 to 4 feet is used for evaluation of potential exposure by burrowing animals and plants.

NA Pathway not applicable.
x Potential pathway.

From Pika/Arcadis 2019

**Conceptual Site Model for Potential Human and Ecological Receptors**
**HAA-01 (Former Fire Training Area and DAACG Chlorinated Solvent Area)**
**Hunter Army Airfield - Savannah, Georgia**

**Figure 2-3**




**Legend**

Map Coordinates: WGS 1984 UTM Zone 17 N, US Feet

0 150 300
Feet

- Shallow Monitoring Well
- Deep Monitoring Well
- Groundwater Flow Direction
- 29 Benzene Concentration
- [29] Duplicate Sample Concentration

Benzene Isocontour

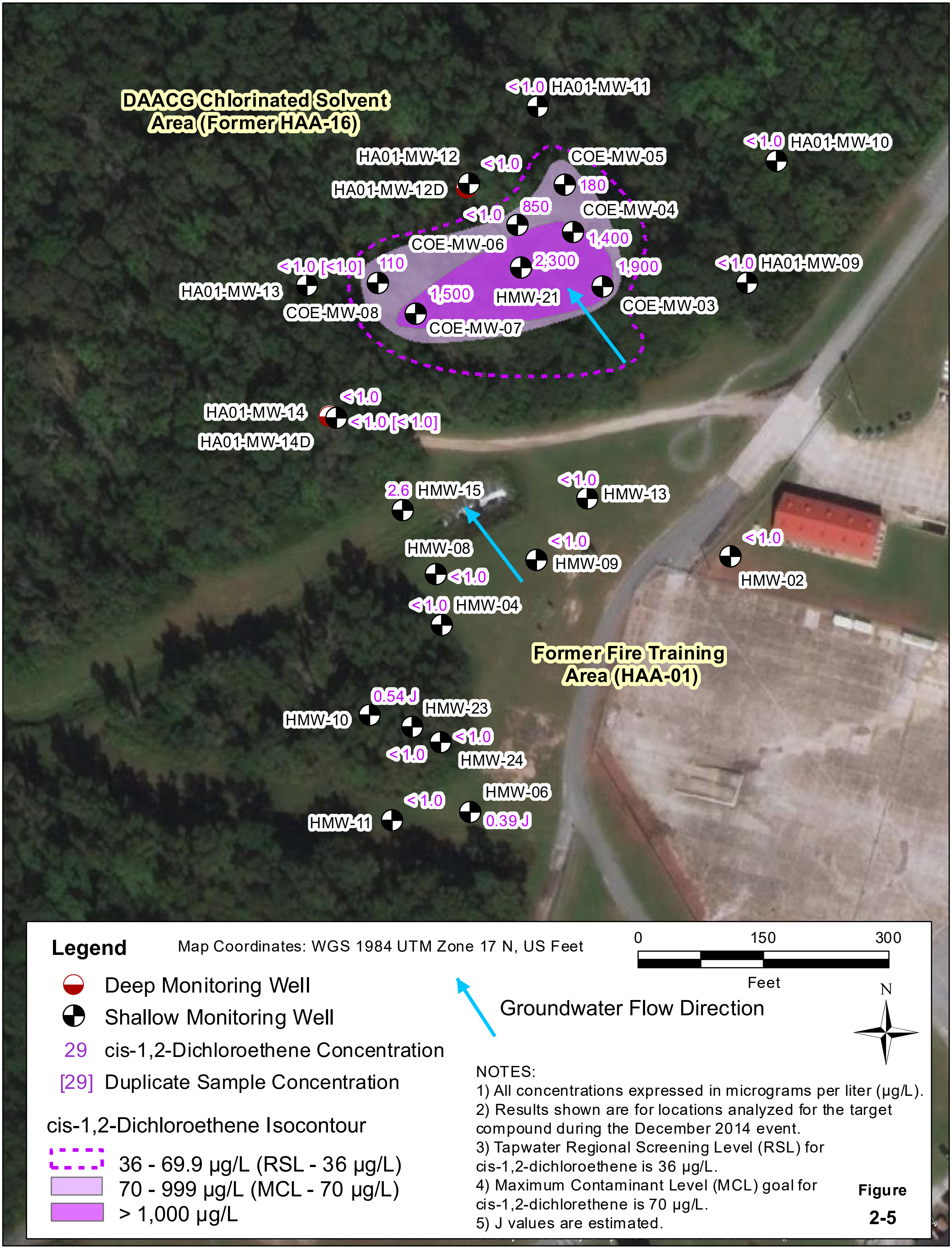
- 0.45 - 4.9 µg/L (RSL - 0.45 µg/L)
- 5.0 - 10 µg/L (MCL - 5.0 µg/L)
- > 10 µg/L

