Final

Site Investigation Report
Former Sandel Flamethrower Range
Parcel 97(7)

Fort McClellan
Calhoun County, Alabama

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Executive Summary

In accordance with Contract Number DACA21-96-D-0018, Task Order CK08, IT Corporation (IT) completed a site investigation (SI) at the Former Sandel Flamethrower Range, Parcel 97(7), at Fort McClellan in Calhoun County, Alabama. The SI was conducted to determine whether chemical constituents are present at the site and, if present, whether the concentrations present an unacceptable risk to human health or the environment. The SI at the Former Sandel Flamethrower Range, Parcel 97(7), consisted of the sampling and analysis of eight surface soil samples, nine subsurface soil samples, and five groundwater samples. In addition, one temporary and four permanent groundwater monitoring wells were installed in the residuum groundwater zone to facilitate groundwater sample collection and to provide site-specific geological and hydrogeological characterization information. As part of this SI, IT incorporated data previously collected by QST Environmental, Inc. at the Former Sandel Flamethrower Range, Parcel 97(7).

The analytical results indicate that metals, volatile organic compounds (VOC), and semivolatile organic compounds (SVOC) were detected in 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 impact to human receptors is expected to be minimal. Although the site is projected for passive recreation/mixed business reuse, the analytical data were screened against residential human health SSSLs to evaluate the site for possible unrestricted future use. In soils, concentrations of volatile and semivolatile organic compounds were below SSSLs and therefore do not pose a threat to human health.

Several metals were detected in two groundwater samples at concentrations exceeding SSSLs and background concentrations. However, only two metals (aluminum and vanadium) also exceeded the background range. The limited distribution and low concentrations of these metals are not expected to pose a threat to human health.

VOCs and SVOCs were not detected in site media at concentrations exceeding ESVs. In addition, the site is located in a developed area of the Main Post near roads and buildings. Consequently, the threat to potential ecological receptors is expected to be low.

Based on the results of the SI, past operations at the Former Sandel Flamethrower Range, Parcel 97(7), do not appear to have 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. Therefore, IT recommends "No Further Action" and unrestricted land reuse at the Former Sandel Flamethrower Range, Parcel 97(7).

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) at the Former Sandel Flamethrower Range, Parcel 97(7), under Contract Number DACA21-96-D-0018, Task Order CK08.

The U.S. Army Environmental Center (AEC) originally contracted QST Environmental, Inc. (QST) to perform the SI at the Former Sandel Flamethrower Range, Parcel 97(7). QST prepared an SI work plan (QST, 1998) and conducted field activities in May 1998. QST collected one of four proposed groundwater samples using direct-push technology (DPT). Groundwater was not encountered in the other three DPT borings installed, and the remaining groundwater samples were not collected. Therefore, the USACE contracted IT to install four permanent groundwater monitoring wells in the residuum and to collect four groundwater samples.

This SI report summarizes field activities, including field sampling and analysis and monitoring well installation activities, and data compiled by IT and QST for the SI conducted at the Former Sandel Flamethrower Range, Parcel 97(7).

1.1 Project Description

The Former Sandel Flamethrower Range, Parcel 97(7), was identified as an area to be investigated prior to property transfer. The site was classified 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 further evaluation.

IT performed field work in accordance with the installation-wide work plan (IT, 1998) and the installation-wide sampling and analysis plan (SAP) (IT, 2000a). The SAP includes the

installation-wide safety and health plan and quality assurance plan. Sampling locations and analytical parameters were specified in the QST work plan (QST, 1998).

The SI included field work to collect eight surface soil samples (collected by QST), nine subsurface soil samples (QST), and five groundwater samples (one by QST and four by IT) to determine if potential site-specific chemicals are present at the Former Sandel Flamethrower Range, Parcel 97(7).

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 Former Sandel Flamethrower Range, Parcel 97(7), 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 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 Sandel Flamethrower Range, also known as Sandel Flame Range, was located on the Main Post west of Justice Avenue (formerly 11th Avenue) and north of Howitzer Hill (Figure 1-1). Based on historical aerial photographs, the approximately 3-acre unfenced range was used from 1954 to 1973. However, the actual period of use may have extended beyond these years.

