Final

Site Investigation Report
Golf Course, Parcels 178(7), 83(7), and 141(7)

Fort McClellan
Calhoun County, Alabama

Prepared for:

U.S. Army Corps of Engineers, Mobile District
109 St. Joseph Street
Mobile, Alabama 36602

Prepared by:

IT Corporation
312 Directors Drive
Knoxville, Tennessee 37923

Task Orders CK05 and CK08
Contract No. DACA21-96-D-0018
IT Project Nos. 774645 and 783149

June 2001

Revision 0

Table of Contents

Page

Table of Contents *(Continued)*

Page

List of Tables

List of Figures

Executive Summary

IT Corporation (IT), under contract with the U.S. Army Corps of Engineers, completed a site investigation (SI) at the Golf Course, Parcels 178(7), 83(7), and 141(7), at Fort McClellan in Calhoun County, Alabama. The SI was conducted to determine whether chemical constituents are present at the Golf Course and, if present, whether the concentrations present an unacceptable risk to human health or the environment. The SI at the Golf Course consisted of the sampling and analysis of 19 surface soil samples, 6 subsurface soil samples, 5 groundwater samples, 5 surface water samples, and 5 sediment samples. In addition, two permanent and three temporary monitoring wells were installed in the residuum groundwater zone to facilitate groundwater sample collection and to provide site-specific geological and hydrogeological characterization information. Data previously collected by QST Environmental Inc. (QST) at the Golf Course were incorporated into this SI report.

IT collected 12 surface soil samples, five surface water samples, and five sediment samples at the Golf Course, Parcel 178(7). In addition, IT collected two groundwater samples at the current pesticide mixing and storage facility, Parcel 83(7). QST collected a total of seven surface soil samples, six subsurface soil samples, and three groundwater samples during the SI at Parcel 83(7) and at the former pesticide mixing and storage facility, Parcel 141(7). The combined analytical results indicate that metals volatile organic compounds (VOC), semivolatile organic compounds (SVOC), chlorinated pesticides, and chlorinated herbicides were detected in the environmental media sampled. Organophosphorus pesticides and polychlorinated biphenyls (PCB) were not detected in any of the environmental media sampled. To evaluate whether the detected constituents present an unacceptable risk to human health or the environment, the analytical results were compared to human health site-specific screening levels (SSSL), ecological screening values (ESV), and background screening values for Fort McClellan.

The potential threat to human health is expected to be minimal. The concentrations of metals and organic compounds in site media are low. Although the Golf Course is projected for continued use as an active recreational area, the soils and groundwater analytical data from the site were screened against residential human health SSSLs to evaluate the site for possible unrestricted land reuse. In soils, the metals concentrations that exceeded SSSLs were below their respective background concentrations or within the range of background values and, thus, do not pose a threat to human health. VOC, SVOC, and pesticide/herbicide concentrations in soils were below SSSLs.

In groundwater, with the exception of aluminum, iron, manganese, and vanadium, detected in two temporary groundwater wells installed using direct-push methods, metals concentrations were within the range of background values. In addition, four pesticides (aldrin, chlordane, dieldrin, and heptachlor epoxide) were detected in one groundwater sample at concentrations exceeding SSSLs. However, the pesticide concentrations were below U.S. Environmental Protection Agency (EPA) drinking water standards and health advisory values. The VOC methyl tertiary butyl ether (MTBE) was detected in one well, located near the current pesticide mixing and storage building (Building 2252), at a concentration of 0.005 milligrams per liter (mg/L). Currently no SSSL exists for MTBE; however, the MTBE concentration was below EPA Region 9 Preliminary Remediation Goal for MTBE in tap water (0.02 mg/L). Given the low concentrations and limited distribution, these compounds are not expected to pose a threat to human health in either the current recreational or residential land-use scenario.

The potential threat to ecological receptors is also expected to be low. Several metals were detected in site media at concentrations exceeding ESVs. However, with the exception of selenium (in four surface soil samples) and lead (one sediment sample), the metals concentrations that exceeded ESVs were below their respective background concentration or within the range of background values. The concentrations of two VOCs (tetrachloroethene and trichloroethene) exceeded ESVs in six of seven surface soil samples. However, none of the VOCs detected exceeded SSSLs. Only one SVOC (fluoranthene) exceeded its ESV in surface soil. The concentrations of three chlorinated pesticides exceeded ESVs in a limited number of surface soil and sediment samples but show no pattern of distribution that would indicate a discrete source. In all likelihood, these pesticides are indicative of historical pesticide use on the golf course as part of a routine maintenance program. Although these pesticides are no longer in use, other pesticides are routinely used at the golf course to maintain the area for its intended purpose. Because the golf course is expected to remain active for the foreseeable future, these sporadic, low-levels of pesticides are not expected to adversely affect the ecological receptors in the vicinity of the golf course.

Based on the results of the SI, past operations at the Golf Course have not adversely impacted the environment. The metals and chemical compounds detected in site media do not pose an unacceptable risk to human health or the environment in either the current recreational or residential land-use scenario. Therefore, IT recommends "No Further Action" and unrestricted land reuse at the Golf Course.

1.0 Introduction

The U.S. Army has selected Fort McClellan (FTMC) located in Calhoun County, Alabama, for closure by the Base Realignment and Closure (BRAC) Commission under Public Laws 100-526 and 101-510. The 1990 Base Closure Act, Public Law 101-510, established the process by which U.S. Department of Defense (DOD) installations would be closed or realigned. The BRAC environmental restoration program requires investigation and cleanup of federal properties prior to transfer to the public domain. The U.S. Army is conducting environmental studies of the impact of suspected contaminants at parcels at FTMC under the management of the U.S. Army Corps of Engineers (USACE)-Mobile District. The USACE contracted IT Corporation (IT) to provide environmental services for completion of the site investigation (SI) of the Golf Course, Parcels 178(7), 83(7), and 141(7), under Contract No. DACA21-96-D-0018, Task Orders CK05 and CK08.

The U.S. Army Environmental Center (AEC) originally contracted QST Environmental, Inc. (QST) to conduct the SI at the Golf Course Pesticide Mix/Storage Facilities (Parcels 83[7] and 141[7]). QST prepared an SI work plan (QST, 1998) and conducted SI field activities in May 1998. However, QST was unable to collect groundwater samples required to complete the SI because of difficulty installing temporary monitoring wells using direct-push technology (DPT). Therefore, IT was tasked to complete the SI at Parcels 83(7) and 141(7) as well as to conduct additional sampling and field activities at Parcel 178(7) described in the IT work plan (IT, 1999a). This SI report presents specific information and results compiled from the IT and QST fieldwork conducted at the Golf Course, Parcels 178(7), 83(7), and 141(7). The site is hereinafter referred to as the Golf Course and includes all associated parcels unless otherwise specified.

1.1 Project Description

The Golf Course, Parcels 83(7), 141(7), and 178(7), were identified as an area to be investigated prior to property transfer. The site was identified as a Category 7 site in the environmental baseline survey (EBS) (Environmental Science and Engineering, Inc. [ESE], 1998). Category 7 sites are areas that are not evaluated and/or that require additional evaluation.

Two site-specific sampling plans were prepared to investigate these sites. QST initially prepared a plan dated March 1998 to investigate the golf course pesticide mixing and storage facilities, Parcels 83(7) and 141(7); IT prepared a site-specific field sampling plan (SFSP) attachment for Parcel 178(7) that was finalized in December 1998 (IT, 1998a). The SFSP was prepared to

provide technical guidance for sample collection and analysis at the Golf Course. The SFSP was used in conjunction with a site-specific safety and health plan (SSHP) as attachments to the installation-wide work plan (IT, 1998b), and the installation-wide sampling and analysis plan (SAP) (IT, 2000a). The SAP includes the installation-wide safety and health plan (SHP) and quality assurance plan (QAP).

The SI included field work to collect 19 surface soil samples (12 by IT and 7 by QST), 6 subsurface soil samples (QST), 5 surface water samples (IT), 5 sediment samples (IT), and 5 groundwater samples (2 by IT and 3 by QST) to determine if potential site-specific chemicals are present at the Golf Course and to provide data useful in any future corrective measures and closure activities.

