FINAL

FORSCOM

# CORRECTIVE ACTION PLAN

# for the

3d Inf Div (Mech)

# TAC-X LANDFILL (SOLID WASTE MANAGEMENT UNIT 3) at FORT STEWART MILITARY RESERVATION FORT STEWART, GEORGIA

Prepared for

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT

Contract No. DACA21-95-D-0022
Delivery Order 0062

**December 2000**

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REGULATORY AUTHORITY
Resource Conservation and Recovery Act
40 CFR 264, Title II, Subpart C, Section 3004;
42 USC 6901 et seq.

Prepared for
U.S. Army Corps of Engineers
Savannah District
Under Contract DACA21-95-D-0022
Delivery Order Number 0062

Prepared by
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December 2000

The undersigned certifies that I am a qualified groundwater scientist who has received a baccalaureate or postgraduate degree in the natural sciences or engineering and that I have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, to enable me to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport. I further certify that this report was prepared by myself or by a subordinate working under my direction.

12/20/00

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00-275(doc)/121800

**SCIENCE APPLICATIONS INTERNATIONAL CORPORATION**

contributed to the preparation of this document and should not
be considered an eligible contractor for its review.

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# ACRONYMS

| | |
|---|---|
| amsl | above mean sea level |
| AWQC | Ambient Water Quality Criterion |
| bgs | below ground surface |
| BHHRA | baseline human health risk assessment |
| BMP | Base Master Plan |
| CAP | Corrective Action Plan |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CMCOPC | contaminant migration constituent of potential concern |
| COC | constituent of concern |
| DERP | Defense Environmental Restoration Program |
| DO | dissolved oxygen |
| DoD | U.S. Department of Defense |
| DPW | Directorate of Public Works |
| ECOPC | ecological constituent of potential concern |
| EPA | U.S. Environmental Protection Agency |
| ESV | ecological screening value |
| FSMR | Fort Stewart Military Reservation |
| GEPD | Georgia Environmental Protection Division |
| GSSL | Generic Soil Screening Level |
| HHCOPC | human health constituent of potential concern |
| HHPRE | human health preliminary risk evaluation |
| HQ | hazard quotient |
| ILCR | incremental lifetime cancer risk |
| MCL | maximum contaminant level |
| O&M | operations and maintenance |
| ODAST | One-dimensional Analytical Solute Transport |
| PCB | polychlorinated biphenyl |
| RCRA | Resource Conservation and Recovery Act |
| Redox | oxidation-reduction potential |
| RFI | RCRA Facility Investigation |
| SRC | site-related contaminant |
| SVOC | semivolatile organic compound |
| SWMU | Solid Waste Management Unit |
| USACE | U.S. Army Corps of Engineers |
| VOC | volatile organic compound |

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# 1.0 INTRODUCTION

## 1.1 SCOPE

This report documents the Corrective Action Plan (CAP) for the TAC-X Landfill, Solid Waste Management Unit (SWMU) 3 at the Fort Stewart Military Reservation (FSMR), Georgia. A Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was conducted in November and December of 1997. The revised final Phase II RFI Report (SAIC 2000) determined that this SWMU required a CAP to evaluate appropriate remedial actions to eliminate or minimize potential risks associated with the TAC-X Landfill. Implementation of the remedy selected in this CAP is required for this site to protect the health of humans coming in contact with the site. This report has been prepared by Science Applications International Corporation for the U.S. Army Corps of Engineers (USACE), Savannah District, under Contract DACA21-95-D-0022, Delivery Order No. 0062.

The TAC-X Landfill is located about 1.25 miles south of the northern Fort Stewart boundary, approximately 3.5 miles south-southwest of Pembroke, Georgia, and less than 1 mile southeast of Dean Field and the TAC-X (Noncommissioned Officers' Academy). The site is accessed by a 0.1-mile unpaved road on the southwestern side of Fort Stewart Road 42. The TAC-X Landfill comprises approximately 6.3 acres, with two trenchlike depressions present at the site. One of the trenches is reportedly unused. The reported dimensions of the disposal trench are 20 feet wide by 400 feet long by 5 feet to 6 feet deep. A site reconnaissance in November 1993 observed household-type debris (e.g., plastic spoons and bags) within the overburden pile on the western side of the disposal trench. Aged refuse is reported to be present at the bottom of the disposal trench (Geraghty and Miller 1992). Further background information concerning the landfill is provided in Chapter 2. The history of the TAC-X Landfill is summarized in Section 2.1.

Based on the findings presented in the revised final Phase II RFI Report for 16 SWMUs dated April 2000 (SAIC 2000), a "no further action required" status has been assigned to the TAC-X Landfill for investigative purposes. As recommended by the revised final Phase II RFI Report for 16 SWMUs and as concurred to by the Georgia Environmental Protection Division (GEPD) (approval letter from Mr. Bruce Khaleghi to Colonel Gregory Stanley dated December 8, 2000), a CAP has been prepared for SWMU 3 because buried waste will remain in place. Implementation of the selected remedy documented by this CAP is necessary to control intrusive activities at this site, to be protective of the health of humans potentially coming in contact with the buried waste, and to prevent the use of groundwater as a drinking water source. As concurred to by GEPD, this CAP has been prepared to evaluate the use of institutional controls to protect human health. A "no action" alternative is also presented and evaluated to provide a comparison to the institutional controls alternative.

The CAP describes and provides designs for the selected remedy and includes plans for its implementation along with a plan for operations and maintenance (O&M) of the selected remedy. Also included in this plan are a detailed cost estimate and a schedule of implementation for the selected corrective action.

## 1.2 SITE BACKGROUND

USACE installed four monitoring wells in 1980, and groundwater and surface water samples were collected that same year. Iron was detected at concentrations that exceeded the drinking water standard. Chemical data from the site indicated that the surface water in the area was not being significantly degraded as a result of past operation of the landfill. Iron concentrations in the surface water near the landfill were reported as high; however, concentrations of iron near background values were reported a short distance from the landfill. Four soil borings were installed to a depth of 50 feet, and one soil boring was installed to a depth of 100 feet during a 1982 Environmental Science and Engineering study. Subsurface soil samples were collected for analysis of geotechnical parameters. No samples were submitted for analysis of chemical parameters. In 1993, as part of the Phase I RFI, one surface soil sample was collected from a location near the southern end of the marshy area and analyzed for volatile organic compounds (VOCs), total RCRA metals, and pesticides/polychlorinated biphenyls (PCBs). Groundwater samples were collected from four monitoring wells using non-low-flow techniques. Groundwater was analyzed for VOCs, total RCRA metals, and pesticides/PCBs. Due to drought conditions, a surface water sample was not collected from the marshy area. Arsenic and lead are considered to be site-related contaminants (SRCs) in surface soil based upon the Phase I RFI. 2-Butanone was detected in groundwater. Lead was detected in monitoring well TX-M3 at a concentration above the reference background criterion, but not above its U.S. Environmental Protection Agency (EPA) action level. Non-low-flow techniques were used to collect the groundwater samples, and the elevated lead concentration might be due to particulates in groundwater. The Phase I RFI recommended that a Phase II RFI be performed at SWMU 3.

The objectives for the Phase II RFI, as defined by the Phase II RFI Sampling and Analysis Plan (SAIC 1997) approved by GEPD on October 10, 1997, were as follows:

- determine the horizontal and vertical extents of contamination;
- determine whether contaminants present a threat to human health or the environment;
- determine the need for future action and/or no further action; and
- gather data necessary to support a CAP, if warranted.

The scope of the Phase II fieldwork included the following activities:

- Initial installation of three soil borings and one background well. It was determined during redevelopment of existing wells during the Phase II RFI, however, that the screened intervals of presently existing monitoring wells MW2, MW3, and MW4 were below the water table; therefore, three additional monitoring wells (MW6, MW7, and MW8) were installed near existing wells at the water table. A surface soil sample and a subsurface soil sample were collected from each boring/well. In addition, three surface soil samples were collected from within the trenches of the landfill. All surface and subsurface soil samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides/PCBs, and RCRA metals.

- Installation of four groundwater monitoring wells. Geotechnical samples were collected from the four monitoring well boreholes. The groundwater samples collected from the four newly installed and four existing monitoring wells were analyzed for VOCs, SVOCs, pesticides/PCBs, and RCRA metals. Conductivity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (Redox), and turbidity were measured in the field during sampling.

- Collection of groundwater samples from three hand-auger holes located in the depression area downgradient of the trenches. The groundwater samples collected from the three hand-auger locations were analyzed for VOCs, SVOCs, pesticides/PCBs, and RCRA metals. In addition, dissolved RCRA metals analysis was performed on the groundwater samples. Conductivity, temperature, pH, DO, Redox, and turbidity were measured in the field during sampling.

- Collection of two surface water samples and two sediment samples from the depression area into which the two trenches drain. No upstream locations were available at the site for sampling. The surface water and sediment samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and RCRA metals. One of the sediment locations (SWS1) was resampled for VOCs only on November 30, 1999, to confirm or deny the elevated concentrations of VOCs detected in the first set of samples.

## 1.3 REGULATORY BACKGROUND

Executive Order 12088, signed in 1978, requires federal facilities to comply with federal, state, and local pollution requirements. The Defense Environmental Restoration Program (DERP) was formally established in fiscal year 1984 to promote and coordinate efforts for the evaluation and cleanup of contamination at U.S. Department of Defense (DoD) installations. Executive Order 12580, signed January 23, 1987, relates to Superfund implementation and assigns responsibility for carrying out the DERP to the Secretary of Defense. The Installation Restoration Program was established as part of the DERP to assess potential contamination at DoD installations and formerly used properties and to address site cleanups, as necessary. With the promulgation of RCRA and the subsequent approval of the Georgia Hazardous Waste Management Act by EPA, the state was granted RCRA permitting authority. In accordance with RCRA, the state issued to Fort Stewart, in August 1987, a Hazardous Waste Facility Permit [Georgia Environmental Division Permit No. HW-045 (S&T)]. The permit was renewed in August 1997. The TAC-X Landfill (SWMU 3) is a listed SWMU in Fort Stewart's Subpart B Permit (Appendix A) and, therefore, is subject to investigation according to Title 40, Code of Federal Regulations, Part 264.101(c) [as reported in Section 10.2 of the revised final Phase II RFI Report for 16 SWMUs, dated April 2000 (SAIC 2000)] and to corrective action (the subject of this CAP), if necessary.

## 1.4 REPORT ORGANIZATION

This CAP report is divided into six chapters: (1) Introduction, (2) Site Characterization and Remedial Investigation Results, (3) Justification/Purpose of Corrective Action, (4) Screening of Corrective Actions, (5) Conceptual Design and Implementation Plan, and (6) References. Chapter 1 (Introduction) provides an explanation of the scope of the CAP, presents general background information on the FSMR and specific background information on the site, and provides regulatory background information. Chapter 2 (Site Characterization and Remedial Investigation Results) provides an overview of the site; physical and environmental descriptions; and the nature and extent of contamination, contaminant fate and transport, and preliminary risk evaluation information. Chapter 3 (Justification/Purpose of Corrective Action) presents remedial response objectives and the purpose for corrective action and identifies and describes the corrective action alternatives under evaluation. Chapter 4 (Screening of Corrective Actions) presents an evaluation of corrective actions and screens the corrective actions against established objectives and balancing factors. Chapter 5 (Conceptual Design and Implementation Plan) identifies the selected corrective action, presents design and implementation details, and provides a cost estimate and schedule for the selected remedy. Reference information is presented in Chapter 6. The O&M Plan for the selected remedy is presented as Appendix A. Appendix B presents the Base Master Plan (BMP) and deed recordation requirements. Appendix C presents a site description, directions to the site, and the topographic survey of SWMU 3. Appendix D presents cost estimates for the alternatives.