NOTES:
1) All concentrations expressed in micrograms per liter (µg/L).
2) Results shown are for locations analyzed for the target compound during the December 2014 event.
3) Tapwater Regional Screening Level (RSL) for benzene is 0.45 µg/L.
4) Maximum Contaminant Level (MCL) goal for benzene is 5.0 µg/L.
5) J values are estimated.
6) "<" denotes concentrations that were not detected at the Method Detection Limit, which is the value listed.

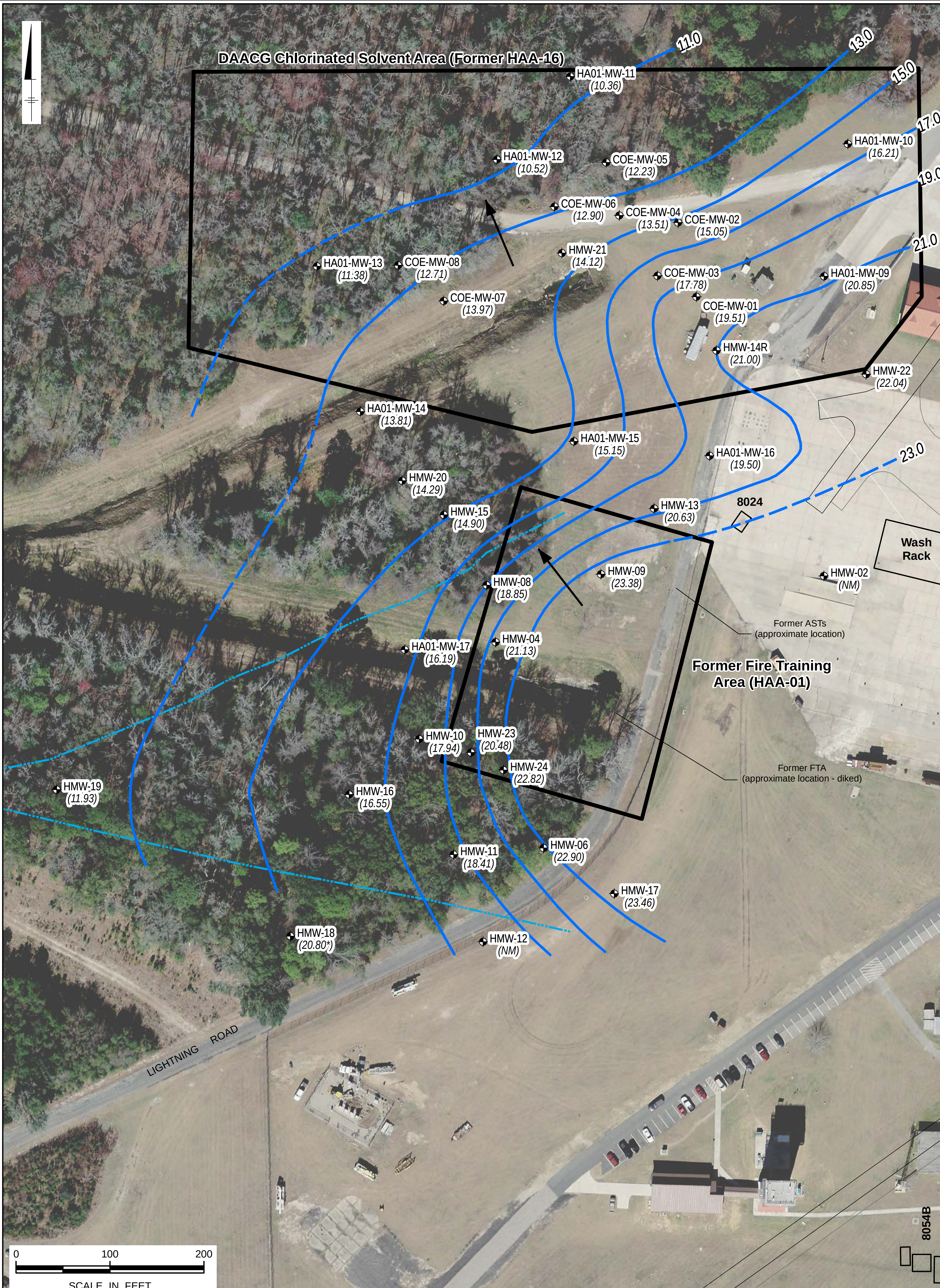
N

**Figure**

**2-4**



DAACG Chlorinated Solvent Area (Former HAA-16)
<1.0 HA01-MW-11
<1.0 HA01-MW-10
HA01-MW-12
<1.0
HA01-MW-12D
COE-MW-05
180
<1.0
850
COE-MW-04
1,400
COE-MW-06
2,300
<1.0 [<1.0]
110
1,900
<1.0 HA01-MW-09
HA01-MW-13
1,500
HMW-21
COE-MW-08
COE-MW-07
COE-MW-03
<1.0
HA01-MW-14
<1.0 [<1.0]
HA01-MW-14D
2.6 HMW-15
<1.0
HMW-13
<1.0
HMW-09
<1.0
HMW-02
HMW-08
<1.0
<1.0 HMW-04
Former Fire Training Area (HAA-01)
0.54 J
HMW-23
HMW-10
<1.0
<1.0
HMW-24
HMW-06
<1.0
HMW-11
0.39 J
Legend
Map Coordinates: WGS 1984 UTM Zone 17 N, US Feet
0 150 300
Feet
Deep Monitoring Well
Shallow Monitoring Well
29 cis-1,2-Dichloroethene Concentration
[29] Duplicate Sample Concentration
Groundwater Flow Direction
N
cis-1,2-Dichloroethene Isocontour
36 - 69.9 µg/L (RSL - 36 µg/L)
70 - 999 µg/L (MCL - 70 µg/L)
> 1,000 µg/L
NOTES:
1) All concentrations expressed in micrograms per liter (µg/L).
2) Results shown are for locations analyzed for the target compound during the December 2014 event.
3) Tapwater Regional Screening Level (RSL) for cis-1,2-dichloroethene is 36 µg/L.
4) Maximum Contaminant Level (MCL) goal for cis-1,2-dichlorethene is 70 µg/L.
5) J values are estimated.
Figure
2-5




PROJECTION: NAD83 StatePlane Georgia East Feet
AERIAL SOURCE: SAGIS (2008).