1.2 Purpose and Objectives

The SI program was designed to collect data from site media and provide a level of defensible data and information in sufficient detail to determine whether chemical constituents are present at the Golf Course at concentrations that present an unacceptable risk to human health or the environment. The conclusions of the SI in Chapter 6.0 are based on the comparison of the analytical results to human health site-specific screening levels (SSSL), ecological screening values (ESV), and background screening values for FTMC. The SSSLs and ESVs were developed by IT as part of the human health and ecological risk evaluations associated with SIs being performed under the BRAC environmental restoration program at FTMC. The SSSLs and ESVs are presented in the *Final Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000b). Background metals screening values are presented in the *Final Background Metals Survey Report, Fort McClellan, Alabama* (Science Applications International Corporation [SAIC], 1998).

Based on the conclusions presented in this SI report, the BRAC Cleanup Team (BCT) will decide either to propose "No Further Action" at the site or to conduct additional work at the site.

1.3 Site Description and History

The Golf Course, Parcel 178(7), is located in the northwest area of the FTMC Main Post and covers approximately 146 acres (Figure 1-1). A variety of pesticides and herbicides have been applied at the golf course over the years. Evidence of inappropriate application of chemicals, spills, or other releases at the golf course was not identified during the EBS. In addition, there have not been any recorded spills or incidences at the golf course (ESE, 1998).

The mixing and storage of pesticides and herbicides for the golf course was first performed at Building T-2249, located near the intersection of Galloway Road and Baltzell Gate Road, from an unknown beginning date until approximately 1985. In 1994, Building T-2249 was demolished. Additional information regarding the building is not known. The site of the former pesticide mixing and storage facility located at Building T-2249 is categorized as Parcel 141(7) and is included in this site investigation.

In 1985, the pesticide mixing and storage facility was moved to a newly constructed building, Building 2252, located on 14th Army Band Road. The current golf course pesticide mixing and storage facility, Building 2252, is categorized as Parcel 83(7) and is also included in this SI.

Licensed and certified government employees and private contractors applied pesticides and herbicides at the golf course. This included golf course employees, employees of the Roads and Grounds Department, or pest management personnel (ESE, 1998). The requirement for certification of all pesticide applicators dates back to the 1970s. Although recertification was required every two years, personnel at the golf course and the Forestry Department did not receive recertification on at least one occasion (ESE, 1998). Typically, pesticide applicators received DOD certification upon completion of training at Fort Sam Houston or obtained certification from outside agencies. Pest management staff obtained additional certification from the State of Alabama beginning in 1983 (ESE, 1998).

The site elevation at the Golf Course ranges from approximately 800 feet at the northern end of the course to approximately 700 feet at the western end of the site along Cane Creek. Cane Creek, a perennial stream, flows to the northwest, transecting the Golf Course from the southeast (Figure 1-2). Remount Creek flows to the north-northwest, where it joins Cane Creek. The confluence of Remount Creek and Cane Creek is located near the central portion of the site and northwest of the golf course clubhouse. The confluence of Cane Creek and South Branch of Cane Creek is in the eastern section of the site. Several other intermittent tributaries feed Cane Creek in the central portion of the Golf Course.

2.0 Previous Investigations

An EBS was conducted by ESE to document the current environmental conditions of all FTMC property (ESE, 1998). The study was to identify sites that, based on available information, have no history of contamination and comply with DOD guidance for fast-track cleanup at closing installations. The EBS also provides a baseline picture of FTMC properties by identifying and categorizing the properties by seven criteria:

1. Areas where no storage, release, or disposal of hazardous substances or petroleum products has occurred (including no migration of these substances from adjacent areas)

2. Areas where only release or disposal of petroleum products has occurred

3. Areas where release, disposal, and/or migration of hazardous substances has occurred, but at concentrations that do not require a removal or remedial response

4. Areas where release, disposal, and/or migration of hazardous substances has occurred, and all removal or remedial actions to protect human health and the environment have been taken

5. Areas where release, disposal, and/or migration of hazardous substances has occurred, and removal or remedial actions are underway, but all required remedial actions have not yet been taken

6. Areas where release, disposal, and/or migration of hazardous substances has occurred, but required actions have not yet been implemented

7. Areas that are not evaluated or require additional evaluation.

The EBS was conducted in accordance with the Community Environmental Response Facilitation Act (CERFA) (Public Law 102-426) protocols and DOD policy regarding contamination assessment. Record searches and reviews were performed on all reasonably available documents from FTMC, ADEM, EPA Region IV, and Calhoun County, as well as a database search of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-regulated substances, petroleum products, and Resource Conservation and Recovery Act (RCRA)-regulated facilities. Available historical maps and aerial photographs were reviewed to document historical land uses. Personal and telephone interviews of past and present FTMC employees and military personnel were conducted. In addition, visual site inspections were conducted to verify conditions of specific property parcels.

CERFA guidelines state that routine pesticide/herbicide use, applied in accordance with manufacturer's directions, is exempt from CERCLA and, therefore, should not disqualify a parcel that is otherwise uncontaminated. Because adequate records of pesticide usage do not exist for the Golf Course, the BCT determined that the Golf Course required additional investigation before release to the public. Therefore, the Golf Course, Parcel 178(7), is classified as a Category 7 CERFA site: areas that have not been evaluated or require additional evaluation. This includes the Pesticide Mixing and Storage Facilities, Parcels 83(7) and 141(7).

3.0 Current Site Investigation Activities

This chapter describes SI activities conducted by IT and QST at the Golf Course, including environmental sampling and analysis and monitoring well installation activities.

3.1 Environmental Sampling

The environmental sampling performed during the SI at the Golf Course included the collection of surface soil samples, subsurface soil samples, surface water samples, sediment samples, and groundwater samples for chemical analysis. The sample locations were determined by observing site physical characteristics during a site walkover, and by reviewing historical documents pertaining to activities conducted at the site. The sample locations, media, and rationales are summarized in Table 3-1. Samples collected by IT are designated with the prefix "PPMP" or "GSBP"; samples collected by QST are designated with the prefix "SI07". Samples were submitted for laboratory analyses of site-related parameters listed in Section 3.3.

3.1.1 Surface Soil Sampling

A total of 19 surface soil samples were collected at the golf course. IT collected 12 surface soil samples during the SI at the Golf Course, Parcel 178(7). Additionally, QST collected 7 surface soil samples at the Golf Course Pesticide Mixing/Storage Facilities, Parcels 83(7) and 141(7). Soil sampling locations and rationales are presented in Table 3-1. Sampling locations are shown on Figures 3-1 through 3-3. Sample designations and quality assurance/quality control (QA/QC) samples are listed in Table 3-2. Soil sampling locations were determined in the field by the on-site geologist based on the sampling rationale, presence of surface structures, site topography, and buried utilities.

IT Sample Collection. Surface soil samples collected by IT at Parcel 178(7) were collected from the upper 1 foot of soil with a 3-inch diameter stainless-steel hand auger using the methodology specified in Section 4.9.1.1 of the SAP (IT, 2000a). Surface soil samples were collected by first removing surface debris, such as rocks and vegetation, from the immediate sample area. The soil was collected with the sampling device and screened with a photoionization detector (PID) in accordance with Section 4.7.1.1 of the SAP (IT, 2000a). The sample was transferred to a clean stainless-steel bowl, homogenized, and placed in the appropriate sample containers. The samples were analyzed for the parameters listed in Table 3-2 using methods outlined in Section 3.3. Sample collection logs are included in Appendix A.

QST Sample Collection. Surface soil samples collected by QST at Parcels 83(7) and 141(7) were collected from 0 to 1 foot bgs using a direct-push sampling system in accordance with the QST work plan (QST, 1998). The samples were analyzed for parameters listed in Table 3-2 using methods outlined in Section 3.3.

3.1.2 Subsurface Soil Sampling

Subsurface soil samples were collected from six soil borings by QST at the Golf Course. The subsurface soil sample locations are shown on Figures 3-2 and 3-3, and the sampling locations and rationales are presented in Table 3-1. Sample designations, depths, and QA/QC samples are listed in Table 3-2. Soil boring sampling locations were determined in the field by the on-site geologist based on the sampling rationale, presence of surface structures, site topography, and buried and overhead utilities. QST contracted Graves Service Company Inc. to complete the soil borings and monitoring well installations.