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# 2.0 SITE CHARACTERIZATION AND REMEDIAL INVESTIGATION RESULTS

Fort Stewart (then known as Camp Stewart) was established in June 1940 as an antiaircraft artillery training center. Between January and September 1945, the Installation operated as a prisoner-of-war camp. The Installation was deactivated in September 1945. In August 1950 Fort Stewart was reactivated to train antiaircraft artillery units for the Korean Conflict. The training mission was expanded to include armor training in 1953. Fort Stewart was designated a permanent Army installation in 1956 and became a flight training center in 1966. Aviation training at the Fort Stewart facilities was phased out in 1973. In January 1974 the 1st Battalion, 75th Infantry was activated at Fort Stewart. Fort Stewart then became a training and maneuver area, providing tank, field artillery, helicopter gunnery, and small arms training for regular Army and National Guard units. These activities comprise the Installation's primary mission today. The 24th Infantry Division, which was reflagged as the 3d Infantry Division in May 1996, was permanently stationed at Fort Stewart in 1975.

The FSMR is located in portions of Liberty, Bryan, Long, Tattnall, and Evans counties, Georgia, approximately 40 miles west-southwest of Savannah, Georgia (Figures 2-1 and 2-2). The cantonment, or garrison area, of the FSMR is located within Liberty County, on the southern boundary of the reservation. The TAC-X Landfill is located in Bryan County, south of the northern Fort Stewart boundary, approximately 3.5 miles south-southwest of Pembroke, Georgia (Figure 2-3).

## 2.1 SITE LOCATION AND HISTORY

SWMU 3, which is approximately 3.5 miles south-southwest of Pembroke, Georgia, and less than 1 mile southeast of Dean Field and the TAC-X (Noncommissioned Officers' Academy), was active from the 1960s until 1982. The waste disposed of at the landfill from the 1960s to 1979 included residential waste, food cans, brush, plastic, and cardboard boxes. From 1979 to 1982, the wastes included grass clippings, tree branches, root stumps, and chunks of asphalt and concrete.

The TAC-X Landfill comprises approximately 6.3 acres, with two trenchlike depressions present at the site. One of the trenches is reportedly unused. The reported dimensions of the disposal trench are 20 feet wide by 400 feet long by 5 feet to 6 feet deep. A site reconnaissance in November 1993 observed household-type debris (e.g., plastic spoons and bags) within the overburden pile on the western side of the disposal trench. Aged refuse is reported to be present at the bottom of the disposal trench (Geraghty and Miller 1992). A site reconnaissance in September 1996 indicated no evidence of any landfill operations. The site is nearly flat, but slopes gently toward the south. Pine trees, brush, and grass cover most of the site. The southernmost portion of the site is marshy, with surface water present.

Based on the findings presented in the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000), a "no further action required" status was assigned to the investigation of the nature and extent of potential contamination associated with SWMU 3. As recommended by the revised final Phase II RFI Report for 16 SWMUs and as concurred to by GEPD (approval letter from Mr. Bruce Khaleghi to Colonel Gregory Stanley dated December 8, 2000), a CAP was recommended for SWMU 3 because buried waste will remain in place. The CAP is necessary to control intrusive activities at this site, to be protective of the health of humans potentially coming in contact with the buried waste, and to prevent the use of groundwater as a drinking water source.

## 2.2 TOPOGRAPHY/PHYSIOGRAPHY/CLIMATE

The FSMR occupies a low-lying, flat region on the coastal plain of Georgia. Surface elevations range from approximately 20 feet to 100 feet above mean sea level (amsl) within the FSMR and generally decrease from northwest to southeast across the reservation. Terraces dissected by surface water drainages dominate the topography. The terraces are remnants of sea level fluctuations. The four terraces present within the FSMR are the Wicomico, Penholoway, Talbot, and Pamlico (Metcalf and Eddy 1996).

There are approximately 6 feet of relief across the TAC-X Landfill. The elevation is approximately 73 feet amsl along the northern boundary and slopes gently to approximately 67 feet amsl along the southern boundary. Two disposal trenches run approximately north to south, terminating in a small, swampy depression. Standing water can accumulate in the depression after rainfall events and was present during the Phase II investigation. Soil from the trenches is mounded along their sides. The site is heavily forested. Existing site features and topography are presented in Figure 2-4.

Fort Stewart has a humid, subtropical climate with long, hot summers. Average temperatures range from 50°F in the winter to 80°F in the summer. Average annual precipitation is 48 inches, with slightly more than half falling from June through September. Prolonged drought is rare in the area, but severe local storms (tornadoes and hurricanes) do occur. Under normal conditions wind speeds rarely exceed 5 knots, but gusty winds of more than 25 knots may occur during summer thunderstorms (Geraghty and Miller 1992).

## 2.3 SITE GEOLOGY

The FSMR is located within the coastal plain physiographic province. This province is typified by southeastward-dipping strata that increase in thickness from 0 feet at the fall line (located approximately 155 miles inland from the Atlantic coast) to approximately 4,200 feet at the coast. State geologic records describe a probable petroleum exploration well (the No. 1 Jelks-Rogers) located in the region as having encountered crystalline basement rocks at a depth of 4,254 feet below ground surface (bgs). This well provided the most complete record for Cretaceous, Tertiary, and Quaternary strata.

The Cretaceous section is approximately 1,970 feet in thickness and is dominated by clastics. The Tertiary section is approximately 2,170 feet in thickness and is dominated by limestone, with a 175-foot-thick cap of dark green phosphatic clay. This clay is regionally extensive and is known as the Hawthorn Group. The interval from approximately 110 feet to the surface is Quaternary in age and composed primarily of sand with interbeds of clay or silt. This section is undifferentiated.

State geologic records contain information regarding a well drilled in October 1942, 1.8 miles north of Flemington at Liberty Field of Camp Stewart (now known as Fort Stewart). This well is believed to have been an artesian well located approximately 0.25 mile north of the runway at Wright Army Airfield within the FSMR. The log for this well describes a 410-foot section, the lowermost 110 feet of which consisted predominantly of limestone, above which 245 feet of dark green phosphatic clay typical of the Hawthorn Group were encountered. The uppermost 55-foot interval was Quaternary-age interbedded sands and clays. The top 15 feet of these sediments were described as sandy clay.

Boring logs showing the types of soil encountered during the Phase II RFI at the TAC-X Landfill in soil screening probes, groundwater screening probes, and monitoring well boreholes are provided on pages A.2-1 through A.2-19 in Appendix A of the revised final Phase II RFI Report for 16 SWMUs

(SAIC 2000). Geological cross sections of the site, depicting the lithology and stratigraphy of the unconsolidated soil deposits beneath the site, as inferred from the soil boring logs, are shown on Figures 10.2-2 and 10.2-3 of the revised final Phase II RFI Report.

The soil present across the TAC-X Landfill consists of alternating layers of sand and clayey sands, as indicated in cross sections A-A′ and B-B′ [Figures 10.2-2 and 10.2-3, respectively, of the revised final Phase II RFI for 16 SWMUs (SAIC 2000)].

Geotechnical soil samples were collected from the four monitoring well boreholes (MW5–MW8), and the results are presented in Table 10.2-3 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). The geotechnical analytical results indicated that tested soil was sand, with the proportion of fine-grained particles varying from 1.3 percent to 5.2 percent by weight. Soil from all the monitoring wells was non-plastic. The soil from the screened intervals in MW-5 and MW-6 had a permeability of $4.50 \times 10^{-5}$ cm/sec and $1.20 \times 10^{-6}$ cm/sec, respectively, which is typical for clayey sands.

## 2.4 SITE HYDROLOGY

The principal surface water body accepting drainage from the FSMR is the Canoochee River, which joins the Ogeechee River (part of the northwestern boundary of the reservation). Canoochee Creek is a tributary of the Canoochee River, which drains much of the western portion of the FSMR. The surface drainage at the site flows to the swampy depression along the south/southwestern boundary of the site. The trenches on-site also drain to the swampy depression. The swampy area ultimately makes its way to the Canoochee River.

## 2.5 HYDROGEOLOGY

The hydrogeology in the vicinity of the FSMR is dominated by two aquifers, referred to as the Principal Artesian Aquifer and the surficial aquifer, that are separated by a confining unit, the Hawthorn Group.

The Principal Artesian Aquifer is the lowermost hydrologic unit; is regionally extensive from South Carolina through Georgia, Alabama, and most of Florida; and is regionally known as the Floridan Aquifer. This aquifer is subdivided into upper and lower hydrogeologic units. The upper hydrogeologic unit is composed primarily of Miocene-age argillaceous sands and clays and Oligocene- to Eocene-age limestones (including the Ocala Group and the Suwannee Limestone, where present) at the top. The upper hydrogeologic unit ranges in thickness from 200 feet to 260 feet and is most productive where it is thickest and where secondary permeability is most developed. The lower hydrologic unit is comprised of the Eocene-age Avon Park Limestone at the base. The transmissivity of the aquifer in the Savannah area ranges from about 28,000 square feet/day to 33,000 square feet/day (Krause and Randolph 1989). Groundwater from this aquifer is primarily used for drinking water (Arora 1984). Thirteen groundwater production wells are used for potable water supply on the FSMR, and one additional production well is used for fire protection.

The confining layer for the Principal Artesian Aquifer is the phosphatic clays of the upper Hawthorn Group. These sediments are regionally extensive and range from 60 feet to 80 feet in thickness at the FSMR. There are minor occurrences of aquifer material within the Hawthorn Group; however, they have limited utilization (Miller 1990).

The uppermost hydrologic unit is the surficial aquifer, which consists of widely varying amounts of sand, silt, and clay ranging from 35 feet to 150 feet in thickness. Well yields from this aquifer would range from 2 gallons to 180 gallons per minute based on geotechnical data from the monitoring wells installed during the Phase II RFI.

Groundwater was encountered at approximately 5 feet bgs along the northern boundary of the site at SB1 to approximately 12 feet bgs along the southern boundary. The shallow groundwater flow direction across the site is to the south-southwest toward the swampy depression area, and the hydraulic gradient is 0.0093 foot/foot [see Figure 10.2-4 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000)]. The deep groundwater flow direction across the site is also to the south-southeast, and the hydraulic gradient is 0.002 foot/foot (see Figure 10.2-5 of the revised final Phase II RFI Report).

## 2.6 SITE ECOLOGY

Approximately 7.8 square miles of the 436.8 square miles at the FSMR comprise the garrison area. The remainder is used for ranges and training areas (approximately 11 percent) or held as non-use areas.

Eighty-four percent of the land is forested (approximately 367.2 square miles). Sixty-six percent of the forest area is pine, with the major species including the slash, loblolly, and longleaf pines. Thirty-four percent of the forest is composed of river bottomlands and swamps whose major species include the tupelo, other gum trees, water oak, and bald cypress trees. The open range and training areas comprise 11 percent of the Installation and consist of grasses, shrubs, and scrub tree (oak) growth.

Aquatic habitats on the FSMR include a number of natural or man-made ponds and lakes, the Canoochee River, Canoochee Creek and its tributaries, and a number of bottomland swamps and pools. The Ogeechee River borders the installation along its northeastern boundary. Organic detritus content is high, and dark coloring of the water is not unusual. Dense growths of aquatic vegetation are also typical, especially during the summer months.

Both terrestrial and aquatic fauna are abundant in the unimproved areas of the FSMR. Major game species found on the Installation include white-tailed deer, feral hog, wild turkey, rabbit, squirrel, and bobwhite in addition to numerous other mammal, bird, reptile, and amphibian species (Environmental Science and Engineering 1982). Dominant fish include bluegill, largemouth bass, crappie, sunfish, channel catfish, minnows, and shiners. Three federally listed threatened or endangered species reside at the FSMR: the American bald eagle, Eastern indigo snake, and red-cockaded woodpecker.