Personnel trained at the site using portable flamethrowers (PFT) and mechanized flamethrowers. The flamethrowers used thickened and unthickened fuel which was mixed in the field using M-4 fuel dispensers. These units were decontaminated by flushing with a low-grade fuel, which was

drained onto the ground and then burned. PFTs were pressurized using compressed air cylinders. The Sandel Flame Range had a total of 30 firing points (ESE, 1998).

Six small buildings were constructed immediately west of the range as part of site operations. The buildings and their uses included the following:

- Building 3189 - Stored mechanized flamethrowers
- Building 3187 - Stored PFTs
- Building 3186 - Stored PFTs
- Building 3177 - Stored PFTs, M-4 fuel dispensers, and compressed air cylinders
- Building 3178 - Stored PFTs, M-4 fuel dispensers, and compressed air cylinders
- Building 3188 - Platoon Headquarters.

Presently the buildings are enclosed in an approximately 70- by 285-foot fenced area (Figure 1-2). This area was most recently used as a prisoner-of-war training area, referred to as the confinement mockup. At an unknown date, Building 3179 was constructed as a guard tower for the confinement mockup activities.

The elevation of the site ranges from approximately 805 to 795 feet above mean sea level (Figure 1-2).

2.0 Previous Investigations

An EBS was conducted by ESE to document 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) (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, the Alabama Department of Environmental Management (ADEM), the U.S. Environmental Protection Agency (EPA) Region IV, and Calhoun County, as well as a database search of Comprehensive Environmental Response, Compensation, and Liability Act-regulated substances, petroleum products, and Resource Conservation and Recovery Act-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.

Previous investigations to document site environmental conditions have not been conducted at the Former Sandel Flamethrower Range, Parcel 97(7). Therefore, the site was classified as a Category 7 CERFA site: areas that are not evaluated or require further evaluation.

3.0 Current Site Investigation Activities

This chapter summarizes SI activities conducted by IT and QST at the Former Sandel Flamethrower Range, Parcel 97(7), including environmental sampling and analysis and groundwater monitoring well installation activities.

3.1 Environmental Sampling

The environmental sampling performed during the SI at the Former Sandel Flamethrower Range, Parcel 97(7), included the collection of surface soil samples, subsurface soil 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. Groundwater samples collected by IT are designated with the prefix "GSBP-97," and soil and groundwater samples collected by QST are designated with the prefix "SI11." Sampling locations are shown on Figure 3-1. Samples were submitted for laboratory analysis of site-related parameters listed in Section 3.3.

3.1.1 Surface Soil Sampling

QST collected eight surface soil samples during the SI at the Former Sandel Flamethrower Range, Parcel 97(7). QST originally designated eleven locations for surface soil sample collection; however, three locations (SI11-SS07, SI11-SS08, and SI11-09) were collected beneath asphalt pavement near the confinement mockup and are reported as subsurface soil samples. Soil sampling locations and rationales are presented in Table 3-1. Sampling locations are shown on Figure 3-1. 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.

Sample Collection. Surface soil samples were collected from 0 to 1 foot below ground surface (bgs) with either direct-push technology or a stainless-steel hand auger (SI11-SS10) 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. Sample collection logs are included in Appendix A.

3.1.2 Subsurface Soil Sampling

QST collected subsurface soil samples from nine soil borings at the Former Sandel Flamethrower Range, Parcel 97(7), as shown on Figure 3-1. Subsurface soil sampling locations and rationales are presented in Table 3-1. Subsurface soil 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 sampling rationale, presence of surface structures, and site topography.

Sample Collection. QST contracted Graves Service Company, Inc. to complete the soil borings. Subsurface soil samples were collected at depths of 2 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 at the Former Sandel Flamethrower Range, Parcel 97(7), as shown on Figure 3-1. IT installed four permanent groundwater monitoring wells, and QST installed one temporary groundwater screening well. Table 3-3 summarizes construction details of the wells installed at the Former Sandel Flamethrower Range, Parcel 97(7). The well construction logs are included in Appendix B.