Sample Collection. QST collected at total of six subsurface soil samples at Parcels 83(7) and 141(7). The subsurface soil samples were collected at a depth interval from 3 to 4 feet bgs using a direct-push sampling system, in accordance with procedures outlined in the QST work plan (QST, 1998).

3.1.3 Well Installation

A total of five groundwater monitoring wells were installed during the SI at the Golf Course, as shown on Figure 3-2. IT installed two permanent groundwater monitoring wells using hollow-stem auger and QST installed three temporary groundwater monitoring wells using DPT. Table 3-3 summarizes the construction details of the wells installed at the Golf Course. The well construction logs are included in Appendix B.

IT Well Installation. IT contracted Miller Drilling Inc. to install two permanent monitoring wells with a hollow-stem auger rig at Parcel 83(7) in August 1999. The permanent wells were installed following procedures outlined in Section 4.7 and Appendix C of the SAP (IT, 2000a). The boreholes at these locations were advanced with a 4.25-inch inside diameter (ID) hollow-stem auger from ground surface to the first water-bearing zone in residuum at the well location. A 2-foot-long, 2-inch ID carbon steel split-spoon sampler was driven at 5-foot intervals to collect residuum for observing and describing lithology. Where split-spoon refusal was encountered, the auger was advanced until the first water-bearing zone was encountered. The on-site geologist logging the auger boreholes continued the lithological log for each borehole from the depth of split-spoon refusal to the bottom of the auger borehole by logging the auger drill

cuttings. The sampler soil was logged to determine lithologic changes and the approximate depth of groundwater encountered during drilling. This information was used to determine the optimal placement of the monitoring well screen interval and to provide site-specific geologic and hydrogeologic information. The lithological log for each borehole is included in Appendix B.

Upon reaching the target depth at each borehole, a 10- or 20-foot length of 2-inch ID, 0.010-inch factory slotted, continuously wrapped, Schedule 40 PVC screen with a 3-inch PVC end cap was placed through the auger to the bottom of the borehole. The screen and end cap were attached to a 2-inch ID, flush-threaded Schedule 40 PVC riser. A sand pack consisting of number 1 filter sand (environmentally safe, clean fine sand, sieve size 20 to 40) was tremied around the well screen to approximately 2 feet above the top of the well screen as the augers were removed. The wells were surged using a solid PVC surge block for approximately 10 minutes, or until no more settling of the filter sand occurred inside the borehole. A bentonite seal, consisting of approximately 2 feet of bentonite pellets, was placed on top of the sand pack and then hydrated with potable water. The annular space was filled to ground surface with a bentonite-cement grout and a concrete surface pad was installed. A locking well cap was placed on the PVC well casing.

The wells were developed by surging and pumping with a 2-inch submersible pump in accordance with methodology outlined in Section 4.8 and Appendix C of the SAP (IT, 2000a). The submersible pump used for well development was moved in an up-and-down fashion to encourage any residual well installation materials to enter the well. These materials were then pumped out of the well to re-establish the natural hydraulic flow conditions. Development continued until the water turbidity was equal to or less than 20 nephelometric turbidity units (NTU) or for a maximum of eight hours. The well development logs are included in Appendix C.

QST Well Installation. QST installed three temporary monitoring wells in the residuum groundwater zone at the Golf Course using a direct-push sampling system. The temporary wells were installed following procedures outlined in the QST work plan (QST, 1998). The well/groundwater sample locations are shown on Figures 3-2 and 3-3.

QST contracted Graves Service Company Inc., to install the temporary wells at Parcels 83(7) and 141(7) using DPT at the locations shown on Figures 3-2 and 3-3. The temporary wells were installed, purged and sampled, and removed within 24 hours (QST, 1998). Well development

was not indicated on QST boring logs, sampling forms, or field notes. Initially, a 2-inch diameter borehole was installed 5 feet into the uppermost water-bearing zone (QST, 1998). Soil descriptions were prepared by the QST geologist and are presented in Appendix B of this SI report. Upon reaching the target depth, a 10-foot long (1-inch nominal diameter), PVC slotted screen (0.010-inch), capped on the bottom, was lowered into the borehole (QST, 1998). In each instance, the top of the screen extended above the ground surface and no riser was used. Sand pack (20/40 silica sand) was placed into the annular space to the ground surface.

3.1.4 Water Level Measurements

The depth to groundwater was measured in the permanent monitoring wells installed by IT at the Golf Course in March 2000, following procedures outlined in Section 4.18 of the SAP (IT, 2000a). Depth to groundwater was measured with an electronic water level meter. The meter probe and cable were cleaned before use at each well following decontamination methodology presented in Section 4.10 of the SAP (IT, 2000a). Measurements were referenced to the top of the PVC casing. A summary of groundwater level measurements is presented in Table 3-4.

3.1.5 Groundwater Sampling

A total of five monitoring wells were sampled at the Golf Course. IT collected groundwater samples from two permanent monitoring wells (GSBP-83-MW01 and GSBP-83-MW02), and QST collected groundwater samples from three DPT wells (SI07-GWS01B, SI07-GWS02, and SI07-GWS05) at the Golf Course. The well/groundwater sampling locations are shown on Figures 3-2 and 3-3. The groundwater sampling locations and rationales are listed in Table 3-1. The groundwater sample designations are listed in Table 3-5.

IT Sample Collection. IT collected groundwater samples following procedures outlined in Section 4.9.1.4 of the SAP (IT, 2000a). Groundwater samples were collected after purging a minimum of three well volumes and after field parameters (temperature, pH, specific conductivity, and turbidity) stabilized. Purging and sampling were performed with a peristaltic pump equipped with Teflon™ tubing (except for VOC samples). Groundwater samples for VOC analysis were collected by filling the Teflon tubing via suction applied by the peristaltic pump, then removing the tubing from the well and the pump head and allowing the groundwater to drain into sample vials. This procedure was repeated until all vials were filled. Field parameters were measured using a calibrated water-quality meter. Field parameter readings are summarized in Table 3-6. Sample collection logs are included in Appendix A. The samples were analyzed for the parameters listed in Section 3.3.

QST Sample Collection. Groundwater samples were collected by QST immediately following completion of well purging using a peristaltic pump. Groundwater parameters were monitored for pH, conductivity, and temperature (turbidity and oxidation-reduction potential were not monitored). Field parameters are summarized in Table 3-6. Sample collection logs are included in Appendix A. The samples were analyzed for the parameters listed in Table 3-5 using methods outlined in Section 3.3.

3.1.6 Surface Water Sampling

IT collected five surface water samples at the Golf Course from the locations shown on Figure 3–1. The surface water sampling locations and rationales are listed in Table 3-1. Sample designations and QA/QC samples are listed in Table 3-7. The sampling locations were determined in the field, based on drainage pathways and actual field observations.

Sample Collection. Surface water samples were collected in accordance with the procedures specified in Section 4.9.1.3 of the SAP (IT, 2000a). The samples were collected by dipping a clean stainless-steel pitcher in the water and pouring the water in the appropriate sample containers. Surface water samples were collected after field parameters had been measured using a calibrated water-quality meter. Surface water field parameters are listed in Table 3-6, and sample collection logs are included in Appendix A. The samples were analyzed for the parameters listed in Table 3-7 using methods outlined in Section 3.3.

3.1.7 Sediment Sampling

IT collected five sediment samples during the SI at the Golf Course. The sediment samples were collected at the same locations as the surface water samples discussed in Section 3.1.6. The locations of the sediment samples collected are shown on Figure 3-1. Sediment sampling locations and rationales are presented in Table 3-1. Sample designations and QA/QC samples are listed in Table 3-7. The final sediment sampling locations were determined in the field, based on drainage pathways and field observations.

Sample Collection. Sediment samples were collected in accordance with the procedures specified in Section 4.9.1.2 of the SAP (IT, 2000a). The sediment samples were collected with a clean stainless-steel spoon or hand auger, transferred to a clean stainless-steel bowl, homogenized, and placed in the appropriate sample containers. Sample collection logs are included in Appendix A. The sediment samples were analyzed for the parameters listed in Table 3-7 using methods outlined in Section 3.3.