**LEGEND**

- Storm Water Drainage Canal
- Monitoring Well (shallow)
- (NS) Not Surveyed
- (NM) Not Measured
- ft amsl - feet above mean sea level
- (21.80*) Not Used to Construct Contours
- (11.93) Groundwater Elevation (ft amsl) Measured December 12, 2014
- Groundwater Contour (ft amsl)
- Inferred where dashed
- Direction of Groundwater Flow

HUNTER ARMY AIRFIELD, GEORGIA

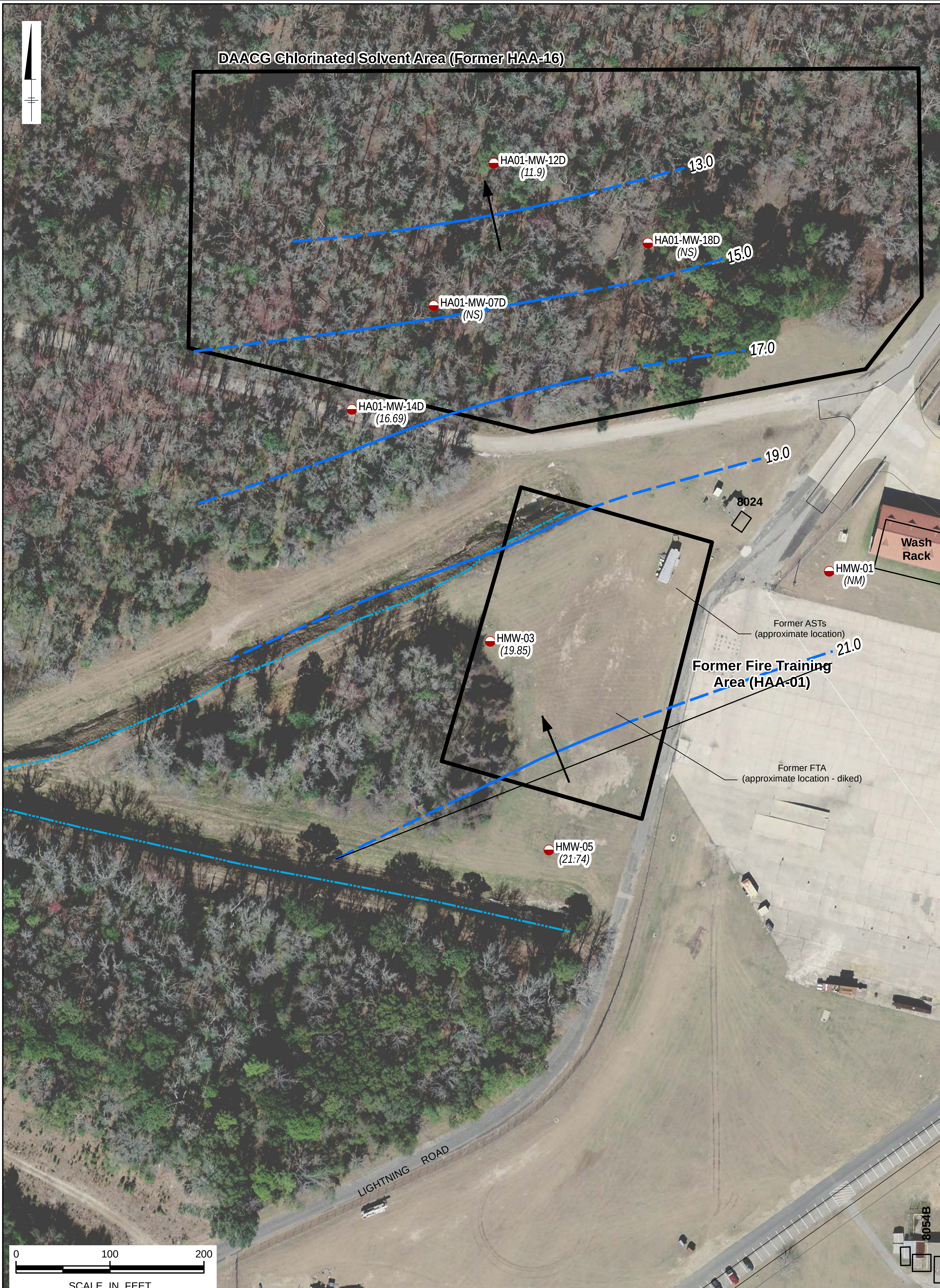
**HAA-01 FORMER FIRE TRAINING/DAACG AREAS REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