IT Well Installation. IT installed four permanent monitoring wells in the residuum groundwater zone at the Former Sandel Flamethrower Range, Parcel 97(7), to collect groundwater samples for laboratory analysis.

IT contracted Miller Drilling, Inc. to install the wells with a hollow-stem auger rig at the locations shown on Figure 3-1. The 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. 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 constructed a lithological log for each borehole by logging the auger drill cuttings. The drill cuttings were 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 geological and hydrogeologic information. The lithological logs for the boreholes are included in Appendix B.

Upon reaching the target depth at each borehole, a 10- or 15-foot-length of 2-inch ID, 0.010-inch factory slotted, Schedule 40 polyvinyl chloride (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 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 well was 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 immediately on top of the sand pack and hydrated with potable water. If the bentonite seal was installed below the water table surface, the bentonite pellets were allowed to hydrate in the groundwater. The bentonite seal placement and hydration followed procedures in Appendix C of the SAP (IT, 2000a). The well was then grouted to ground surface. A locking well cap was placed on the PVC well casing. The well surface completion included placing a protective steel casing over the PVC riser and installing a concrete pad around the protective steel casing. Concrete-filled protective steel posts were placed around the well pad.

The wells were developed by surging and pumping with a 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 in order to re-establish the natural hydraulic flow conditions. Development continued until the water turbidity was equal to or less than 20 nephelometric turbidity units or for a maximum of 8 hours. The well development logs are included in Appendix C.

QST Well Installation. QST installed one temporary screening well (1-inch diameter) in the residuum groundwater zone at the Former Sandel Flamethrower Range, Parcel 97(7), using DPT. The temporary well was installed in accordance with procedures outlined in the QST work plan (QST, 1998). Table 3-3 summarizes construction details of the well installed by QST at the site. The well construction log is included in Appendix B.

QST contracted Graves Service Company Inc. to install the temporary well at Parcel 97(7) with DPT at the location shown on Figure 3-1. The temporary well was installed, purged, sampled, and removed within 24 hours. Initially, a 2-inch diameter borehole for the temporary well was installed using DPT. The 2-inch borehole was advanced up to 5 feet into the uppermost water-bearing zone. Soil descriptions were prepared by the QST geologist and are presented in Appendix B of this SI report. Upon reaching the target depth of the borehole, a 10-foot-length of

1-inch (nominal) diameter Schedule 40 PVC slotted screen (0.010-inch) was attached to a 1-inch (nominal) PVC riser and lowered into the borehole. A sand pack consisting of 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 wells installed by IT at the Former Sandel Flamethrower Range, Parcel 97(7), on March 14, 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 measurement was referenced to the top of the well casing (Table 3-4).

3.1.5 Groundwater Sampling

Groundwater samples were collected from a total of five monitoring wells at the Former Sandel Flamethrower Range, Parcel 97(7). IT collected groundwater samples from four permanent monitoring wells (GSBP-97-MW01, GSBP-97-MW02, GSBP-97-MW03, and GSBP-97-MW04), and QST collected a groundwater screening sample from one DPT temporary well (SI11-GWS02). The well locations are shown on Figure 3-1. 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. Groundwater sample collection was performed following procedures outlined in Section 4.9.1.4 of the SAP (IT, 2000a). Groundwater was sampled after purging a minimum of three well volumes and after field parameters (temperature, pH, dissolved oxygen, specific conductivity, oxidation-reduction potential, and turbidity) stabilized. Purging and sampling were performed with a submersible pump equipped with Teflon™ tubing. 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 Table 3-5 using methods outlined in Section 3.3.

QST Sample Collection. QST collected one groundwater sample immediately following completion of well purging using a peristaltic pump and vacuum jar. Groundwater sample parameters were recorded for pH, conductivity, and temperature (turbidity, dissolved oxygen, and oxidation-reduction potential were not monitored). Field parameter readings are summarized in Table 3-6. The QST sample collection log is included in Appendix A. The sample was analyzed for VOCs (Table 3-5) using EPA Method 8260.