3.2 Surveying of Sample Locations

IT surveyed sample locations using GPS survey techniques described in Section 4.3 of the SAP, and conventional civil survey techniques described in Section 4.19 of the SAP (IT, 2000a). Horizontal coordinates were referenced to the U.S. State Plane Coordinate System, Alabama East Zone, North American Datum, 1983. Elevations were referenced to the North American Vertical Datum of 1988. Horizontal coordinates and elevations are included in Appendix D.

QST surveyed sample locations using GPS survey techniques or traditional surveying techniques described in of the QST work plan (QST, 1998). Map coordinates for each sample location were determined using a Transverse Mercator (UTM) or State Planar grid to within ± 3 feet (± 1 meter).

3.3 Analytical Program

IT and QST samples collected during the SI were analyzed for various physical and chemical parameters. The specific suite of analyses performed was based on the potential site-specific chemicals historically at the site and EPA, ADEM, FTMC, and USACE requirements. Target analysis for samples collected at the Golf Course included the following parameters:

- Target Compound List (TCL) VOCs – EPA Method 5035/8260B
- TCL SVOCs – EPA Method 8270C
- Target Analyte List Metals – EPA Method 6010B/7000
- Chlorinated Pesticides – EPA Method 8081A
- Organophosphorous Pesticides – EPA Method 8141A
- Chlorinated Herbicides – EPA Method 8151A
- Chlorinated Pesticides/PCBs – EPA Method 8080 (QST data only)
- Total Organic Carbon (TOC) – EPA Method 9060
- Grain size – American Society for Testing and Materials D421/D422 (sediment only)
- Anions – EPA Method 300.0.

The samples were analyzed using EPA SW-846 methods, including Update III Methods where applicable.

3.4 Sample Preservation, Packaging, and Shipping

IT collected samples following requirements specified in Section 4.13.2 of the SAP (IT, 2000a) for preservation, packaging, and shipping. Sample containers, sample volumes, preservatives, and holding times for the analyses required in this SI are listed in Section 5.0, Table 5-1, of Appendix B of the SAP (IT, 2000a). Sample documentation and chain of custody were recorded as specified in Section 4.13 of the SAP (IT, 2000a). Completed analysis request and chain of custody records (Appendix A) were secured and included with each shipment of sample coolers to Quanterra Environmental Services in Knoxville, Tennessee. Split samples were shipped to the USACE South Atlantic Division Laboratory in Marietta, Georgia.

QST preserved, packaged, and shipped samples following guidelines specified in the QST work plan (QST, 1998).

3.5 Investigation-Derived Waste Management and Disposal

IT Investigation-Derived Waste. IT investigation-derived waste (IDW) was managed and disposed as outlined in Appendix D of the SAP (IT, 2000a). The IDW during the SI at the Golf Course was segregated as follows:

- Drill cuttings
- Purge water from well development and sampling activities, and decontamination fluids
- Spent well materials, and personal protective equipment.

Solid IDW was stored inside the fenced area surrounding Buildings 335 and 336 in lined roll-off bins prior to characterization and final disposal. Solid IDW was characterized using toxicity characteristic leaching procedure (TCLP) analyses. Based on the results, drill cuttings and personal protective equipment generated during the SI at the Golf Course were disposed as nonregulated waste at the Industrial Waste Landfill on the Main Post of FTMC.

Liquid IDW was contained in the existing 20,000-gallon sump associated with the Building

T-338 vehicle washrack. Liquid IDW was characterized by VOC, SVOC, and metals analyses. Based on the analyses, liquid IDW was discharged as nonregulated waste to the FTMC wastewater treatment plant on the Main Post.

QST Investigation-Derived Waste. QST-generated IDW was managed and disposed as outlined in the QST work plan (QST, 1998). Borehole cuttings were collected as they were generated and screened with a photoionization detector (PID). If the PID indicated greater than 50 parts per million (ppm) VOCs in the air, then the soil was containerized in 55-gallon drums. All drilling fluids, purge water, and decontamination fluids were containerized in drums or other appropriate containers. All IDW was characterized as either hazardous or nonhazardous by TCLP analyses. If the IDW exceeded the TCLP regulatory criteria, then it was disposed as hazardous waste in an approved hazardous waste facility.

3.6 Variances/Nonconformances

There were not any variances or nonconformances to the SFSP recorded by IT during completion of the SI at the Golf Course. QST did not document any variances or nonconformances to the QST work plan (QST, 1998).

3.7 Data Quality

IT Data. Samples collected by IT were collected, documented, handled, analyzed, and reported in a manner consistent with the SI work plan, the FTMC SAP and QAP, and standard, accepted methods and procedures. Sample collection logs pertaining to the collection of these samples were reviewed and organized for this report and are included in Appendix A. The field sample analytical data are presented in tabular form in Appendix E.

Data were reported and evaluated in accordance with Corps of Engineers South Atlantic Savannah Level B criteria (USACE, 1994) and the stipulated requirements for the generation of definitive data (Section 3.1.2 of Appendix B of the SAP [IT, 2000a]). Chemical data were reported via hard-copy data packages by the laboratory using Contract Laboratory Program-like forms. A summary of validated data is included in Appendix E. A complete (100 percent) Level III data validation effort was performed on the reported analytical data. Appendix F includes data validation summary reports that discuss the IT data validation. Selected results were rejected or otherwise qualified based on the implementation of accepted data validation procedures and practices during the validation effort. These qualified parameters are highlighted

in the report. The validation-assigned qualifiers were added to the FTMC ITEMS database for tracking and reporting.

QST Data. QST data were submitted to the IRDMIS database at the conclusion of SI field activities. Hard-copy data packages were sent to the U.S. Army Environmental Center (AEC) in Edgewood, Maryland, for storage. IT retrieved the electronic data via IRDMIS and the original data packages from the AEC for evaluation. From the IRDMIS data, IT was able to identify the key fields of information (analytical records, well construction and geotechnical information, sample location information, and water level readings) and translate the data into the ITEMS database.

QST hard-copy analytical data packages were validated during a complete (i.e., 100 percent) Level III data validation effort. Appendix F includes a copy of the data validation summary report that discusses the QST data validation. Selected results were rejected or qualified based on the implementation of accepted data validation procedures and practices. These qualified parameters are highlighted in the data validation report. In addition, during the validation the electronic results were compared to the hard-copy results. Concentrations in the database were corrected where necessary and validation qualifiers added to the QST data using ITEMS to reflect the findings summarized in the QST data validation report.

After the QST data validation was complete and the results updated, the QST data and the IT data were merged using ITEMS for inclusion in this SI report. The combined validated analytical data are presented in tabular form in Appendix E. The qualified data were used in comparisons to the SSSLs and ESVs developed by IT in Chapter 5.0. Rejected data (assigned an "R" data qualifier) were not used in comparisons to SSSLs and ESVs. The IT and QST data presented in this report, except where qualified, meet the principle data quality objective for this SI.

4.0 Site Characterization

Subsurface investigations performed at the Golf Course provided soil, geologic, and groundwater data. These data were used to characterize the geology and hydrogeology of the site.

4.1 Regional and Site Geology

4.1.1 Regional Geology

Calhoun County includes parts of two physiographic provinces, the Piedmont Upland Province and the Valley and Ridge Province. The Piedmont Upland Province occupies the extreme eastern and southeastern portions of the county and is characterized by metamorphosed sedimentary rocks. The generally accepted range in age of these metamorphics is Cambrian to Devonian.

The majority of Calhoun County, including the Main Post of FTMC, lies within the Appalachian fold-and-thrust structural belt (Valley and Ridge Province) where southeastward-dipping thrust faults with associated minor folding are the predominant structural features. The fold-and-thrust belt consists of Paleozoic sedimentary rocks that have been asymmetrically folded and thrust-faulted, with major structures and faults striking in a northeast-southwest direction.

Northwestward transport of the Paleozoic rock sequence along the thrust faults has resulted in the imbricate stacking of large slabs of rock referred to as thrust sheets. Within an individual thrust sheet, smaller faults may splay off the larger thrust fault, resulting in imbricate stacking of rock units within an individual thrust sheet (Osborne and Szabo, 1984). Geologic contacts in this region generally strike parallel to the faults, and repetition of lithologic units is common in vertical sequences. Geologic formations within the Valley and Ridge Province portion of Calhoun County have been mapped by Warman and Causey (1962), Osborne and Szabo (1984), and Moser and DeJarnette (1992), and vary in age from Lower Cambrian to Pennsylvanian.