**Shallow Potentiometric Surface Map (December 2014)**

Pika/Arcadis 2019

FIGURE **2-6**

CITY: CITRIX DIV/GROUP: IM/DV LD: (B.ALTOM) PIC: (T.TALELE) PM: (S.GIBBONS) TM: (M.SACCENTE) BY: KSINSABAUGH
PROJECT: 10153001.0001.EE001 PATH: Z:\GISPROJECTS_ENV\HAAF_PIKA\MAPDOCS\H01\2017\H01 RIFS\F3-2B H01_RIFS 201412 POT D.MXD SAVED: 6/19/2017




PROJECTION: NAD83 StatePlane Georgia East Feet
AERIAL SOURCE: SAGIS (2008).

**LEGEND**

- Storm Water Drainage Canal
- Monitoring Well (deep)
- (NS) Not Surveyed
- (NM) Not Measured
- (21.74) Groundwater Elevation (ft amsl) Measured December 12, 2014
- Groundwater Contour (ft amsl)
- Inferred where dashed
- Direction of Groundwater Flow

ft amsl - feet above mean sea level

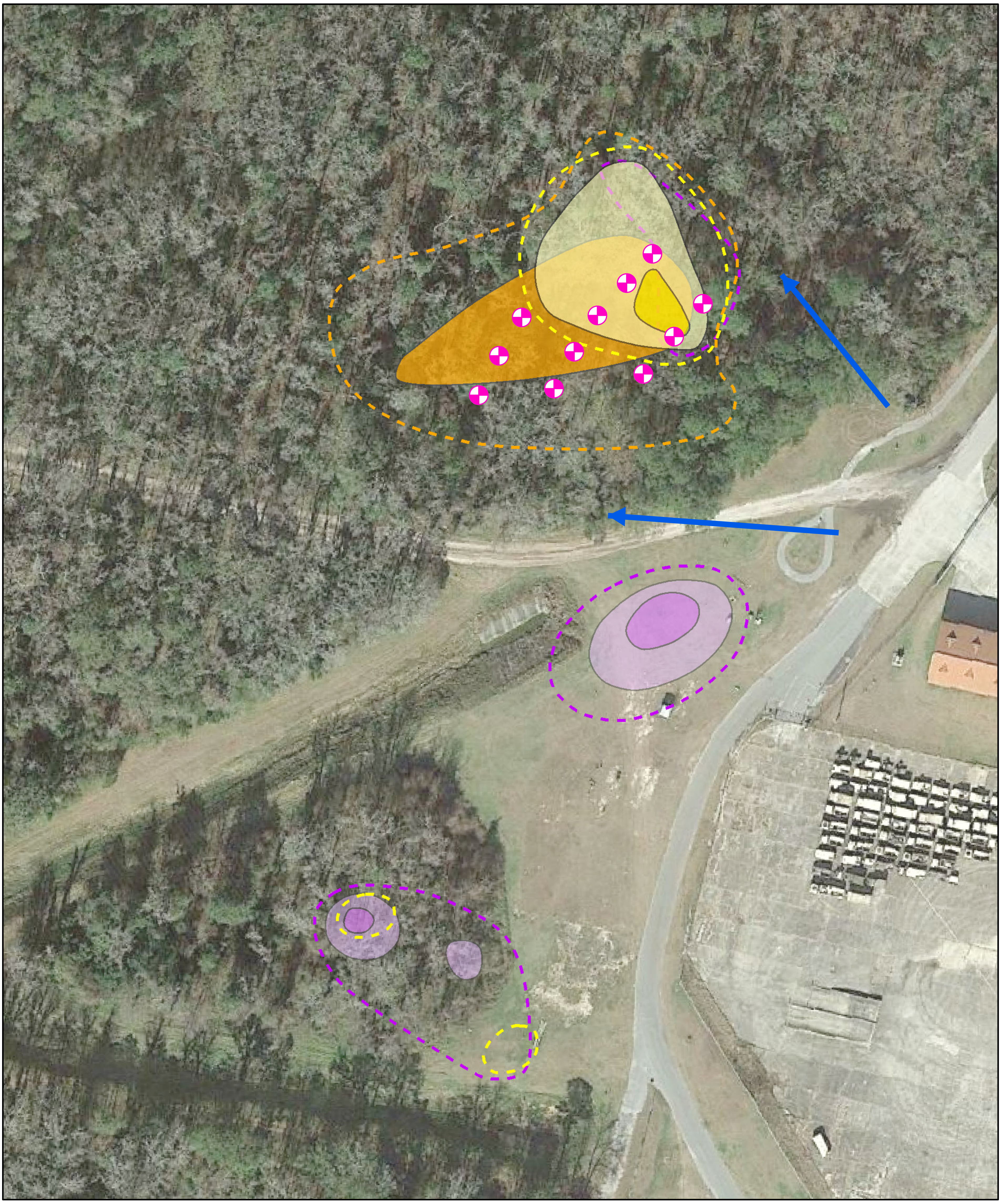
HUNTER ARMY AIRFIELD, GEORGIA

**HAA-01 FORMER FIRE TRAINING/DAACG AREAS REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

**Deep Potentiometric Surface Map (December 2014)**

Pika/Arcadis 2019

FIGURE **2-7**



LEGEND

| | | |
|---|---|---|
| cis1,2-DCE >1,000 | Vinyl Chloride >100 | Benzene > 10 |
| cis1,2-DCE 70-999 | Vinyl Chloride 10-100 | Benzene 5.0 - 10 |
| cis1,2-DCE 36-69.9 | Vinyl Chloride 2.0-9.9 | Benzene 0.45 - 4.9 |
| Groundwater Flow Direction | Vinyl Chloride 0.019-1.9 | Planned Injection Wells |

0 50 100

Feet

NOTES & SOURCES

Map Coordinates: NAD 83
State Plane Georgia East (Feet)

All concentrations in µg/L

N

KEMRON ENVIRONMENTAL SERVICES ATLANTA, GEORGIA

DRAWING DATE: 3/10/21

PROJECT: HAA-01
Hunter Army Airfield
Savannah, GA

Drawn by: CJ

Reviewed by: MSC