3.2 Surveying of Sample Locations

IT sample locations were surveyed using global positioning system 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 of 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 global positioning system survey techniques or traditional surveying techniques described in the QST work plan (QST, 1998). Map coordinates for each sample location were determined using a Transverse Mercator or State Planar grid to within ± 3 feet (± 1 meter). Horizontal coordinates and elevations are included in Appendix D.

3.3 Analytical Program

Samples collected during the SI were analyzed for various 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. Samples collected at the Former Sandel Flamethrower Range were analyzed for the following parameters:

- Target compound list volatile organic compounds (VOC) - EPA Method 5035/8260B
- Target compound list semivolatile organic compounds (SVOC) - EPA Method 8270C
- Target analyte list metals - EPA Method 6010B/7000 (groundwater samples only)
- Total organic carbon - EPA Method 9060 (selected soil samples only).

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

3.4 Sample Preservation, Packaging, and Shipping

IT preserved, packaged, and shipped samples following requirements specified in Section 4.13.2 of the SAP (IT, 2000a). Sample containers, sample volumes, preservatives, and holding times for the analyses required in this SI are listed in Chapter 5.0, Table 5-1, of Appendix B of the SAP (IT, 2000a). Sample documentation and chain-of-custody records 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.

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 generated during the SI at the Former Sandel Flamethrower Range, Parcel 97(7), was segregated as follows:

- Drill cuttings
- Purge water from well development, 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 Former Sandel Flamethrower Range, Parcel 97(7), 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).

3.6 Variances/Nonconformances

Neither IT nor QST documented any variances or nonconformances during completion of the SI at the Former Sandel Flamethrower Range, Parcel 97(7).

3.7 Data Quality

IT Data. The field samples were collected, documented, handled, analyzed, and reported in a manner consistent with the FTMC installation-wide work plan; the SAP and quality assurance plan; 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. As discussed in Section 3.6, there were not any variances or nonconformances to impact the usability of the data.

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 analytical 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 a data validation summary report that discusses the results of the IT data validation. Selected results were rejected or otherwise qualified based on the implementation of accepted data validation procedures and practices. 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 their field activities. Hard-copy data packages were sent to the 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 (100 percent) Level III data validation effort. Appendix F includes a data validation summary report that discusses the results of 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 were updated, the QST and 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 the

comparisons to the SSSLs and ESVs developed by IT. 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 Former Sandel Flamethrower Range, Parcel 97(7), provided soil, geologic, and groundwater data 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 (Osborne and Szabo, 1984). The Knox Group underlies a large portion of the Pelham Range area.

The Ordovician Newala and Little Oak Limestones overlie the Knox Group. The Newala Limestone consists of light to dark gray, micritic, thick-bedded limestone with minor dolomite. The Little Oak Limestone is comprised of dark gray, medium- to thick-bedded, fossiliferous, argillaceous to silty limestone with chert nodules. These limestone units are mapped together as undifferentiated at FTMC and other parts of Calhoun County. The Athens Shale overlies the Ordovician limestone units. The Athens Shale consists of dark-gray to black shale and graptolitic shale with localized interbedded dark gray limestone (Osborne et al., 1989). These units occur within an eroded "window" in the uppermost structural thrust sheet at FTMC and underlie much of the developed area of the Main Post.

Other Ordovician-aged bedrock units mapped in Calhoun County include the Greensport Formation, Colvin Mountain Sandstone, and Sequatchie Formation. These units consist of various siltstones, sandstones, shales, dolomites and limestones, and are mapped as one, undifferentiated unit in some areas of Calhoun County. The only Silurian-age sedimentary formation mapped in Calhoun County is the Red Mountain Formation. This unit consists of interbedded red sandstone, siltstone, and shale with greenish-gray to red silty and sandy limestone.