The habitats at SWMU 3 are classified as "forestlands" consisting mainly of well-spaced, mature pine and aquatic habitats. The surrounding forest is mixed pine–hardwood and much denser, with a thick understory. Just south of the old trench area is a wetland, or ephemeral pond, with tannic water exceeding 1 foot in depth at many places. Sediments in this area are soft and organic. Aquatic flora occurs along the old trenches and at the mouth of the wetland area.

## 2.7 NATURE AND EXTENT OF CONTAMINATION

The results of chemical analyses performed during the Phase I and Phase II RFIs indicated that soil, groundwater, and sediment contain organic and metal contaminants at concentrations greater than their reference background concentrations. No contaminants were detected in surface water.

The reference background criteria for the TAC-X Landfill have been developed based on data from background samples collected across the FSMR for SWMUs under Phase I and/or Phase II RFIs. In general, reference background samples were collected in each medium at locations upgradient or upstream of each site so as to be representative of naturally occurring conditions at SWMUs under investigation. In addition, soil collected during the Phase I RFI [from the Burn Pits (SWMUs 4A–4F), Active Explosive Ordnance Disposal Area (SWMU 12A), etc.] was included in the background data set if it was determined to come from upgradient of the site and to be of sufficient quality to be representative of natural background conditions at the FSMR. A summary of the sample locations by medium at each SWMU and the source of the data (Phase I and II RFI analytical data) is presented in Table 5-1 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000).

EPA Region IV methodology (EPA 1995) was used as guidance for the development of the background data set for screening metals data. In cases in which enough samples (e.g., more than 20) are collected to define background, a background upper tolerance level can be calculated. In cases in which too few samples (e.g., fewer than 20) are collected to define background, background can be calculated as two times the mean background concentration (EPA 1995). Given that fewer than 20 background samples were collected for the FSMR, the latter method was used for calculating reference background concentrations.

The reference background concentrations for surface soil, subsurface soil, and groundwater were calculated as two times the average concentration of all of the locations selected to be in the background data set. If a chemical was not detected at a site, then one-half the detection limit was used as the concentration when calculating the reference mean background concentration. Because there was no upstream surface water or sediment location for SWMU 3, the site-specific background location for the Former 724th Tanker Purging Station (SWMU 26) was used for SWMU 3.

Inorganics were considered to be SRCs if their concentrations were above the reference background concentrations. Organics were considered to be SRCs if they were simply detected because organic constituents are considered anthropomorphic in nature.

Appendix G of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) presents a summary of the background data as well as the two-times-mean background concentrations. Given the limited background data, the mean concentration established by the U.S. Geological Survey for soil in the eastern United States (USGS 1984) is also presented for comparative purposes. Because of the limited number of background samples, the screening value for background may be heavily skewed as a result of an outlier in the sampling data. The nature and extent of contamination by medium is summarized below. A tabular summary of SRCs by medium for the TAC-X Landfill is presented in Table 2-1. The Phase I and Phase II RFI sample locations are presented in Figure 2-5.

### 2.7.1 Surface Soil

Eleven surface soil samples were collected from four monitoring well boring locations, three soil boring locations, and four surface soil samples during the Phase I and Phase II RFIs. No VOCs were detected in surface soil. Low, isolated concentrations of bis(2-ethylhexyl)phthalate (an SVOC) and four pesticides (alpha-BHC, gamma-BHC, heptachlor epoxide, and methoxychlor) were detected in surface soil. Arsenic, chromium, and lead were detected at concentrations above reference background criteria in one of 10 surface soil samples. Bis(2-ethylhexyl)phthalate, alpha-BHC, gamma-BHC, heptachlor epoxide, methoxychlor, arsenic, chromium, and lead were considered to be SRCs in surface soil.

### 2.7.2 Subsurface Soil

Seven subsurface soil samples were collected during the Phase II RFI from four monitoring well boring locations and three soil boring locations. Two VOCs (2-butanone and acetone), one SVOC [bis(2-ethylhexyl)phthalate], and three pesticides (4,4'-DDE; aldrin; and methoxychlor) were detected in

Table 2-1. Summary of Site-related Contaminants, SWMU 3

| Analyte | Maximum Concentration (mg/kg) | | | Maximum Concentration (µg/L) | |
|---|---|---|---|---|---|
| | Surface Soil | Subsurface Soil | Sediment | Groundwater | Surface Water |
| ***Volatile Organic Compounds*** | | | | | |
| 2-Butanone | ND | 0.0044 | 0.495 | ND | ND |
| 2-Hexanone | ND | ND | 0.0034 | 5.6 | ND |
| Acetone | ND | 0.0932 | 0.618 | 264 | ND |
| Benzene | ND | ND | 0.0033 | ND | ND |
| Carbon disulfide | ND | ND | 0.006 | ND | ND |
| Methylene chloride | ND | ND | ND | ND | ND |
| Toluene | ND | ND | 0.212 | ND | ND |
| ***Semivolatile Organic Compounds*** | | | | | |
| Benzo(*b*)fluoranthene | ND | ND | ND | ND | 6.6 |
| Bis(2-ethylhexyl)phthalate | 0.248 | 0.387 | ND | ND | ND |
| ***Pesticides/PCBs*** | | | | | |
| 4,4'-DDE | ND | 0.00064 | ND | ND | ND |
| 4,4'-DDT | ND | ND | ND | 0.025 | ND |
| Aldrin | ND | 0.00061 | ND | ND | ND |
| alpha-BHC | 0.00047 | ND | ND | ND | ND |
| beta-BHC | ND | ND | ND | 0.016 | ND |
| delta-BHC | ND | ND | ND | 0.082 | ND |
| gamma-BHC (Lindane) | 0.0012 | ND | ND | ND | ND |
| Heptachlor epoxide | 0.00054 | ND | ND | ND | ND |
| Methoxychlor | 0.0086 | 0.0048 | ND | ND | ND |
| ***Metals*** | | | | | |
| Arsenic | 24[a] | BRBC | 29.7 | ND | 7.3 |
| Barium | BRBC | BRBC | 60 | 92.3 | 59.6 |
| Cadmium | ND | 0.25 | ND | 0.82 | ND |
| Chromium | 7.8 | 25.5 | 23.3 | 6.8 | 13.9 |
| Lead | 73.97[a] | BRBC | 14.7 | 11.1 | 9 |
| Mercury | BRBC | BRBC | 0.08 | 0.46 | ND |
| Selenium | BRBC | BRBC | 2.6 | BRBC | ND |

[a]Phase I RFI data.
BRBC = Below reference background criteria.
ND = Not detected.

subsurface soil. Chromium and cadmium were detected at concentrations above reference background criteria in one (MW6) of seven subsurface soil samples. 2-Butanone; acetone; bis(2-ethylhexyl)phthalate; 4,4'-DDE; aldrin; methoxychlor; cadmium; and chromium were considered to be SRCs in subsurface soil at SWMU 3.

### 2.7.3 Groundwater

Low, isolated concentrations of acetone (a VOC) and three pesticides (4,4'-DDT; beta-BHC; and delta-BHC) were detected in groundwater collected from Geoprobe locations. Barium, cadmium, chromium, lead, and mercury were detected at concentrations above reference background criteria in groundwater collected from Geoprobe locations. However, corresponding dissolved metal concentrations for all five constituents were below reference background concentrations, indicating that the total metals might be associated with particulates in the groundwater.

A low, isolated concentration of 2-hexanone (a VOC) was detected in groundwater collected from monitoring well MW6. Mercury was detected at concentrations (0.15 µg/L and 0.16 µg/L) slightly above the reference background criteria (0.14 µg/L) in two of eight groundwater samples collected from the monitoring wells.

2-Hexanone; acetone; 4,4'-DDT; beta-BHC; delta-BHC; barium; cadmium; chromium; lead; and mercury were considered to be SRCs in groundwater.

### 2.7.4 Surface Water

One SVOC [benzo(*b*)fluoranthene] was detected in surface water. Arsenic, barium, chromium, and lead were detected in surface water at concentrations above reference background criteria.

Seven VOCs (acetone, methylene chloride, 2-butanone, 2-hexanone, benzene, carbon disulfide, and toluene) were detected in sediment. Acetone and methylene chloride were initially detected at one of two sediment locations at concentrations of 7.7 mg/kg and 6.49 mg/kg, respectively. These elevated concentrations were believed to be the result of field and laboratory contamination, and the location was resampled. Acetone was detected at a concentration of 0.618 mg/kg, and methylene chloride was not detected in the resampled sediment, indicating that the elevated levels of acetone and methylene chloride were probably the results of field or laboratory contamination. Methylene chloride is not considered to be an SRC in sediment. 2-Butanone, 2-hexanone, benzene, carbon disulfide, and toluene were detected in only the resampled sediment; therefore, 2-butanone, 2-hexanone, acetone, benzene, carbon disulfide, and toluene are considered to be SRCs in sediment.

Arsenic, barium, chromium, lead, mercury, and selenium were detected in sediment at concentrations above reference background criteria. Sediment samples from SWS1 had significantly higher concentrations than did those from SWS2.

## 2.8 CONTAMINANT FATE AND TRANSPORT

### 2.8.1 Leachability Analysis

Contaminant fate and transport analysis provided an assessment of the potential migration pathways and transport mechanisms affecting the chemicals at the site. In particular, the leachability of contaminants from soil and sediment to groundwater and their natural attenuation in groundwater were evaluated.

The site characterization identified inorganic, organic, and pesticide SRCs in surface soil, subsurface soil, and sediment (Table 2-1). These constituents were compared to EPA Generic Soil Screening Levels (GSSLs; EPA 1996a) to determine if these constituents might leach from soil or sediment into groundwater at concentrations that exceed groundwater standards [i.e., concentrations that exceed the maximum contaminant level (MCL) or, in the absence of an MCL, the risk-based concentration for drinking water (EPA 1996b)].

Based on the leachability analysis, there are no contaminant migration constituents of potential concern (CMCOPCs) in surface or subsurface soil.

Of the SRCs identified in sediment, only arsenic, at a concentration of 29.7 mg/kg, slightly exceeded its GSSL of 29 mg/kg [see Table 10.2-12 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000)]. Arsenic was detected in surface water; however, the surface water concentration

(0.0073 mg/L) did not exceed its MCL (0.05 mg/L). Arsenic was not detected in groundwater. Arsenic in sediment was not considered to be a CMCOPC based on leaching to groundwater.

### 2.8.2 Fate and Transport Modeling

Fate and transport modeling was performed to quantitatively assess the risks associated with exposure to mercury in deep surficial groundwater [an ecological constituent of potential concern (ECOPC; see Section 2.9.2)] for the uncertainty evaluation of the preliminary ecological risk evaluation.

### 2.8.3 Migration of groundwater to surface water

Fate and transport modeling was performed to quantitatively assess the risk to ecological receptors from mercury in deep surficial groundwater that may migrate to Canoochee River approximately 10,000 feet downgradient of SWMU 3. The One-dimensional Analytical Solute Transport (ODAST) Model was used to estimate the concentration of mercury in the deep groundwater at Canoochee River. The model assumed that the concentration in Canoochee River are equal to the concentration in the adjacent groundwater. This assumption is conservative, given that it assumes that there is no dilution of the constituents upon discharge of groundwater into the surface water body that is approximately 10,000 feet downgradient of the site.

The ODAST model assumed that the concentration of metals at the source location would remain constant for a period of 70 years. The ODAST model was simulated for a period of 1,000 years. The ODAST modeling results estimated that the concentration of mercury in Canoochee River will be 1.8E-7 μg/L.