TITLE

**HAA-01 Planned Injection Wells and Primary Groundwater COCs**

FIGURE

**2-8**

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# Appendix A

# GAEPD Approval Letter

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

**Richard E. Dunn, Director**

**Land Protection Branch**
2 Martin Luther King, Jr. Drive
Suite 1054, East Tower
Atlanta, Georgia 30334
404-656-7802

March 10, 2021

Mr. James L. Heidle, Public Works Director
Headquarters, 3D Infantry Division (Mechanized) and Fort Stewart
Directorate of Public Works, Building 1137
Environmental Branch
1550 Veterans Parkway
Fort Stewart, GA 31314-4927

RE: Final Proposed Plan for HAA-01 Former Fire Training Area and Departure/Arrival Airfield Control Group Chlorinated Solvent Area; Hunter Army Airfield, Savannah, Georgia.

Dear Mr. Heidle:

The Land Protection Branch of the Georgia Environmental Protection Division (EPD) has reviewed the above referenced document, received December 18, 2020. Based on that review, no comments were generated. A copy of the document will be placed on file at EPD's office.

Should you have any questions concerning this correspondence, please contact Sharon Priyadarshini or Mo Ghazi at (404) 656-2833.

Sincerely,

*Kim B. Hembree*

Kim Hembree, Manager
Department of Defense Facilities Unit
Hazardous Waste Management Program

cc: Tressa Rutland, Fort Stewart (tressa.m.rutland2.civ@mail.mil)
Algeana L. Stevenson (algeana.l.stevenson.civ@mail.mil)

File: Hunter Army Airfield (G)

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