The basal unit of the sedimentary sequence in Calhoun County is the Cambrian Chilhowee Group. The Chilhowee Group consists of the Cochran, Nichols, Wilson Ridge, and Weisner Formations (Osborne and Szabo, 1984) but in Calhoun County is either undifferentiated or divided into the Cochran and Nichols Formations and an upper, undifferentiated Wilson Ridge and Weisner Formation. The Cochran is composed of poorly sorted arkosic sandstone and conglomerate with interbeds of greenish-gray siltstone and mudstone. Massive to laminated, greenish-gray and black mudstone makes up the Nichols Formation, with thin interbeds of

siltstone and very fine-grained sandstone (Szabo et al., 1988). These two formations are mapped only in the eastern part of the county.

The Wilson Ridge and Weisner Formations are undifferentiated in Calhoun County and consist of both coarse-grained and fine-grained clastics. The coarse-grained facies appears to dominate the unit and consists primarily of coarse-grained, vitreous quartzite, and friable, fine- to coarse-grained, orthoquartzitic sandstone, both of which locally contain conglomerate. The fine-grained facies consists of sandy and micaceous shale and silty, micaceous mudstone which are locally interbedded with the coarse clastic rocks. The abundance of orthoquartzitic sandstone and quartzite suggests that most of the Chilhowee Group bedrock in the vicinity of FTMC belongs to the Weisner Formation (Osborne and Szabo, 1984).

The Cambrian Shady Dolomite overlies the Weisner Formation northeast, east and southwest of the Main Post and consists of interlayered bluish-gray or pale yellowish-gray sandy dolomitic limestone and siliceous dolomite with coarsely crystalline porous chert (Osborne et al., 1989). A variegated shale and clayey silt have been included within the lower part of the Shady Dolomite (Cloud, 1966). Material similar to this lower shale unit was noted in core holes drilled by the Alabama Geologic Survey on FTMC (Osborne and Szabo, 1984). The character of the Shady Dolomite in the FTMC vicinity and the true assignment of the shale at this stratigraphic interval are still uncertain (Osborne, 1999).

The Rome Formation overlies the Shady Dolomite and locally occurs to the northwest and southeast of the Main Post as mapped by Warman and Causey (1962) and Osborne and Szabo (1984), and immediately to the west of Reilly Airfield (Osborne and Szabo, 1984). The Rome Formation consists of variegated, thinly interbedded grayish-red-purple mudstone, shale, siltstone, and greenish-red and light gray sandstone, with locally occurring limestone and dolomite. The Conasauga Formation overlies the Rome Formation and occurs along anticlinal axes in the northeastern portion of Pelham Range (Warman and Causey, 1962); (Osborne and Szabo, 1984) and the northern portion of the Main Post (Osborne et al. 1997). The Conasauga Formation is composed of dark-gray, finely to coarsely crystalline medium- to thick-bedded dolomite with minor shale and chert (Osborne et al., 1989).

Overlying the Conasauga Formation is the Knox Group, which is composed of the Copper Ridge and Chepultepec dolomites of Cambro-Ordovician age. The Knox Group is undifferentiated in Calhoun County and consists of light medium gray, fine to medium crystalline, variably bedded to laminated, siliceous dolomite and dolomitic limestone that weather to a chert residuum

The Jacksonville Thrust Fault is the most significant structural geologic feature in the vicinity of FTMC, both for its role in determining the stratigraphic relationships in the area and for its contribution to regional water supplies. The trace of the fault extends northeastward for approximately 39 miles between Bynum, Alabama and Piedmont, Alabama. The fault is interpreted as a major splay of the Pell City Fault (Osborne and Szabo, 1984). The Ordovician sequence that makes up the Eden thrust sheet is exposed at FTMC through an eroded "window," or "fenster," in the overlying thrust sheet. Rocks within the window display complex folding, with the folds being overturned and tight to isoclinal. The carbonates and shales locally exhibit well-developed cleavage (Osborne and Szabo, 1984). The FTMC window is framed on the northwest by the Rome Formation, north by the Conasauga Formation, northeast, east, and southwest by the Shady Dolomite, and southeast and southwest by the Chilhowee Group (Osborne et al., 1997).

4.1.2 Site Geology

Several soil types and mapping units describe the soils at the Golf Course (U.S. Department of Agriculture, 1961):

- Montevallo shaly silty clay loam, 10 to 40 percent slopes, severely eroded (MtD3) - highest elevation at the north end of the site
- Montevallo shaly silty clay loam, 6 to 10 percent slopes, severely eroded (MtC3) – next-to-highest elevations in both the northern and southern sections of the site
- Philo and Stendal soils, local alluvium, 0 to 2 percent slopes (PkA) - along Remount Creek in southern section of the site, south of Baltzell Gate Road
- Philo and Stendal fine sandy loams, 0 to 2 percent slopes (PhA) – along Cane Creek throughout the site
- Anniston and Allen gravelly loams, 15 percent slopes, eroded (AcE2) – along southwestern edge of site between railroad tracks and Baltzell Gate Road in the western end of the site.

These mapping units are subunits of the following soil series:

- Montevallo series
- Philo series
- Stendal series
- Anniston series
- Allen series.

The Montevallo series consists of shallow, well-drained, strongly acid soils that have developed in the residuum of interbedded shale and fine-grained sandstone or limestone. Where these soils are not eroded, the surface soil is very dark grayish-brown to very dark-brown shaly silt loam. Fragments of shale, less than 2 inches in size, are common in the soil. The depth to bedrock typically ranges from 1 to 1.5 feet bgs. The depth to the water table for this series is usually greater than 20 feet bgs.

The Philo series consists of strongly acid, moderately well drained soils that are developing in local and general alluvium. The parent material washed mainly from sandstone and shale, but some of it originated from limestone. Philo soils occur on first bottoms along most streams in the northern part of Calhoun County. The surface soil is very dark grayish-brown to dark-brown fine sandy loam, and the subsoil is dark-brown, slightly mottled, fine sandy loam.

The Stendal series consists of strongly acid, somewhat poorly drained soils that are developing in general alluvium that washed chiefly from sandstone and shale. Some of the material originated from limestone. These soils occur on first bottoms along most streams in the northern part of Calhoun County. The surface soil is a dark grayish-brown fine sandy loam, and the subsurface soil is a dark-brown, mottled, fine sandy loam.

For the Philo and Stendal series soils, the depth to bedrock typically is 6 feet bgs or greater. The depth to the water table for this series is usually 1 to 2 feet bgs.

The Anniston series of soils consists of strongly acid, deep, well-drained soils that have developed in old local alluvium. The parent material washed from the adjacent, higher-lying Linker, Muskingum, Enders, and Montevallo soils. The surface soils are primarily dark-brown loam, and the subsoil is primarily dark-red sandy clay loam. These sites contain sandstone and quartzite gravel and cobbles, which measure as much as 8 inches in diameter, on the surface and throughout the soil.

The Allen series consists of deep, strongly acid, well-drained soils that have developed in old alluvium. The parent material washed from the adjacent, higher-lying Linker, Muskingum, Enders, and Montevallo soils, which developed from weathered sandstone, shale, and quartzite. The surface soils are primarily dark grayish-brown fine sandy clay loam. Fragments of sandstone and quartzite, as large as 8 inches in diameter, are on the surface and throughout the soil.

For the Anniston and Allen series soils, the depth to bedrock typically is 2 feet to greater than 10 feet bgs. The depth to the water table for this series is usually greater than 20 feet bgs.

Bedrock beneath the Golf Course is mapped as Mississippian/Ordovician Floyd and Athens shale, undifferentiated, and a limestone unit of unknown age. These units occur within the eroded "window" in the uppermost structural thrust sheet at FTMC and underlie much of the developed area of the Main Post. The Pell City Fault runs near the western side of the Golf Course, and an inferred fault bounds the limestone within the Golf Course boundaries. The younger Mississippian/Ordovician age geologic units occur, on the eastern side of these faults while on the western side of the faults, older Cambrian-age geologic units occur. Figure 4-1 shows the geologic features associated with the Golf Course.