## 2.9 PRELIMINARY RISK EVALUATION

### 2.9.1 Human Health Preliminary Risk Evaluation

The human health preliminary risk evaluation (HHPRE) included a Step 1 risk evaluation to determine potential human health risks associated with the constituents present at the site. Human health constituents of potential concern (HHCOPCs) were defined as those constituents present at concentrations higher than their reference background criteria and higher than their respective risk-based or applicable or relevant and appropriate requirement–based screening criteria [see Table 10.2-13 of the revised final Phase II RFI Report (SAIC 2000)]. SRCs for surface soil, subsurface soil, groundwater, surface water, and sediment evaluated under the HHPRE are presented in Table 2-1.

Arsenic was the only constituent identified as a potential HHCOPC in surface soil.

No HHCOPCs were identified in subsurface soil at SWMU 3.

Based on the human health screening, delta-BHC and mercury are HHCOPCs in groundwater.

The maximum concentrations of benzo(*b*)fluoranthene and arsenic exceeded the human health criteria and Ambient Water Quality Criterion (AWQC) for surface water. Chromium and lead exceeded their respective AWQCs. Therefore, benzo(*b*)fluoranthene, arsenic, chromium, and lead are HHCOPCs for surface water.

Arsenic was the only chemical identified as a potential HHCOPC in sediment.

A baseline human health risk assessment (BHHRA; see Section 2.10) was performed to quantitatively assess the risks associated with exposure to the HHCOPCs: arsenic in surface soil and sediment; delta-BHC and mercury in groundwater; and benzo(*b*)fluoranthene, arsenic, chromium, and lead in surface water.

### 2.9.2 Ecological Preliminary Risk Evaluation

Acetone, arsenic, barium, carbon disulfide, and selenium were identified as ECOPCs in sediment. Preliminary and supplemental risk calculations, however, resulted in hazard quotients (HQs) of less than one for wildlife receptors; therefore, ECOPCs in sediment are unlikely to pose a risk to wildlife receptors.

Benzo(*b*)fluoranthene, barium, and lead were indicated as ECOPCs in surface water. Preliminary and supplemental risk calculations for mink and green herons exposed to ECOPCs in surface water, however, resulted in HQs of less than one; therefore, ECOPCs in surface water are unlikely to pose a risk to wildlife receptors.

Chromium and lead were indicated as ECOPCs in surface soil at SWMU 3. Supplemental risk calculations for chromium and lead, however, resulted in HQs of less than one; therefore, chromium and lead in surface soil are unlikely to pose a risk to robins.

Barium; cadmium; lead; mercury; 4,4'-DDT; and delta-BHC in shallow groundwater are ECOPCs for wetland biota because they are present at levels exceeding surface water ecological screening values (ESVs). The unfiltered shallow groundwater (hand-augered samples) overestimates the potential concentration (dissolved portion) of constituents in surface water; therefore, the wetlands biota located in the marshy area are not at a significant risk from these constituents.

Mercury and 4,4'-DDT in shallow surficial groundwater are ECOPCs for wildlife receptors. Based on the magnitude of the HQs calculated in the supplemental risk calculations, mercury and 4,4'-DDT are unlikely to be potential hazards to wildlife receptors feeding in the marshy area adjacent to SWMU 3.

Mercury in deep surficial groundwater at SWMU 3 is an ECOPC for aquatic biota and wildlife receptors. Mercury is unlikely to be a potential hazard to aquatic biota living in downgradient surface water bodies because the predicted maximum discharge concentration of mercury from modeling after dilution does not exceed the ESV. Mercury is unlikely to be a potential hazard to wildlife receptors ingesting aquatic biota living in downgradient surface water bodies because the supplemental risk calculations using the mean groundwater concentration of mercury result in HQs of less than one for mink and 3.0 for green herons using conservative exposure assumptions.

In summary, the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) concluded that there is no present ecological risk at SWMU 3 and that the site is unlikely to pose an ecological risk in the future; therefore further investigation and/or evaluation of ECOPCs was not required.

## 2.10 BASELINE HUMAN HEALTH RISK ASSESSMENT

The BHHRA addressed the risks associated with exposure to the following HHCOPCs: arsenic (surface soil, surface water, and sediment), chromium (surface water), lead (surface water), mercury (groundwater), delta-BHC (groundwater), and benzo(*b*)fluoranthene (surface water). No CMCOPCs were identified for this site.

The potential risks associated with exposure to lead were quantified based on the blood-lead levels resulting from exposure to lead in various media. The potential risks associated with exposure to lead could not be quantified. given that the Integrated Exposure Uptake Biokinetic Model for Lead in Children (EPA 1994) used to estimate blood-lead levels does not address intermittent exposures such as incidental ingestion of surface water as a result of wading. Given that the primary exposure pathway is incidental ingestion, the exposure concentration in surface water was compared to risk-based screening values for drinking water.

Current on-site receptor populations include an Installation worker, a juvenile trespasser, and a sportsman. However, due to the limited potential exposure of a sportsman from bioaccumulation, the sportsman was not assessed in the baseline risk assessment. Future on-site and off-site land-use populations include an Installation worker, a juvenile trespasser/wader, and a resident (adult and child). These receptor populations represent both on-site and off-site receptors. The residential receptor population was divided into an adult and a child because the adult receptor is at greater risk from exposure to carcinogens, while the child is at greater risk from exposure to noncarcinogens. The reader is referred to Appendix I, Section I.2.2 ("Identification of Potential Receptor Populations and Associated Exposure Pathways") of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) for a more detailed discussion on the potential exposure pathways and the differences between the exposure of the adult and child resident receptors.

Juvenile receptors (i.e., a juvenile trespasser and a juvenile wader) had incremental lifetime cancer risks (ILCRs) that exceeded the target level of $1 \times 10^{-6}$. Benzo(*b*)fluoranthene in surface water is the risk driver, with ILCRs that exceeded $1 \times 10^{-6}$ for all of the juvenile receptors; therefore, benzo(*b*)fluoranthene was identified as a constituent of concern (COC) in surface water.

The on-site Installation workers (both current and future) had ILCRs that exceeded the target level of $1 \times 10^{-6}$. Arsenic in surface soil is the risk driver, with ILCRs that exceeded $1 \times 10^{-6}$ for both the current and future Installation workers; therefore, arsenic was identified as a COC in surface soil.

The ILCRs for the future on-site resident child and resident adult exceeded the target level of $1 \times 10^{-6}$, with ILCR values of $1.21 \times 10^{-5}$ and $7.30 \times 10^{-6}$, respectively. Arsenic in surface soil was identified as a COC for both of these receptors, with a ILCRs of $1.17 \times 10^{-5}$ for the resident child and $6.40 \times 10^{-6}$ for the resident adult.

Chromium (surface water), lead (surface water), mercury (groundwater), and delta-BHC (groundwater) are not risk drivers at this site; therefore, these constituents are not considered to be COCs. Arsenic was identified as a COC in surface soil only. It is not a COC in surface water or sediment. Benzo(*b*)fluoranthene was identified as a COC in surface water.

Remedial levels were derived for arsenic in surface soil and benzo(*b*)fluoranthene in surface water based on an ILCR of $5.0 \times 10^{-5}$. The development of remedial levels for arsenic and benzo(*b*)fluoranthene is summarized below:

**Arsenic.** The recommended risk-based remedial level for arsenic in surface soil is 30.3 mg/kg (Table 2-2). This concentration is greater than the maximum detected concentration of 24 mg/kg. Given that the maximum concentration is below the recommended remedial value, no further action is required to address the presence of arsenic in surface soil.

**Table 2-2. Remedial Levels for Surface Soil and Surface Water, SWMU 3**

| Constituent of Concern | Maximum Detected Concentration (mg/kg) | Risk-based Remedial Levels (mg/kg) ILCR | | |
|---|---|---|---|---|
| | | $1 \times 10^{-6}$ | $1 \times 10^{-5}$ | $5 \times 10^{-5}$ |
| ***Surface Soil*** | | | | |
| Arsenic | 24 | 0.6 | 6.1 | **30.3** |
| | | | | |
| ***Surface Water*** | | | | |
| Benzo(*b*)fluoranthene | 0.0066 | 0.0010 | 0.0101 | **0.0505** |

**Bold** indicates concentrations above recommended remedial levels.

**Benzo(*b*)fluoranthene.** The recommended risk-based remedial level for benzo(*b*)fluoranthene in surface water is 0.0505 mg/L (Table 2-2). This value is greater than the maximum detected value of 0.0066 mg/L. Given that the maximum concentration is below the recommended remedial value, no further action is required to address the presence of benzo(*b*)fluoranthene in surface water.

# 3.0 JUSTIFICATION/PURPOSE OF CORRECTIVE ACTION

## 3.1 PURPOSE

EPA has established corrective action standards that reflect the major technical components that should be included with a selected remedy (EPA 1988). These include the following: (1) protect human health and the environment; (2) attain media cleanup standards set by the implementing agency; (3) control the source of releases so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment; (4) comply with any applicable standards for management of wastes; and (5) other factors.

## 3.2 REMEDIAL RESPONSE OBJECTIVES

Based on the findings of the site characterization at this SWMU, the primary purpose for implementing corrective measures at SWMU 3 is limited to protection of human health and safety. To achieve this goal, two primary remedial response objectives have been established for SWMU 3: (1) to prohibit the ingestion of shallow groundwater from the subject site and (2) to prohibit the disturbance of surface and subsurface soil to minimize contact with soil and buried waste. Any corrective measures that pose a significant threat to human health during implementation (e.g., methods that would involve disturbance of subsurface soil) will not be evaluated. Implementation of the selected remedial response will achieve the best overall results with respect to such factors as long-term reliability and effectiveness, short-term effectiveness, implementability, and cost.

## 3.3 IDENTIFICATION OF REMEDIAL LEVELS

As discussed in Chapter 2, remedial levels were developed for the COC at SWMU 3. Arsenic was identified as a COC for surface soil at the site. Benzo(*b*)fluoranthene was identified as a COC in surface water through direct exposure. The maximum concentrations of arsenic in surface soil and benzo(*b*)fluoranthene in surface water were below their respective remedial levels (Table 2-2); therefore, the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) concluded that no further action was needed to address arsenic in surface soil and benzo(*b*)fluoranthene in surface water. With the concurrence of GEPD (approval letter from Mr. Bruce Khaleghi to Colonel Gregory Stanley dated December 8, 2000), the revised final Phase II RFI Report recommended that institutional controls be implemented at SWMU 3. Institutional controls will be protective of human health because land-use restrictions will limit direct contact with the potential buried debris and the use of shallow groundwater for drinking purposes.

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# 4.0 SCREENING OF CORRECTIVE ACTIONS

This section identifies corrective action technologies applicable to the TAC-X Landfill. The technologies that are retained following screening are then presented as corrective action alternatives that address limiting exposure to subsurface contamination. These alternatives are then evaluated with respect to protection of human health and life-cycle cost.

## 4.1 SCREENING CRITERIA

The first step in the development of corrective action alternatives involves the identification and screening of technologies applicable to the site. The purpose of this step is to list and evaluate the general suitability of remedial technologies for meeting the stated corrective action objectives. The options presented here will be evaluated for their general ability to protect and reduce the risk to human health.

The technologies will be discussed sufficiently to allow them to be compared using three general criteria that will function as balancing factors: effectiveness, implementability, and cost. An explanation of each criterion is provided below.

### 4.1.1 Effectiveness

This criterion evaluates the extent to which a corrective action reduces overall risk to human health and the environment. It also considers the degree to which the action provides sufficient long-term controls and reliability to prevent exposures that exceed levels protective of human and environmental receptors. Factors considered include performance characteristics, maintenance requirements, and expected durability.