The Devonian Frog Mountain Sandstone consists of sandstone and quartzitic sandstone with shale interbeds, dolomudstone, and glauconitic limestone (Szabo et al., 1988). This unit locally occurs in the western portion of Pelham Range.

The Mississippian Fort Payne Chert and the Maury Formation overlie the Frog Mountain Sandstone and are composed of dark- to light-gray limestone with abundant chert nodules and greenish-gray to grayish-red phosphatic shale, with increasing amounts of calcareous chert toward the upper portion of the formation (Osborne and Szabo, 1984). These units occur in the northwestern portion of Pelham Range. Overlying the Fort Payne Chert is the Floyd Shale, also of Mississippian age, which consists of thin-bedded, fissile brown to black shale with thin

intercalated limestone layers and interbedded sandstone. Osborne and Szabo (1984) reassigned the Floyd Shale, which was mapped by Warman and Causey (1962) on the Main Post of FTMC, to the Ordovician Athens Shale on the basis of fossil data.

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

The soils mapped at the Former Sandel Flamethrower Range, Parcel 97(7), consist of Anniston and Allen gravelly loam (AcC2), 6 to 10 percent slopes, eroded. The Anniston and Allen series of soils (which are mapped together as undifferentiated) consist of deep, well drained, strongly acidic, friable soils that formed in old local alluvium that washed from adjacent, higher lying Linker, Muskingum, Enders, and Montevallo soils. In turn, these soils developed from weathered sandstone, shale, and quartzite. The texture of the subsoil ranges from light clay loam to clay or silty clay loam. Sandstone and quartzite gravel and cobbles can be found throughout the soil (U.S. Department of Agriculture, 1961).

The Former Sandel Flamethrower Range, Parcel 97(7), is situated immediately north of a splay of the Jacksonville Fault. Bedrock beneath the site is mapped as Mississippian/Ordovician Floyd and Athens shale, undifferentiated. The area to the south of the site (south of the fault) is underlain by the Cambrian Chilhowee Group (Osborne, et al., 1997).

Based on direct-push and hollow-stem auger boring data collected during the SI, residuum beneath the Former Sandel Flamethrower Range, Parcel 97(7), consists of predominantly silt and clay overlying weathered shale. The depth to the weathered shale ranged from approximately 5 to 15 feet bgs across the site. Direct-push refusal was encountered at depths ranging from approximately 5 to 13 feet bgs. Competent bedrock was not encountered during drilling.

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 (NOAA, 1998). The major surface water features at the Main Post of FTMC include Remount Creek, 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 Former Sandel Flamethrower Range, Parcel 97(7), follows the general topography and flows northwest towards an intermittent stream located west of Justice Avenue. The intermittent stream flows to the northeast and eventually empties into South Branch of Cane Creek.

4.2.2 Hydrogeology

On March 14, 2000, static groundwater levels were measured in the four permanent monitoring wells installed by IT (as summarized in Table 3-4). Based on a base-wide groundwater flow map, groundwater flow at the site is generally to the north-northwest towards the tributary to South Branch of Cane Creek (Figure 4-1). This suggests that the area is hydraulically connected to the creek.

During well installation activities, groundwater was encountered in residuum at a depth of 8 feet bgs at GSBP-97-MW01. Groundwater was not encountered in the residuum during the installation of the remaining wells. The static groundwater level for this well, summarized in Table 3-4, was approximately 7.5 feet above the depth to water data from the boring log for GSBP-97-MW01 (Appendix B). This indicates that the groundwater has an upward hydraulic gradient and is under semiconfined conditions.

5.0 Summary of Analytical Results

The results of the chemical analysis of samples collected at the Former Sandel Flamethrower Range, Parcel 97(7), indicate that metals, VOCs, and SVOCs were detected in the various site media. To evaluate whether the detected constituents present an unacceptable risk to human health and the environment, analytical results were compared to the 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 ongoing SIs being performed under the BRAC Environmental Restoration Program at FTMC.