Based on the direct-push and hollow-stem auger boring data collected during the SI, residuum beneath the Golf Course consists of predominantly silt and clay overlying a weathered shale. The weathered shale was encountered at about 5 to 12 feet bgs at the Golf Course.

4.2 Site Hydrology

4.2.1 Surface Hydrology

Precipitation in the form of rainfall averages about 54 inches annually in Anniston, Alabama, with infiltration rates annually exceeding evapotranspiration rates. The major surface water features at the Main Post of FTMC include Remount Creek, Cane Creek, South Branch Cane Creek and Cave Creek. These waterways flow in a general northwest to westerly direction towards the Coosa River on the western boundary of Calhoun County.

Surface runoff at the Golf Course follows site topography and generally flows to the southeast and northwest towards Cane Creek and Remount Creek. Cane Creek, a perennial stream, flows to the northwest and transects the Golf Course from the southeast to the northwest (Figure 1-2). Remount Creek flows to the north-northwest until it joins Cane Creek. The confluence of Remount Creek and Cane Creek is located in the central section of the site and northwest of the Golf Course clubhouse. The confluence of Cane Creek and South Branch of Cane Creek is in the eastern section of the site. Several other intermittent tributaries feed Cane Creek in the central portion of the Golf Course.

4.2.2 Hydrogeology

Static groundwater levels were measured in the two monitoring wells installed by IT at the Golf Course on March 14, 2000. Table 3-4 summarizes the measured groundwater elevations.

Shallow groundwater flow direction is probably controlled by the topography and Cane Creek. Groundwater would likely flow to the south toward Cane Creek in the northern portion of the Golf Course. Groundwater flow in the southern portion of the site would likely flow in a northerly direction along Remount Creek towards Baltzell Gate Road and Cane Creek.

5.0 Summary of Analytical Results

The results of the chemical analyses of samples collected at the Golf Course indicate that metals, VOCs, SVOCs, pesticides, herbicides, and anions were detected in the various site media. To evaluate whether the detected constituents present an unacceptable risk to human health and the environment, the analytical results were compared to the residential human health SSSLs and ESVs for FTMC. The SSSLs and ESVs were developed by IT for human health and ecological risk evaluations as part of the on-going site investigations being performed under the BRAC environmental restoration program at FTMC. Metal concentrations exceeding the SSSLs and ESVs were subsequently compared to background metals screening values (SAIC, 1998) to determine if the metals concentrations are within natural background concentrations. Summary statistics for background metals samples collected at FTMC (SAIC, 1998) are included in Appendix G.

Six compounds were quantified by both SW-846 Method 8260B (as VOC) and Method 8270C (as SVOC), including 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 1,3-dichlorobenzene, 1,2-dichlorobenzene, hexachlorobutadiene, and naphthalene. Method 8260B yields a reporting limit of 0.005 milligrams per kilogram (mg/kg), while Method 8270C has a reporting limit of 0.330 mg/kg, which is typical for a soil matrix sample. Because of the direct nature of the Method 8260B analysis and its resulting lower reporting limit, this method should be considered superior to Method 8270C when quantifying low levels (0.005 to 0.330 mg/kg) of these compounds. Method 8270C and its associated methylene chloride extraction step is superior, however when dealing with samples that contain higher concentrations (greater than 0.330 mg/kg) of these compounds. Therefore, all data were considered, and none were categorically excluded. Data validation qualifiers were helpful in evaluating the usability of data, especially if calibration, blank contamination, precision, or accuracy indicator anomalies were encountered. The validation qualifiers and concentrations reported (e.g., whether concentrations were less than or greater than 0.330 mg/kg) were used to determine which analytical method was likely to return the more accurate result.

The following sections and Tables 5-1 through 5-5 summarize the results of the comparison of detected constituents to the SSSLs, ESVs, and background screening values. Complete analytical results are presented in Appendix E.

5.1 Surface Soil Analytical Results

Nineteen surface soil samples were collected for chemical analysis at the Golf Course. Surface soil samples were collected from the upper 1 foot of soil at the locations shown on Figures 3-1 through 3-3. Analytical results were compared to SSSLs, ESVs, and background screening values, as presented in Table 5-1.

Metals. Twenty-one metals were detected in surface soil samples collected at the Golf Course. With the exceptions of silver, cadmium, mercury, and selenium, the detected metals were present in each of the surface soil samples.

The concentrations of aluminum (at sample locations SI07-SS03, SI07-SS05, SI07-SS06, and SI07-SS07), arsenic (at 19 locations), chromium (PPMP-178-SS01 and SI07-SS05), iron (19 locations), and manganese (10 locations) exceeded SSSLs. With the exception of arsenic at 6 locations, the concentrations of these metals were below their respective background concentrations. However, the arsenic results were within the range of background values determined by SAIC (1998) (Appendix G).

Aluminum (12 locations), arsenic (eight locations), chromium (12 locations), iron (12 locations), manganese (10 locations), mercury (PPMP-178-SS01 and PPMP-178-SS03), selenium (10 locations), vanadium (12 locations), and zinc (PPMP-178-SS03, PPMP-178-SS07, and PPMP-178-SS11) concentrations exceeded ESVs. With the exception of selenium at 4 locations, the concentrations of these metals were below their respective background concentrations or within the range of background values. The selenium concentrations (up to 1.8 mg/kg) marginally exceeded the range of background selenium values (up to 1.3 mg/kg).

Volatile Organic Compounds. Seven of the 19 surface soil samples collected at the Golf Course, were analyzed for VOCs. These samples were collected by QST at Parcels 83(7) and 141(7). Twelve VOCs, including benzene, ethylbenzene, toluene, xylene, tetrachloroethene, and trichloroethene, were detected in subsurface soil samples. The concentrations of tetrachloroethene and trichloroethene (ranging from 0.0057 to 0.012 mg/kg) exceeded ESVs in six of the seven soil samples. However, none of the VOCs detected exceeded SSSLs.

Semivolatile Organic Compounds. Seven of the 19 surface soil samples collected at the Golf Course were analyzed for SVOCs. These samples were collected by QST at Parcels 83(7) and 141(7). Twelve SVOCs were detected in these samples. With the exception of fluoranthene in one sample, SVOC concentrations in surface soils were below SSSLs and ESVs. The

concentration of fluoranthene (0.115 mg/kg) at sample location SI07-SS02 marginally exceeded the ESV (0.10 mg/kg) but was below the SSSL.

Pesticides and Herbicides. Seven chlorinated pesticides (4,4'-dichlorodiphenyldichloroethene [DDE], 4,4'- dichlorodiphenyltrichloroethane [DDT], chlordane, dieldrin, alpha-chlordane, gamma-chlordane, and methoxychlor) were detected in surface soil samples collected at the Golf Course. Chlorinated pesticides were detected in the surface soils collected from sample locations PPMP-178-SS02, PPMP-178-SS04, PPMP-178-SS06, PPMP-178-SS10, SI07-SS01, SI07-SS02, SI07-SS03, SI07-SS04, and SI07-SS05. Organophosphorus pesticides and chlorinated herbicides were not detected in any of the surface soil samples collected at the Golf Course.

Pesticide concentrations in surface soils were below SSSLs. The concentrations of 4,4'-DDE (three locations), 4,4'-DDT (three locations), and dieldrin (two locations) exceeded ESVs.

Anions. Three anions (chloride, nitrate, and sulfate) were detected in six of the twelve surface soil samples collected by IT (surface soil samples collected by QST were not analyzed for anions). Background values, SSSLs, or ESVs do not exist for anions. Analytical results are summarized in Table 5-1 and in Appendix E.

Total Organic Carbon. Seven surface soil samples (collected by QST) were analyzed for TOC content. TOC concentrations ranged from 1,520 to 47,800 mg/kg, as summarized in Appendix E.

5.2 Subsurface Soil Analytical Results

Six subsurface soil samples were collected by QST for chemical analysis at the Golf Course. Subsurface soil samples were collected at depths greater than 1 foot bgs at the locations shown on Figure 3-2 and Figure 3-3. Analytical results were compared to SSSLs and background screening values, as presented in Table 5-2.

Metals. Twenty metals were detected in subsurface soil samples collected at the Golf Course. The concentrations of four metals (aluminum, arsenic, iron, and manganese) exceeded SSSLs. With the exception of one arsenic result (SI07-SS02), the concentrations of these metals were below their respective background concentrations. However, the arsenic result was within the range of background values (Appendix G).