### 4.1.2 Implementability

This criterion evaluates the technical and administrative factors affecting implementation of a corrective action and considers the availability of services and materials required during implementation. Technical factors assessed include ease and reliability of initiating construction and operations, prospects for implementing any additional future actions, and adequacy of monitoring systems to detect failures. Technical feasibility considers the performance history of the technologies in direct applications or the expected performance for similar applications. Uncertainties associated with construction, operations, and performance monitoring are also considered.

Service and material considerations include equipment and operator availability and applicability or development requirements for prospective technologies. The availability of services and materials is addressed by analyzing the material components of the proposed technologies and then determining the locations and quantities of materials. Administrative factors include ease of obtaining permits, enforcing deed recordation requirements, and maintaining long-term control of the site.

### 4.1.3 Cost

Relative costs are included for the corrective actions. The estimates are intended to facilitate evaluation and comparison among alternatives; therefore, typical cost-estimating contingencies common to all alternatives have been excluded from the estimates at the screening level of evaluation because all of the alternatives will have similar contingencies.

## 4.2 EVALUATION OF CORRECTIVE ACTION TECHNOLOGIES

Three categories of corrective actions were identified: (1) no action, (2) institutional controls: land-use controls, and (3) institutional controls: physical barriers. Additionally, an option to monitor groundwater will be evaluated for both corrective action categories involving institutional controls. These corrective action technologies are described in Table 4-1. The technologies were evaluated using the screening criteria of effectiveness, implementability, and cost. Results of that screening evaluation are also shown in Table 4-1.

The no action alternative provides a baseline against which other options can be compared. Under the no action alternative, no further action would be taken. No cost would be associated with the selection of this alternative. The acceptability of the no action alternative is judged in relation to the assessment of known site risks and by comparison with other corrective action alternatives.

The no action alternative is not considered to be viable because it provides no reliable or effective method for protecting human health; therefore, the no action alternative will be eliminated from further evaluation.

Institutional controls include actions taken to restrict access to contaminated areas by establishing legal land-use controls or by providing physical barriers to access. Physical barriers and/or land-use restrictions would provide effective, readily implementable, and cost-effective methods for preventing human exposure to buried waste at the site. Land-use controls include deed recordation, controls implemented through the BMP, zoning controls, and placement of signs restricting access. Physical barriers include installation of a barbed-wired, chain-link fence around the site boundary. Abandonment of groundwater wells no longer needed for site monitoring is also considered as a method for discouraging the use of groundwater at the site. Groundwater monitoring of selected wells would provide information associated with contaminant concentration trends because contaminants might continue to leach to groundwater over time. This activity would involve the use of selected wells for groundwater monitoring purposes only and the abandonment of the remaining wells.

## 4.3 CORRECTIVE ACTION ALTERNATIVES

The technologies retained following the screening-level step were combined in various ways to develop alternatives that would meet the remedial response objective of protection of human health. Two alternatives were identified and subsequently evaluated. The option of groundwater monitoring instead of well abandonment will also be evaluated for each of the two alternatives.

- Alternative 1: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Well Abandonment, Post-mounted Warning Signs, Implementation of O&M Plan

- Alternative 1a: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Groundwater Monitoring, Abandonment of Unused Wells, Post-mounted Warning Signs, Implementation of O&M Plan

- Alternative 2: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Well Abandonment, Chain-link Fence Barrier, Fence-mounted Warning Signs, Implementation of O&M Plan

**Table 4-1. Evaluation of Corrective Actions, SWMU**

| Action | Description | Effectiveness | Implementability | Cost[a] |
|---|---|---|---|---|
| No Action | The no action alternative provides a baseline against which other actions can be compared. Under the no action alternative, all source materials, soil, and groundwater would be left "as is," without implementation of any removal, treatment, or other mitigating actions to reduce existing or potential future human exposure to buried waste by human disturbance. | This alternative would not address the corrective action objectives for the site. This alternative would not provide protection of human health because there would not be sufficient controls to prevent human exposure to buried waste. | There would be no implementability involved for this alternative because no action would be taken. | There would be no cost associated with the no action alternative. |
| Institutional Controls: Land-use Controls | Land-use controls would reduce potential hazards by limiting exposure of humans to contaminated soil. Land-use restrictions and institutional control requirements that would be enforced would include restrictions through deed recordation, the BMP and zoning controls, warning signs posted around the site, groundwater use restriction (monitoring only, if necessary), well abandonment, and applicable state land-use control management systems in effect at the time of transfer. Activities, such as excavation or construction, that would disturb surface soil would be prohibited under the deed recordation. | Land-use restrictions would be effective and provide long-term reliability with respect to preventing human exposure to buried waste within the boundaries of the site. The technology would not provide physical barriers to restrict access to the site; therefore, noncompliance with these land-use restrictions could result in exposure to contaminated media. The BMP is an effective tool for ensuring establishment of land-use restrictions because requirements of the BMP are enforced by the FSMR in accordance with written policies and procedures. | These institutional controls would be readily implementable. The property will remain under federal ownership for the foreseeable future. The BMP is implementable because procedures and policies are in place at the FSMR to facilitate its implementation. | The costs would be low. The cost for deed recordation, the BMP and zoning controls, post-mounted signs, abandonment of the wells, and implementation of the O&M Plan for 30 years would range between approximately $90,000 and $120,000. |
| Institutional Controls: Physical Barriers | Physical barriers would reduce potential hazards by limiting exposure of humans to contaminated soil. Physical barriers would include chain-link fencing topped with barbed wire, landfill access gates, and warning signs around the site. | This technology would be effective and provide long-term reliability with respect to minimizing human exposure to buried waste within the boundaries of the site by physically restricting access. | Physical barriers would be readily implementable. The property will remain under federal ownership for the foreseeable future. The BMP is implementable because procedures and policies are in place at the FSMR to facilitate its implementation. | Installation of fencing would be expensive. The costs for fencing, including 30 years of O&M, would range between approximately $170,000 and $190,000. |

*Note:* Footnote appears on page 4-4.

**Table 4-1. Evaluation of Corrective Actions, SWMU 3 (continued)**

| Action | Description | Effectiveness | Implementability | Cost[a] |
|---|---|---|---|---|
| Groundwater Monitoring | Groundwater monitoring would serve to provide information concerning trends associated with the concentrations of constituents over time. Monitoring would continue on an annual basis for a period of 5 years to evaluate potential constituent leaching from the buried waste. | Monitoring would provide an effective method for evaluating concentrations of constituents in groundwater over time. | Technologies and resources are available for collection and analysis of groundwater resources. | Groundwater sampling is relatively expensive. The cost for groundwater sampling for 5 years would range between approximately $90,000 and $110,000. This includes other direct costs (e.g., pumps, meters), travel and per diem for the sampling crew, laboratory analysis, quality assurance, and reporting for five sampling events. |

[a]An approximate range of the capital and O&M costs for 30 years is presented for evaluation of the relative costs of the alternative. The range does not include engineering management, health and safety, contractor profit, or contingency costs.

- Alternative 2a: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Groundwater Monitoring, Abandonment of Unused Wells, Chain-link Fence Barrier, Fence-mounted Warning Signs, Implementation of O&M Plan

### 4.3.1 Evaluation Factors

Based on the results of the technology screening, each of the retained technologies is considered applicable to the site and implementable; therefore, two primary evaluation factors were used in the preferred corrective action alternative: protection of human health and life-cycle costs.

***Protection of Human Health***

The effectiveness of each proposed alternative at protecting human health at this site is dependent upon its ability to prohibit human activity associated with disturbance of subsurface soil and usage of shallow groundwater. For each alternative the level of protection of human health was evaluated and compared with those of the other alternatives. For retained Alternatives 1 and 2, usage of groundwater would be prohibited through abandonment of existing wells and through legal land-use controls (i.e., BMP, deed recordation, and zoning). For both options to these alternatives, usage of groundwater for drinking would be prohibited, and environmental monitoring would be required for 5 years to evaluate potential constituent leaching from buried waste through legal land-use controls (i.e., BMP and deed recordation). For both alternatives and their options, legal land-use controls and warning signs would also restrict activities associated with disturbance of subsurface soil. In Alternative 2 additional protection would be provided through the use of fencing to restrict access to the site.

***Life-cycle Costs***

The life-cycle cost estimates are budget estimates based on conceptual design and are to be used for purposes of comparison. Costs are estimated for capital construction, administration, and O&M. The cost estimates were derived from current information, including vendor quotes and conventional cost estimating guides (e.g., Means 1999 and ECHOS 1998). The actual costs of the project would depend on the labor and material costs, site conditions, competitive market conditions, final project scope, and implementation schedule at the time the corrective action was initiated. The life-cycle cost estimates are not adjusted to present worth costs, and no escalation factors have been applied.

### 4.3.2 Evaluation of Corrective Action Alternatives

The corrective action alternatives are summarized in Table 4-2, along with the associated levels of protection of human health and the associated life-cycle costs.

The alternatives would include the following common features:

- BMP, deed recordation, and zoning controls to prohibit the use of groundwater for drinking water and intrusion into subsurface soil;

- abandonment of site monitoring wells;

- installation of warning signs; and

- implementation of an O&M Plan to maintain the conditions of the signage.

**Table 4-2. Corrective Action Alternatives, SWMU 3**

| Corrective Action | Description | Protection of Human Health | Cost | Comments |
|---|---|---|---|---|
| Alternative 1: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Well Abandonment, Post-mounted Warning Signs, Implementation of O&M Plan | This action would require legal and local land-use controls and signage to enforce restrictions on land and groundwater usage. This alternative would also include abandonment of eight (MW1–MW8) groundwater monitoring wells. | Protection of human health would be primarily dependent upon enforcement of compliance with land-use controls. Existing natural barriers (e.g., heavily forested, swampy areas) provide effective restrictions on human access to the site to further discourage any unauthorized excavation activities. | $174,154 | Least expensive providing sufficient level of protection. |
| Alternative 1a: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Groundwater Monitoring, Abandonment of Unused Wells, Post-mounted Warning Signs, Implementation of O&M Plan | This action has similar requirements to those of Alternative 1; however, four of the wells (MW5, MW6, MW7, and MW8) would be used for groundwater monitoring for a 5-year period to evaluate potential constituent leaching from buried waste. MW1, MW2, MW3, and MW4 would be abandoned, and MW5, MW6, MW7, and MW8 would be abandoned at the completion of the groundwater monitoring program. | Protection of human health would be similar to that afforded by Alternative 1. Data generated from groundwater monitoring could be used to determine the need to provide further protection of human health. | $344,344 | Moderately expensive providing increased level of protection. |
| Alternative 2: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Well Abandonment, Chain-link Fence Barrier, Fence-mounted Warning Signs, Implementation of O&M Plan | This action would require legal and local land-use controls and signage to enforce restrictions on land and groundwater usage. Physical barriers to be installed would include a 2,098-linear-foot chain-link fence topped with barbed wire along the entire perimeter of the site. This alternative would also include abandonment of eight (MW1–MW8) groundwater monitoring wells. | In addition to the protection provided by Alternative 1a, human access would be further restricted by fencing along the boundaries of the site. The fencing would be more effective than signs alone in deterring or discouraging unauthorized entry and/or excavation activities. | $285,881 | Significantly more expensive with only slight increase in level of protection to potential buried waste compared to that afforded by Alternative 1. |

**Table 4-2. Corrective Action Alternatives, SWMU 3 (continued)**

| Corrective Action | Description | Protection of Human Health | Cost | Comments |
|---|---|---|---|---|
| Alternative 2a: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Groundwater Monitoring, Abandonment of Unused Wells, Chain-link Fence Barrier, Fence-mounted Warning Signs, Implementation of O&M Plan | This action has similar requirements to those of Alternative 2; however, four of the wells (MW5, MW6, MW7, and MW8) would be used for groundwater monitoring for a 5-year period to evaluate potential constituent leaching from buried waste. MW1, MW2, MW3, and MW4 would be abandoned, and MW5, MW6, MW7, and MW8 would be abandoned at the completion of the groundwater monitoring program. | Protection of human health would be similar to that afforded by Alternative 2. Data generated from groundwater monitoring could be used to determine the need to provide further protection of human health. | $454,521 | Most expensive providing highest level of protection. |

The paragraphs below summarize the evaluation of the two corrective action alternatives with respect to the primary evaluation factors of protection of human health and life-cycle cost.

**Alternative 1: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Well Abandonment, Post-mounted Warning Signs, Implementation of O&M Plan**

This alternative would provide for the implementation of land-use controls during the period of ownership by DoD through enforcement of the BMP and deed recordation. This alternative would protect human health by preventing human exposure to buried waste by the establishment of legal land-use restrictions. The BMP is an effective tool for ensuring that unauthorized disturbance of subsurface soil at the site and ingestion of groundwater from the site are prohibited while the property is under DoD ownership. If this property was to be transferred in the future, notification of the property transfer would be made to regulatory authorities. The following provisions would ensure implementation of land-use controls subsequent to property transfer: deed recordation; the purchase agreement or lease; zoning controls; applicable state land-use control management systems in effect at the time the property was transferred; community, transferee, or governmental notice (if needed); and self-certification (if feasible). To reduce potential exposure to health hazards associated with SWMU 3, warning signs stating restrictions on human activity within the SWMU would be posted at 200-foot intervals around the boundary of the site. The placement of signs for Alternative 1 is shown in Figure 4-1. Signs and existing natural barriers (e.g., heavily forested, swampy areas) would be effective at restricting human access to the site because they would discourage any inadvertent or unsuspecting excavation activities. Warning signs and posts would be repaired and/or replaced as needed through implementation of a documented O&M Plan. Shallow groundwater is not used as a source of drinking water at the site, and given the availability of the underlying Floridan Aquifer, it is unlikely that the shallow groundwater would ever be used for drinking water. The eight monitoring wells (MW1 through MW8) installed as part of either the Phase I or Phase II RFI and remaining at the SWMU 3 site would be abandoned. Institutional controls prohibiting the use of groundwater would, therefore, be effective at protecting human health.

This is the least expensive of the two alternatives and options, with a life-cycle cost of approximately $174,154.

**Alternative 1a: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Groundwater Monitoring, Abandonment of Unused Wells, Post-mounted Warning Signs, Implementation of O&M Plan**

This optional alternative has the same features as those described in Alternative 1, with the exception that four wells (MW5, MW6, MW7, and MW8) would be used for groundwater monitoring, and the remaining wells (MW1, MW2, MW3, and MW4) would be abandoned. Use of groundwater wells for the purpose of drinking water would be expressly prohibited by land-use restrictions provided by the BMP and deed recordation. Provisions for groundwater monitoring would be documented in both the BMP and deed recordation. These provisions would include monitoring of one upgradient well (MW5) and three downgradient wells (MW6, MW7, and MW8). Groundwater samples would be collected from these wells once every year for a period of 5 years to evaluate potential constituent leaching from the buried waste. No specific monitoring requirements are specified under RCRA for corrective actions at SWMUs; however, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires a 5-year review to evaluate the performance and residual risk associated with a selected alternative (including alternatives in which waste remains in place). Five years of groundwater monitoring was selected based on the 5-year review requirement for remedial actions under CERCLA. The results would be presented in an annual report, in association with the O&M report. Groundwater samples would be analyzed for the potential SRCs: VOCs, SVOCs, and RCRA metals. With the concurrence of GEPD, monitoring wells MW5, MW6, MW7, and MW8 would be abandoned after the completion of the groundwater monitoring program. The monitoring wells to be sampled and to be abandoned are identified on Figure 4-1.

The sampling of groundwater annually for 5 years has a significant impact on the cost of this alternative. The groundwater monitoring alone costs $104,000, resulting in a life-cycle cost of approximately $344,344 or nearly two times Alternative 1's life-cycle cost.

**Alternative 2: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Well Abandonment, Chain-link Fence Barrier, Fence-mounted Warning Signs, Implementation of O&M Plan**

This alternative is similar to Alternative 1 in that the land-use control provisions would remain the same (i.e., BMP, deed recordation, zoning control). Also, the eight existing wells (MW1 through MW8) would be abandoned, existing physical barriers would be maintained, and an O&M Plan would be implemented. This alternative would also provide approximately 2,098 linear feet of 6-foot-high chain-link fencing topped with three strands of barbed wire. The fence would provide a physical deterrent to public access around the entire landfill. Fence-mounted warning signs would be positioned approximately every 200 feet. One 20-foot-wide gate would be installed to allow access to the site for inspection and maintenance. The placement of signage and fencing for Alternative 2 is shown in Figure 4-2. The effectiveness of Alternative 2 would be significantly greater than that of Alternative 1 due to the greater level of protection against inadvertent intruders as a result of the fencing. The effectiveness of Alternative 2 at preventing the use of groundwater would be equal to that of Alternative 1. The O&M Plan would also include maintenance and repair of the fence and signs.

This alternative is more expensive than Alternative 1. The capital cost for the installation of fencing is approximately $45,658, resulting in a life-cycle cost of approximately $285,881, or nearly one and one-half times Alternative 1's life-cycle cost.

**Alternative 2a: Institutional Controls: BMP, Deed Recordation, Zoning Controls, Maintenance of Existing Natural Barriers, Groundwater Monitoring, Abandonment of Unused Wells, Chain-link Fence Barrier, Fence-mounted Warning Signs, Implementation of O&M Plan**

This optional alternative has the same features as those described in Alternative 2, with the exception that four wells (MW5, MW6, MW7, and MW8) would be used for groundwater monitoring, and the remaining wells (MW1, MW2, MW3, and MW4) would be abandoned. Use of groundwater wells for the purpose of drinking water would be expressly prohibited by land-use restrictions provided by the BMP and deed recordation. Provisions for groundwater monitoring would be documented in both the BMP and deed recordation. These provisions would include monitoring of one upgradient well (MW5) and three downgradient wells (MW6, MW7, and MW8). Groundwater samples would be collected from these wells once every year for a period of 5 years to evaluate potential constituent leaching from the buried waste. No specific monitoring requirements are specified under RCRA for corrective actions at SWMUs; however, CERCLA requires a 5-year review to evaluate the performance and residual risk associated with a selected alternative (including alternatives in which waste remains in place). Five years of groundwater monitoring was selected based on the 5-year review requirement for remedial actions under CERCLA. The results would be presented in an annual report, in association with the O&M report. Groundwater samples would be analyzed for the potential SRCs: VOCs, SVOCs, and RCRA metals. With the concurrence of GEPD, monitoring wells MW5, MW6, MW7, and MW8 would be abandoned after the completion of the groundwater monitoring program. The monitoring wells to be sampled and to be abandoned are identified in Figure 4-2.

The fencing combined with the sampling of groundwater annually for 5 years makes this alternative the most expensive. The groundwater monitoring alone costs $104,000, resulting in a life-cycle cost of approximately $454,521, or approximately 24 percent and 37 percent more than Alternative 1a and Alternative 2, respectively.

# 5.0 CONCEPTUAL DESIGN AND IMPLEMENTATION PLAN

This section presents a conceptual design and plan for implementation of the selected corrective action alternative. Based on the level and type of subsurface soil and groundwater contamination, a cost-effective corrective action was selected that would adequately protect human health. The technology evaluation presented in Chapter 4 compared two different corrective action alternatives and two optional alternatives based on their effectiveness at protecting human health and on their life-cycle costs. Based on that evaluation, Alternative 1 was selected because it will provide a sufficient level of protection of human health cost-effectively.

## 5.1 SELECTED CORRECTIVE ACTION

The selected corrective action alternative involves a multi-layered approach to restricting human activity within the boundaries of the subject site. The selected set of institutional controls comprising this alternative will provide a combination of land-use restrictions and prohibitions as well as physical barriers. Land-use restrictions will be documented and/or enforced through deed recordation, the BMP, zoning restrictions, and signage.

Alternative 1 has been selected because it will provide effective protection of human health cost-effectively. Although the installation of fencing would provide an additional degree of protection, Alternative 2 is not considered to be cost-effective. The additional protection that the fence would provide against inadvertent access to the site and unauthorized excavation below ground would be minimal and would not justify the significantly greater expense of implementing Alternative 2. Groundwater monitoring as described under Alternatives 1a and 2a would not provide enough additional protection to human health to justify the increased costs. The groundwater presently does not present a risk to human health. No COCs have been identified in subsurface soil, groundwater, or sediment. The COCs identified in surface soil (arsenic) and surface water [benzo(*b*)fluoranthene] were detected at concentrations below their respective remedial levels. The institutional controls described for Alternative 1 will provide a sufficient level of protection of human health and an adequate degree of long-term reliability and effectiveness as well as short-term effectiveness. The institutional controls under Alternative 1 can be easily and cost-effectively implemented. Justification for selection of this corrective action alternative is further detailed in the following evaluations of effectiveness, implementability, and cost.

### 5.1.1 Effectiveness

Post-mounted warning signs and documented land-use restrictions will be highly effective and will provide long-term reliability with respect to preventing human exposure through physical contact with the buried waste within the boundaries of SWMU 3. To maintain an acceptable level of long-term reliability and effectiveness, the BMP will establish land-use controls during ownership by DoD. Prior to planning any construction activities at the FSMR, the BMP must be reviewed. In addition, all construction projects will be reviewed during the planning stages for approval by the Base Master Planner and the FSMR Directorate of Public Works (DPW). These land-use controls will remain in effect after transfer from DoD ownership by restrictions imposed through deed recordation.

Additionally, the proposed abandonment of monitoring wells (MW1, MW2, MW3, MW4, MW5, MW6, MW7, and MW8) and the groundwater-use restrictions will provide an effective method for preventing the use of groundwater for drinking water or for irrigation at the site. The surficial aquifer is not an adequate source of drinking water at the FSMR and is not used. The BMP will be modified to officially restrict its use, further preventing use of the surficial groundwater at the site.

An annual O&M program will be administered to replace or repair warning signs, which may deteriorate over time (see Appendix A). Implementation of the O&M Plan will ensure the effectiveness of this program. The O&M program for this CAP will involve inspection as well as potential replacement or repair of warning signs.

Providing institutional controls over the short term will be a very effective means of minimizing or eliminating human exposure to buried waste within the boundaries of SWMU 3. Warning signs will be most effective over the short term. Current risk is below remedial levels, and use of the site is limited to outdoor classroom-style training, so access is already limited.

### 5.1.2 Implementability

Very few factors limit implementability of the institutional controls under evaluation. On-site personnel or contractors can readily perform posting of signs. The materials for the installation of warning signs are readily available to local contractors. Annual O&M inspections require few resources with respect to inspection personnel and materials for repair. Establishment of an adequate combination of land-use management tools will require additional time and effort for development, preparation, and processing of the necessary paperwork; however, the time and resources are available to administer and acquire the necessary land-use controls because the property is not expected to be sold or leased in the near future. Administrative provisions already exist to allow for incorporation of land-use controls into the BMP and to facilitate deed recordation.

### 5.1.3 Cost

The estimated total life-cycle cost of installation of warning signs, well abandonment, administrative activities associated with acquisition of legal controls, O&M activities, and management and oversight is $174,154. This alternative provides adequate protection of human health and the environment.