Volatile Organic Compounds. Thirteen VOCs, including benzene, ethylbenzene, toluene, xylene, tetrachloroethene, and trichloroethene, were detected in subsurface soil samples collected at the Golf Course. VOC concentrations in subsurface soils were below SSSLs.

Semivolatile Organic Compounds. One SVOC (bis[2-ethylhexyl]phthalate) was detected in four of the subsurface soil samples collected at the Golf Course. Bis(2-ethylhexyl)phthalate, a common laboratory contaminant, was detected at concentrations below the SSSL.

Pesticides/PCBs. Five pesticides (4,4'-DDT, chlordane, dieldrin, alpha-chlordane, and gamma-chlordane) were detected in subsurface soil samples at concentrations below SSSLs. PCBs were not detected in any of the subsurface soil samples collected at the Golf Course.

Herbicides. One herbicide (dichloroprop) was detected in three of the subsurface soil samples collected at the Golf Course. The dichloroprop concentrations were below the SSSL.

Total Organic Carbon. Two of the six subsurface soil samples (SI07-SS02 and SI07-SS05) were analyzed for TOC content. TOC concentrations were 3,280 and 10,900 mg/kg, respectively, as summarized in Appendix E.

5.3 Groundwater Analytical Results

Two permanent monitoring wells (installed by IT) and three temporary wells (installed by QST) were sampled at the Golf Course. The well locations are shown on Figures 3-2 and 3-3. Analytical results were compared to SSSLs and background screening values, as presented in Table 5-3.

Metals. Twenty-two metals, including aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, vanadium, and zinc, were detected in groundwater samples collected at the Golf Course. The concentrations of ten metals (aluminum, antimony, arsenic, barium, chromium, iron, lead, manganese, nickel, and vanadium) exceeded SSSLs in the groundwater samples. With the exceptions of aluminum, iron, manganese, and vanadium at two temporary groundwater monitoring wells installed using direct-push, (SI07-GWS02 and SI07-GWS05), the concentrations of these metals were below their respective background concentrations or within the range of background values (Appendix G). The concentrations of aluminum, iron, and vanadium in SI07-GWS02 exceeded SSSLs and the range of background

values. In addition, the concentrations of aluminum, iron, manganese, and vanadium in SI07-GWS05 exceeded SSSLs and the range of background values.

Three 1-inch temporary wells were installed at the Golf Course using small-diameter DPT. DPT temporary wells have very limited annular space available for filter-pack sand. The limited filter sand does not provide adequate filtration in soils with fine-grained silt and clay particles. Although purge records for the three temporary wells did not indicate groundwater turbidity levels, however, it is suspected that the samples from these wells had high turbidity at the time of sample collection that caused the elevated metals results. Monitoring turbidity is necessary to determine when purging should end and when sampling should begin.

Based on the results of a groundwater resampling effort (Appendix H) conducted by IT to evaluate the effects of turbidity on the concentrations of metals in groundwater, it was concluded that high turbidity at the time of sample collection results in elevated concentrations of metals (IT, 2000c). The resampling effort demonstrated that the concentrations of most metals in the lower turbidity samples were significantly lower than in the higher turbidity samples.

Volatile Organic Compounds. Eight VOCs (acetone, carbon disulfide, chloromethane, methyl tertiary butyl ether [MTBE], methylene chloride, naphthalene, 1,2,3-trichlorobenzene, and 1,2,4-trichlorobenzene) were detected in groundwater samples collected at the Golf Course. The carbon disulfide results, naphthalene results, 1,2,3-trichlorobenzene results, 1,2,4-trichlorobenzene results, and two of the three acetone results were flagged with a "B" data qualifier, signifying that these compounds were also detected in an associated laboratory or field blank sample. All VOC concentrations were below SSSLs, with the exception of acetone in the sample from SI07-GWS01. However, acetone is a common laboratory chemical and the result is believed to be a laboratory artifact. MTBE was detected in one well (SI07-GWS05) at a concentration of 0.005 mg/L. Currently no SSSL exists for MTBE.

Semivolatile Organic Compounds. The SVOCs phenol, 4-methylphenol, and bis(2ethylhexyl)phthalate (a common laboratory contaminant) were detected in one groundwater sample (SI07-GWS01) at concentrations below SSSLs. SVOCs were not detected in any of the other groundwater samples collected at the Golf Course.

Pesticides and Herbicides. Four pesticides (aldrin, chlordane, dieldrin, and heptachlor epoxide) were detected in one groundwater sample (SI07-GWS02) at concentrations exceeding SSSLs. Pesticide concentrations ranged from 0.0000072 to 0.0006 mg/L. Pesticides were not

detected in any of the other groundwater samples collected at the Golf Course. In addition, herbicides were not detected in any of the groundwater samples collected at the Golf Course.

5.4 Surface Water Analytical Results

Five surface water samples were collected at the Golf Course at the locations shown on Figure 3-1. Analytical results were compared to recreational site user human health SSSLs, ESVs, and background concentrations, as presented in Table 5-4.

Metals. Ten metals were detected in surface water samples collected at the Golf Course. Each of the detected metals was present in the sample collected at PPMP-178-SW/SD01. Sample locations PPMP-178-SW/SD02 and PPMP-178-SW/SD03 each contained nine of the ten detected metals.

The thallium concentration (0.0058 mg/L) at PPMP-178-SW/SD01 exceeded the SSSL. In addition, the concentration of thallium exceeded the background range (0.0042 mg/L). However, the thallium result was flagged with a "B" data qualifier, signifying that this metal was also detected in an associated laboratory or field blank sample. The concentrations of aluminum (at two locations), barium (five locations), lead (three locations), manganese (two locations), and thallium (one location) exceeded ESVs. With the exception of the thallium result, the concentrations of these metals were below their respective background concentrations.

Pesticides and Herbicides. Chlorinated pesticides, organophosphorus pesticides, and chlorinated herbicides were not detected in any of the surface water samples collected at the Golf Course.

Anions. Chloride and sulfate were detected in each of the five surface water samples collected by IT. Background values, SSSLs, or ESVs do not exist for anions. Analytical results are summarized in Table 5-4 and in Appendix E.

5.5 Sediment Analytical Results

Five sediment samples were collected for chemical and physical analyses at the Golf Course at the locations shown on Figure 3-1. Analytical results were compared to SSSLs, ESVs, and background concentrations, as presented in Table 5-5.

Metals. Nineteen metals were detected in the sediment samples collected at the Golf Course. The selenium and sodium results were flagged with a "B" data qualifier, signifying that these

metals were also detected in an associated laboratory or field blank sample. None of the metals was detected at a concentration exceeding its SSSL. Copper and lead were detected at three locations (PPMP-178-SW/SD01, PPMP-178-SW/SD02, and PPMP-178-SW/SD05) at concentrations exceeding ESVs and their respective background concentrations. With the exception of lead at PPMP-178-SW/SD01, the copper and lead concentrations were within the range of background values. The lead concentration (159 mg/kg) exceeded the range of background lead values (110 mg/kg).

Pesticides and Herbicides. Five chlorinated pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, beta-BHC, and delta-BHC) were detected in two of the sediment samples collected at the Golf Course. Organophosphorus pesticides and chlorinated herbicides were not detected in any of the sediment samples collected at the Golf Course. Sample locations PPMP-178-SW/SD01 and PPMP-178-SW/SD05 each contained four of the five detected pesticides; pesticides were not detected at the other sample locations. None of the detected pesticides was present at a concentration exceeding its SSSL. The 4,4'-DDE concentrations exceeded the ESV at two locations (PPMP-178-SW/SD01 and PPMP-178-SW/SD05).

Anions. Sulfate was detected in four in the five sediment samples collected by IT (bromide, chloride, total fluoride, nitrate, nitrite, and orthophosphate were not detected in the sediment samples collected). Background values, SSSLs, or ESVs do not exist for anions. Analytical results are summarized in Table 5-5 and in Appendix E.

Total Organic Carbon. TOC concentrations, in the five sediment samples collected by IT, ranged from 2,680 to 23,500 mg/kg. TOC results are summarized in Table 5-5 and in Appendix E.

Grain Size. Grain size distribution was determined in each of the five sediment samples collected by IT. Grain size results are included in Appendix E.