## 5.2 CONCEPTUAL DESIGN

During the period of ownership by DoD, institutional controls will be recorded to ensure implementation in the BMP. Notification of transfer will be made to regulatory authorities upon transfer of the property. Land-use restrictions and institutional control requirements that are expected to be enforced subsequent to property transfer include the following: deed recordation; the purchase agreement or lease; zoning controls; applicable state land-use control management systems in effect at the time the property is transferred; community, transferee, or governmental notice (if needed); and self-certification (if feasible). To reduce potential exposure to human health hazards associated with SWMU 3, warning signs stating restrictions on human activity within the SWMU will be mounted on poles around the boundary of the site (see Figure 4-1).

All activities that would involve disturbance of the subsurface will be minimized in accordance with all land-use control mechanisms. Activities that will be prohibited include military training activities that would disturb the subsurface soil, hunting, recreational activities, and construction of residential facilities; however, the following activities, conducted in a manner that would minimize disturbance of the subsurface, will be permitted

- timber harvesting (possible in the future),
- performance of wildlife studies,
- provision and maintenance of feed lots for deer, and
- outdoor classroom-style military training (subsurface disturbance not allowed).

### 5.2.1 Establishment of Institutional Controls

Prior to installation of warning signs at the SWMU, land-use and "zoning-like" requirements for the subject site will be incorporated into the BMP, which will include all restrictions and provisions documented in Appendix B of this report. The BMP will include a description of institutional controls provided in this CAP. The appropriate implementing document(s) will include land-use prohibitions and restrictions, including those related to activities that disturb the subsurface and to construction of new buildings. The appropriate implementing document(s) will also provide allowances for those activities that do not impact the subsurface, as described above. Reference to documents relevant to the corrective actions performed at this SWMU will also be included in the BMP.

Deed recordation and the purchase or lease agreement upon property transfer will also incorporate land-use controls. Deed recordation provisions and requirements are described in Appendix B. The deed recordation will, in perpetuity, notify any potential purchaser of the property that SWMU 3 has been used as a landfill. The purchase agreement(s) and deed recordation or lease agreement will reference this CAP and other environmental documents that contain the rationale for the restrictions. As required by the DoD policy "Responsibility for Additional Environmental Cleanup after Transfer of Property," the property disposal agent will ensure that the transfer documents for real property reflect the land-use controls. The legal office of the USACE and its telephone number will be included as a point of contact in the purchase agreement and deed in case a problem arises with a use control, additional contamination is found, or the transferee wishes to revise or terminate a land-use control. All applicable and appropriate state land-use control management systems in effect at the time of transfer will also be implemented. Additional land-use control mechanisms related to property transfer (e.g., notices, media-use restrictions, self-certification) will be evaluated and implemented as necessary and appropriate.

A survey plat has been prepared (Appendix C) by a professional land surveyor certified in the state of Georgia. The plat will be included in the BMP. The survey plat indicates the location and dimensions of SWMU 3 with respect to permanently surveyed benchmarks. The plat contains a prominently displayed note that states Fort Stewart's obligation to prohibit disturbance of SWMU 3 in accordance with this CAP.

### 5.2.2 Warning Signs

Ten permanent warning signs will be mounted on poles at approximately 200-foot intervals surrounding the perimeter of SWMU 3, as shown in Figure 4-1. These signs will be worded as shown below.

**FORMER LANDFILL**
**NO TRESPASSING**
**CONTACT DPW**
**REGARDING USE RESTRICTIONS**
**767-2010**

Each sign will have the dimensions of 24 inches by 24 inches. Warning signs will be metal plates with reflective paint and of weather-resistant construction. The signs will have a brown background and white lettering.

The positioning of each sign will provide maximum visibility from all locations outside the SWMU's boundaries. All signs will be permanently labeled (for identification purposes) on the back with a numerical identification number as shown on Figure 4-1.

The warning signs at the TAC-X Landfill will be inspected annually in accordance with the O&M Plan. Damaged signs will be repaired or replaced as needed. Repair or replacement of signs will occur within 1 month of inspection. Should damage be observed between inspections, repair or replacement will occur within 1 month of observation.

### 5.2.3 Well Abandonment

Eight monitoring wells (MW1, MW2, MW3, MW4, MW5, MW6, MW7, and MW8) will be properly abandoned. The abandonment of monitoring wells will include removal of the protective guard posts, concrete pad, and surface casing and grouting of the wells to ground surface. The debris from the abandonment of the monitoring wells will be disposed of at the Fort Stewart Sanitary Landfill.

## 5.3 COST ESTIMATE

A detailed cost estimate for implementation of institutional controls at the TAC-X Landfill is provided in Appendix D. The life-cycle cost estimate for the selected institutional controls alternative is $174,154, which includes $19,538 for capital costs and $92,819 for O&M.

## 5.4 IMPLEMENTATION SCHEDULE

Implementation of the corrective action will begin once approval of this CAP is received from GEPD. The schedule presented in **Table 5-1** has been established for implementation of institutional controls at this site.

**Table 5-1. Corrective Action Implementation Schedule, SWMU 3**

| Task | Time from GEPD Approval of CAP (days) |
|---|---|
| Procure signs and materials. | 90 |
| Record institutional controls in BMP and any other approved implementing document. | 120 |
| Perform well abandonment. | 120 |
| Install warning signs. | 120 |
| Perform inspections (implement O&M Plan). | Annually[a] |
| Repair/replace signs. | As needed |
| Notify GEPD of property transfer. | Prior to property transfer |
| Establish appropriate legal land-use controls for property transfer (e.g., deed recordation, lease or purchase agreements) | Prior to property transfer |

[a]The first O&M report will be submitted to GEPD 455 days after the installation of the warning signs, with subsequent reports submitted annually thereafter.

# 6.0 REFERENCES

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# APPENDIX A

# OPERATIONS AND MAINTENANCE PLAN

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# OPERATIONS AND MAINTENANCE PLAN

The following Operations and Maintenance (O&M) Plan will be implemented for a period of 30 years to ensure that signs and barriers remain in good condition. O&M will include documented inspections as well as any necessary repairs to or replacement of materials (e.g., signs). This plan outlines the roles and responsibilities for O&M (Table A-1) and provides a detailed description of O&M requirements for this site.

**Table A-1. O&M Roles and Responsibilities**

| Role | Responsibilities |
|---|---|
| Inspection and Maintenance Supervisor | • Facilitate assignment of qualified personnel to perform inspections.<br>• Provide instruction to qualified personnel.<br>• Establish dates for annual inspections.<br>• Collect, sign, and maintain field inspection and maintenance logs.<br>• Facilitate acquisition and provision of materials for repair or replacement of warning signs.<br>• Acquire maintenance support to make any necessary repairs or replacements of warning signs by preparing work requests.<br>• Provide any necessary instruction to maintenance personnel regarding repair or replacement of warning signs.<br>• File documentation associated with repairs/replacements.<br>• Prepare and submit annual O&M reports to the Georgia Environmental Protection Division (GEPD). |
| O&M Inspector | • Walk/drive around perimeter of site.<br>• Observe any damage to warning signs and any signs of human activity within the boundary of the solid waste management unit (SWMU).<br>• Document all findings and repair/replacement recommendations on Inspection and Maintenance Logsheet.<br>• Submit Inspection and Maintenance Logsheet and Site Inspection Map to Inspection and Maintenance Supervisor.<br>• Verbally clarify findings to Inspection and Maintenance Supervisor as needed. |
| Maintenance Personnel | • Acquire materials necessary for repair/replacement of warning signs.<br>• Perform repairs or replace signs as described by work request.<br>• Document that work request has been performed.<br>• Provide documentation of completed work to Inspection and Maintenance Supervisor. |

***Detailed Description of O&M Activities***

**General.** An Inspection and Maintenance Supervisor will be assigned to provide oversight and administration of O&M activities performed at the TAC-X Landfill (SWMU 3). The supervisor will ensure that qualified and trained personnel are selected to perform inspection and maintenance activities. Inspections and maintenance will be performed annually beginning 1 year after installation of the warning signs at the SWMU. All activities associated with field inspections and maintenance activities will be recorded in field inspection logs and maintenance documentation.

**Inspections.** The O&M Inspector will walk or drive the perimeter of SWMU 3 and observe any damage or deterioration of the warning signs. Any evidence of human activity within the boundaries of the SWMU will also be noted. Information from the field inspection observations shall be documented in the Inspection and Maintenance Logsheet (Figure A-1) and on the Site Inspection Map (Figure A-2). Information to be documented in the log will include the year of inspection, the number of signs to be repaired/replaced, the identification number of signs that require repair or replacement, an indication of the type of damage to the warning sign, and the signature of the inspector. The inspector will present the field logs and Site Inspection Map to the Inspection and Maintenance Supervisor within 24 hours of inspection. The inspector will also verbally report any findings that require clarification.

The Site Inspection Map (Figure A-2) will also be used to document which signs will require repair or replacement, as well as which signs were checked but will not require repair or replacement. Markings on the Site Inspection Map shall be made in accordance with the instructions provided on Figure A-2.

**Maintenance.** The Inspection and Maintenance Supervisor will ensure the procurement of any additional materials and supplies needed to repair or replace warning signs using work requests. The supervisor will ensure that maintenance personnel are assigned to perform any needed repairs or replacements. The Inspection and Maintenance Supervisor will provide a detailed description of the needed repairs or replacements to the maintenance personnel. The maintenance personnel will acquire the necessary supplies to make repairs or replace signs. The maintenance personnel, in accordance with the schedule requested by the supervisor, will then perform the repair and/or replacement of warning signs and will document the repairs and replacements on the Inspection and Maintenance Logsheet provided by the Inspection and Maintenance Supervisor (see Figure A-1). The completed maintenance log will be signed and dated by the maintenance personnel and submitted to the Inspection and Maintenance Supervisor for review and approval. All documentation associated with maintenance will be filed and maintained by the supervisor.

**Reporting.** Inspections and maintenance activities will also be summarized in an annual report entitled the *Corrective Action Plan Progress Report for SWMU 3.* The Inspection and Maintenance Supervisor will be responsible for preparing the report based on information provided in the Inspection and Maintenance Logsheets. The Inspection and Maintenance Supervisor will prepare and submit the initial *Corrective Action Plan Progress Report for SWMU 3* to GEPD for review and approval within 455 days of the installation of the warning signs at the TAC-X Landfill.

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# APPENDIX B

# BASE MASTER PLAN AND DEED RECORDATION REQUIREMENTS

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I certify that I have read and concur with the land recordation requirements presented in the Base Master Plan for the TAC-X Landfill (SWMU 3).

________________________________________ ________________________

Principal Executive Officer or Authorized Agent | Date
Fort Stewart Military Reservation

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# Introduction

This appendix presents the requirements for the Base Master Plan (BMP) and deed recordation for the implementation of the selected remedial alternative for the area identified as the TAC-X Landfill [Solid Waste Management Unit (SWMU) 3]. The selected remedial alternative for the TAC-X Landfill is protective of human health and includes the following features:

- BMP, deed recordation, and zoning controls that restrict the use of groundwater and prohibit intrusion into subsurface soil;
- abandonment of eight monitoring wells (MW1, MW2, MW3, MW4, MW5, MW6, MW7, and MW8);
- installation of warning signs; and
- implementation of an Operations and Maintenance (O&M) Plan to maintain the conditions of the signage.

The selected alternative is fully described in Chapter 5 of this report.

The requirements for the BMP identify land-use restrictions and requirements to be incorporated into and enforced by the Fort Stewart Military Reservation BMP until transfer of ownership of the TAC-X Landfill from the federal government. The requirements for deed recordation identify the present (i.e., as of December 2000) applicable requirements for the area identified as the TAC-X Landfill upon its future transfer out of government ownership.

# Base Master Plan
# for
# Solid Waste Management Unit 3,
# TAC-X Landfill

The information/items and restrictions below will be included in the BMP, which will be effective until the transfer of ownership of the TAC-X Landfill property.

1. The following information will be documented in the BMP:

   a. All activities on the property that may result in disturbance of subsurface soil and/or substantially interfere with implementation of the O&M Plan are prohibited.

   b. Although use of groundwater beneath the subject property is not expressly prohibited, installation of groundwater wells, including monitoring wells, within the boundaries of this property is expressly prohibited.

   c. Military training exercises that may disturb the subsurface soil, hunting, and recreational activities are expressly prohibited.

   d. All construction within the property boundaries is expressly prohibited.

   e. The O&M Plan for the TAC-X Landfill, which requires maintenance of permanent markers (signs) every 200 feet to delineate the restricted area, is to be implemented. The BMP shall reference the O&M Plan or include the plan as an attachment or appendix.

   f. The BMP will also document the following specific activities that will be permitted within the boundaries of the subject site

      (1) timber harvesting,
      (2) performance of wildlife studies,
      (3) provision and maintenance of feed lots for deer, and
      (4) outdoor classroom-style military training (subsurface disturbance not allowed).

2. Site Survey:

   a. The BMP will include a written description of the boundaries of the site in accordance with the survey plat included in this Corrective Action Plan. Both the written description and the survey plat are presented in Appendix C.

   b. A copy of the survey plat, which indicates the location and dimensions of the disposal unit with respect to permanently surveyed benchmarks, will be included in the BMP. The survey plat is presented in Appendix C.

# Deed Recordation

Deed recordation will be provided at the time of transfer out of government ownership and will comply with *DoD Guidance on Land Use Controls for Property Transferred Out of Federal Ownership* (Working Draft). Deed recordation for the TAC-X Landfill (SWMU 3) will conform to the following requirements:

1. Deed recordation will be made through the execution of a restrictive covenant for the property. The covenant will be recorded with the clerk of the superior court for the county of Bryan. The language will be consistent with applicable state property and environmental laws in effect at the time of transfer.

2. A copy of the restrictive covenant should be provided to the zoning or land-use planning authority that has jurisdiction over this property. Such restrictions should run with the land and be binding on the owner's successors and assignees.

3. The restrictive covenant will be written by the real estate office of the Savannah District of the U.S. Army Corps of Engineers. As required by the real estate office, the following items will be provided to facilitate preparation of the deed:

   a. a survey plat (see Appendix C of this Corrective Action Plan),
   b. a legal description of the property, and
   c. use restrictions and other provisions (see Item 4 below).

4. The following restrictions/provisions may be documented in the restrictive covenant:

   a. The subject area will be limited to industrial use only.

   b. Activities on the property that may result in disturbance of subsurface soil and/or substantially interfere with implementation of the O&M Plan will be restricted.

   c. Any use of shallow groundwater beneath the subject property will be prohibited, except where monitoring is determined to be necessary by regulatory authorities.

   d. Maintenance of permanent markers (signs) approximately every 200 feet around the perimeter of the site that meet the requirements established by this Corrective Action Plan for SWMU 3 will be required to delineate the restricted area.

   e. The legal office of the U.S. Army Corps of Engineers and its telephone number will be included as the point of contact and documented in the deed in case a problem arises with a use control, additional contamination is found, or the transferee wishes to revise or terminate a land-use control.

5. After the language is drafted, the disposal agent should coordinate with the Georgia Environmental Protection Division for verification that the restrictions reflect the environmental concerns of the site.

6. The property disposal agent's office should also provide a copy of the deed to local offices such as the Building Permits Division and the Water Resources Branch.

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## APPENDIX C

## SITE DESCRIPTION, DIRECTIONS TO THE SITE, AND SURVEY PLAT

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# SITE DESCRIPTION AND DIRECTIONS TO THE SITE FOR THE TAC-X LANDFILL

***Site Description***

The TAC-X Landfill [Solid Waste Management Unit (SWMU) 3] is located approximately 3.5 miles south-southwest of Pembroke, Georgia, and less than 1 mile southeast of Dean Field. The TAC-X Landfill comprises approximately 6.3 acres. Four topographic survey points define the northeast, northwest, southeast and southwest corners of SWMU 3. There are approximately 6 feet of relief across the TAC-X Landfill. The elevation is approximately 73 feet above mean sea level (amsl) along the northern boundary and slopes gently downward to approximately 67 feet amsl along the southern boundary. Two disposal trenches run approximately north to south, terminating in a small, swampy depression. Standing water can accumulate in the depression after rainfall events and was present during the Phase II Resource Conservation and Recovery Act Facility Investigation. Soil from the trenches is mounded along their sides. One of the trenches is reportedly unused. The reported dimensions of the disposal trench are 20 feet wide by 400 feet long by 5 feet to 6 feet deep. The TAC-X Landfill was active from the 1960s until 1982. The waste disposed of at the landfill from the 1960s to 1979 included residential waste, food cans, brush, plastic, and cardboard boxes. From 1979 to 1982, the wastes included grass clippings, tree branches, root stumps, and chunks of asphalt and concrete. A site reconnaissance in November 1993 observed household-type debris (e.g., plastic spoons and bags) within the overburden pile on the western side of the disposal trench. Aged refuse is reported to be present at the bottom of the disposal trench. A site reconnaissance in September 1996 indicated no evidence of any landfill operations. The site is heavily forested. Pine trees, brush, and grass cover most of the site. The southernmost portion of the site is marshy, with surface water present. The enclosed plat, based on a survey performed in April 2000, defines the current site features of SWMU 3.

***Directions to Site***

Starting from the Intersection of Georgia Highways 119 and 144 on the northern perimeter of the Fort Stewart garrison area, proceed north 14.1 miles on Georgia Highway 119, and take a left (west) at the Noncommissioned Officers Academy (NCO) sign. Proceed 1.3 miles, and take a left (south) at the first dirt road on the left past the bridge over Gator Swamp Creek. Proceed 0.15 mile, and you will enter the TAC-X Landfill. Warning signs will be posted approximately every 200 feet around the perimeter of the landfill after the implementation of the controls recommended by this Corrective Action Plan.

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# APPENDIX D

# COST ESTIMATE

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| | Cost Estimate for SWMU 3 | Alternative 1 Institutional Controls: Land Use Controls with Signs | Alternative 1A Institutional Controls: Land Use Controls with Signs and Groundwater Monitoring | Alternative 2 Institutional Controls: Land Use Controls with Signs and Fence | Alternative 2A Institutional Controls: Land Use Controls with Signs, Fence, and Groundwater Monitoring |
|---|---|---|---|---|---|
| **1.0** | **Capital Costs** | | | | |
| 1.1 | Engineering Services | | | | |
| 1.1.1 | Work Plan/Site Safety and Health Plan | $2,000 | $5,000 | $3,000 | $5,000 |
| 1.1.2 | Contracting/Procurement | $1,000 | $2,000 | $1,000 | $2,000 |
| 1.1.3 | Engineering Oversight | $1,200 | $3,000 | $1,200 | $3,000 |
| **1.1** | **Total Costs for Engineering Services** | **$4,200** | **$10,000** | **$5,200** | **$10,000** |
| **1.2** | **Installation/Establishment of Institutional Controls** | | | | |
| 1.2.1 | *Tree and Brush Clearing and Chipping* | | | 1049 | 1049 |
| 1.2.2 | *Signs and Posts Installation* | | | | |
| | 1.2.2.1 Warning Signs | $5,930 | $5,930 | $5,930 | $5,930 |
| | 1.2.2.2 Posts (includes shipping) | $208 | $208 | -- | |
| | 1.2.2.3 Sign/Post Installation Labor | $1,000 | $1,000 | $0 | $0 |
| | Subtotal of Warning Signs Installation | $7,138 | $7,138 | $5,930 | $5,930 |
| 1.2.3 | *Chain-link (6' high, 3 strands barbed wire) Fence with One Swing Gate* | | | | |
| | 1.2.3.1 Chain-link Fence Installation | -- | | $44,202 | $44,202 |
| | 1.2.3.2 Gate Installations | -- | | $1,456 | $1,456 |
| | Subtotal of Fence and Gate Installation | $0 | $0 | $45,658 | $45,658 |
| 1.2.4 | *Abandonment of Groundwater Wells* | | | | |
| | 1.2.4.1 Mobilization and Demobilization | $2,000 | $2,000 | $2,000 | $2,000 |
| | 1.2.4.2 Well Abandonment | $3,200 | $3,200 | $3,200 | $3,200 |
| | Subtotal of Well Abandonment | $5,200 | $5,200 | $5,200 | $5,200 |
| 1.2.5 | *Groundwater Monitoring* | | | | |
| | 1.2.5.1 Mobilization and Demobilization | | $10,000 | | $10,000 |
| | 1.2.5.2 Technical Labor | | $26,000 | | $26,000 |
| | 1.2.5.3 ODCs (pumps, meters, travel, per diem) | | $25,000 | | $25,000 |
| | 1.2.5.4 Laboratory Analysis | | $12,000 | | $12,000 |
| | 1.2.5.5 Data QA | | $6,000 | | $6,000 |
| | 1.2.5.6 Groundwater Monitoring Report | | $25,000 | | $25,000 |
| | Subtotal of Groundwater Monitoring | $0 | $104,000 | $0 | $104,000 |

| | Cost Estimate for SWMU 3 | Alternative 1 | Alternative 1A | Alternative 2 | Alternative 2A |
|---|---|---|---|---|---|
| | | **Institutional Controls: Land Use Controls with Signs** | **Institutional Controls: Land Use Controls with Signs and Groundwater Monitoring** | **Institutional Controls: Land Use Controls with Signs and Fence** | **Institutional Controls: Land Use Controls with Signs, Fence, and Groundwater Monitoring** |
| 1.2.7 | *Deed Recordation* | | | | |
| | Allowance* | $3,000 | $3,000 | $3,000 | $3,000 |
| **1.2** | **Total Installation/Establishment of Institutional Controls** | **$15,338** | **$119,338** | **$60,837** | **$164,837** |
| **1.0** | **Total Capital Costs** | **$19,538** | **$129,338** | **$66,037** | **$174,837** |
| | | | | | |
| **2.0** | **Operations and Maintenance (30 years)** | | | | |
| 2.1 | Replacement/Repair of Warning Signs and/or Posts** | $10,708 | $10,708 | $8,896 | $8,896 |
| 2.2 | Replacement/Repair of Fencing*** | -- | -- | $27,395 | $27,395 |
| 2.3 | Annual Inspection and Reports | $77,111 | $77,111 | $77,111 | $77,111 |
| 2.4 | Administration of Operations and Maintenance Plan Requirements | $5,000 | $5,000 | $5,000 | $5,000 |
| **2.0** | **Total Costs for Operations and Maintenance** | **$92,819** | **$92,819** | **$118,402** | **$118,402** |
| | | | | | |
| | Subtotal Project Costs | $112,357 | $222,157 | $184,439 | $293,239 |
| | Engineering Management (10 percent of subtotal) | $11,236 | $22,216 | $18,444 | $29,324 |
| | Contingency (20 percent of subtotal) | $22,471 | $44,431 | $36,888 | $58,648 |
| | Health and Safety (15 percent of subtotal) | $16,854 | $33,324 | $27,666 | $43,986 |
| | Contractor Profit (10 percent of subtotal) | $11,236 | $22,216 | $18,444 | $29,324 |
| | **Total Project Costs** | **$174,154** | **$344,344** | **$285,881** | **$454,521** |

* Allowance based upon estimate using best professional judgment.
** Assumes sign and/or post repair/replacement allowance of 25 percent of total installation cost every 5 years for a period of 30 years.
*** Assumes fence repair/replacement allowance of 10 percent of total installation cost every 5 years for a period of 30 years.