6.0 Summary, Conclusions, and Recommendations

IT Corporation, under contract with the USACE, completed an SI at the Golf Course at FTMC in Calhoun County, Alabama. The SI was conducted to determine whether chemical constituents are present at the Golf Course and, if present, whether the concentrations present an unacceptable risk to human health or the environment. The SI at the Golf Course consisted of the sampling and analysis of 19 surface soil samples, 6 subsurface soil samples, 5 groundwater samples, 5 surface water samples, and 5 sediment samples. In addition, two permanent and three temporary monitoring wells were installed in the residuum groundwater zone to facilitate groundwater sample collection and to provide site-specific geological and hydrogeological characterization information. Data previously collected at the Golf Course by QST Environmental Inc. were incorporated into this SI report.

IT collected 12 surface soil samples, 5 surface water samples, and 5 sediment samples at the Golf Course, Parcel 178(7). In addition, IT collected 2 groundwater samples at the current pesticide mixing and storage facility, Parcel 83(7). QST collected a total of 7 surface soil samples, 6 subsurface soil samples, and 3 groundwater samples during the SI at Parcel 83(7) and the former pesticide mixing and storage facility, Parcel 141(7). The combined analytical results indicate that metals, VOCs, SVOCs, chlorinated pesticides, and chlorinated herbicides were detected in the environmental media sampled. Organophosphorus pesticides and PCBs were not detected in any of the environmental media sampled. To evaluate whether the detected constituents present an unacceptable risk to human health or the environment, the analytical results were compared to human health SSSLs, ESVs, and background screening values for FTMC.

The potential threat to human health is expected to be minimal. The concentrations of metals and organic compounds in site media are low. Although the Golf Course is projected for continued use as an active recreational area, the soils and groundwater analytical data from the site were screened against residential human health SSSLs to evaluate the site for possible unrestricted land reuse. In soils, the metals concentrations that exceeded SSSLs were below their respective background concentrations or within the range of background values and, thus, do not pose a threat to human health. VOC, SVOC, and pesticide/herbicide concentrations in soils were below SSSLs.

In groundwater, with the exception of aluminum, iron, manganese, and vanadium, detected in two temporary groundwater wells (SI07-GWS02 and SI07-GWS05) installed using direct-push methods, metals concentrations were within the range of background values. In addition, four

pesticides (aldrin, chlordane, dieldrin, and heptachlor epoxide) were detected at concentrations exceeding SSSLs in one groundwater sample (SI07-GWS02) collected in the area of the former pesticide mixing and storage area. However, the pesticide concentrations were below EPA drinking water standards and health advisory values (EPA, 2000a). The VOC MTBE was detected in one well (SI07-GWS05), located near the current pesticide mixing and storage building (Building 2252), at a concentration of 0.005 mg/L. Currently no SSSL exists for MTBE. However, the MTBE concentration was below the EPA Region 9 Preliminary Remediation Goal of 0.020 mg/L for MTBE in tap water (EPA, 2000b). Given the low concentrations and limited distribution, these compounds are not expected to pose a threat to human health in either the current recreational or the residential land-use scenario.

The potential threat to ecological receptors is also expected to be low. Several metals were detected in site media at concentrations exceeding ESVs. However, with the exception of selenium (in four surface soil samples) and lead (one sediment sample), the metals concentrations that exceeded ESVs were below their respective background concentration or within the range of background values. The concentrations of two VOCs (tetrachloroethene and trichloroethene) exceeded ESVs in six of seven surface soil samples. However, none of the VOCs detected exceeded SSSLs. Only one SVOC (fluoranthene) exceeded its ESV in one surface soil sample. The concentrations of three chlorinated pesticides (4,4'-DDT, 4,4'-DDE, and dieldrin) exceeded ESVs in a limited number of surface soil and sediment samples but show no pattern of distribution that would indicate a discrete source. In all likelihood, these pesticides are indicative of historical pesticide use on the golf course as part of a routine maintenance program. Although these pesticides are no longer in use, other pesticides are routinely used at the golf course to maintain the area for its intended purpose. Because the golf course is expected to remain active for the foreseeable future, these sporadic, low-levels of pesticides are not expected to adversely affect the ecological receptors in the vicinity of the golf course.

Based on the results of the SI, past operations at the Golf Course have not adversely impacted the environment. The metals and chemical compounds detected in site media do not pose an unacceptable risk to human health or the environment in either the current recreational or residential land-use scenario. Therefore, IT recommends "No Further Action" and unrestricted land reuse at the Golf Course.

7.0 References

Cloud, P. E., Jr., 1966, ***Bauxite Deposits of the Anniston, Fort Payne, and Asheville Areas, Northeast Alabama***, U. S. Geological Survey Bulletin 1199-O, 35p.

Environmental Science and Engineering, Inc. (ESE), 1998, ***Final Environmental Baseline Survey, Fort McClellan, Alabama***, prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland, January.

Fort McClellan (FTMC), 1997, ***Fort McClellan Comprehensive Reuse Plan***, Fort McClellan Reuse and Redevelopment Authority of Alabama, prepared under contract to the Calhoun County Commission, November.

IT Corporation (IT), 2000a, ***Final Installation-Wide Sampling and Analysis Plan, Fort McClellan, Calhoun County, Alabama***, March.

IT Corporation (IT), 2000b, ***Final Human Health and Ecological Screening Values and PAH Background Summary Report, Fort McClellan, Calhoun County, Alabama***, July.

IT Corporation (IT), 2000c, Letter to Ellis Pope (USACE from Jeannie Yacoub (IT), "Groundwater Resampling Results", August 7.

IT Corporation (IT), 1998a, ***Final Site-Specific Field Sampling Plan Attachment Site Investigation at the Golf Course, Parcel 178(7), Fort McClellan, Calhoun County, Alabama***, December.

IT Corporation (IT), 1998b, ***Final Installation-Wide Work Plan, Fort McClellan, Calhoun County, Alabama***, August.

Moser, P. H. and S. S. DeJarnette, 1992, ***Groundwater Availability in Calhoun County, Alabama***, Geological Survey of Alabama Special Map 228.

Osborne, W. E., 1999, Personal Communication with John Hofer (IT), November 16.

Osborne, W. E., and Szabo, M. W., 1984, ***Stratigraphy and Structure of the Jacksonville Fault, Calhoun County, Alabama***, Alabama Geological Survey Circular 117.

Osborne, W. E., Irving, G. D., and Ward, W. E., 1997, ***Geologic Map of the Anniston 7.5' Quadrangle, Calhoun County, Alabama***, Alabama Geologic Survey Preliminary Map, 1 sheet.

Osborne, W. E., Szabo, M. W., Copeland, C. W. Jr., and Neathery, T. L., 1989, ***Geologic Map of Alabama***, Alabama Geologic Survey Special Map 221, scale 1:500,000, 1 sheet.

QST Environmental Inc. (QST), 1998, ***Final Site Investigation Work Plan, Fort McClellan, Alabama***, March.

Science Applications International Corporation (SAIC), 1998, ***Final Background Metals Survey Report, Fort McClellan, Alabama***, July.

Szabo, M. W., Osborne, W. E., Copeland, C. W., Jr., and Neathery, T. L., compilers, 1988, ***Geologic Map of Alabama***, Alabama Geological Survey Special Map 220, scale 1:250,000, 5 sheets.

U.S. Army Corps of Engineers (USACE), 1994, ***Requirements for the Preparation of Sampling and Analysis Plans***, Engineer Manual EM 200-1-3, September 1.

U.S. Department of Agriculture (USDA), 1961, ***Soil Survey, Calhoun County, Alabama***, Soil Conservation Service, Series 1958, No. 9, September.

U.S. Environmental Protection Agency (EPA), 2000a, ***Drinking Water Standards and Health Advisories***, EPA 822-B-00-001, Office of Water, Summer.

U.S. Environmental Protection Agency (EPA), 2000b, ***Region 9 Preliminary Remediation Goals***, November.

Warman, J. C, and Causey, L. V., 1962, ***Geology and Ground-water Resources of Calhoun County, Alabama***, Alabama Geological Survey County Report 7, 77 p.

ATTACHMENT 1

LIST OF ABBREVIATIONS AND ACRONYMS