Metal concentrations exceeding the SSSLs and ESVs were subsequently compared to metals background screening values (background concentrations) to determine if the metals concentrations are within natural background concentrations (SAIC, 1998). Summary statistics for background metals samples collected at FTMC 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 (RL) of 0.005 milligrams per kilogram (mg/kg), while Method 8270C has an RL 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 RL, 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 5-3 summarize the results of the comparisons 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

Eight surface soil samples were collected for chemical analysis at the Former Sandel Flamethrower Range, Parcel 97(7). Surface soil samples were collected from the upper 1 foot of soil at the locations shown on Figure 3-1. Analytical results were compared to residential human health SSSLs and ESVs, as presented in Table 5-1.

Volatile Organic Compounds. Seven VOCs (2-butanone, acetone, benzene, ethylbenzene, styrene, toluene, and xylene) were detected in surface soil samples collected at the site. VOC concentrations in the surface soil samples ranged from 0.00061 to 0.1 mg/kg. VOC concentrations in surface soils were below SSSLs and ESVs.

Semivolatile Organic Compounds. The SVOC bis(2-ethylhexyl)phthalate was detected in one sample (11-SS04A) at an estimated concentration below the SSSL and ESV. (Estimated concentrations are flagged with a "J" data qualifier, indicating that the compound/analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed.)

Total Organic Carbon. One surface soil sample (11-SS03A) was analyzed for TOC content. TOC concentration in the sample was 11,500 mg/kg, as shown in Table 5-1 and summarized in Appendix E.

5.2 Subsurface Soil Analytical Results

Nine subsurface soil samples were collected for chemical analysis at the Former Sandel Flamethrower Range, Parcel 97(7). Subsurface soil samples were collected at depths ranging from 2 to 4 feet bgs at the locations shown on Figure 3-1. Analytical results were compared to residential human health SSSLs, as presented in Table 5-2.

Volatile Organic Compounds. Nine VOCs were detected in subsurface soil samples collected at the Former Sandel Flamethrower Range, Parcel 97(7). The methylene chloride results were flagged with a "B" data qualifier, signifying that this compound was also detected in an associated laboratory or field blank sample. VOC concentrations in the subsurface soil samples ranged from 0.00049 to 0.012 mg/kg. The VOC concentrations in subsurface soils were below SSSLs.

Semivolatile Organic Compounds. The SVOC bis(2-ethylhexyl)phthalate was detected in one sample (11-SS01B) at an estimated concentration below the SSSL.

Total Organic Carbon. Three subsurface soil samples (11-SS03B, 11-SS05B, and 11-SS08) were analyzed for TOC content. TOC concentrations in the samples ranged from 1,020 to 2,390 mg/kg, as shown in Table 5-2 and summarized in Appendix E.

5.3 Groundwater Analytical Results

Groundwater samples were collected from four permanent monitoring wells and one temporary monitoring well at the Former Sandel Flamethrower Range, Parcel 97(7), at the locations shown on Figure 3-1. Analytical results were compared to residential human health SSSLs and metals background screening values, as presented in Table 5-3.

Metals. Twenty metals were detected in groundwater samples collected at the Former Sandel Flamethrower Range, Parcel 97(7). Sample location GSBP-97-MW04 contained 19 of the 20 detected metals.

Several metals were detected in two of the four groundwater samples at concentrations exceeding SSSLs and background concentrations. Sample location GSBP-97-MW04 had nine metals detected above SSSLs and six metals detected above background; however, only two metals (aluminum and vanadium) exceeded the background range. Turbidity at the time of sample collection from GSBP-97-MW04 was 276 nephelometric turbidity units (NTU). Results from GSBP-97-MW02 indicated six metals detected above SSSLs and seven metals detected above background concentrations; however, none exceeded the background range.

Based on the results of a groundwater resampling effort (Appendix H) conducted by IT at FTMC 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).

By comparison, the groundwater samples collected from the remaining permanent monitoring wells (GSBP-97-MW01 and GSBP-97-MW03; turbidity of 14 and 25 NTUs, respectively) had only one metal (thallium) detected at a concentration exceeding background and only three metals (iron, manganese, and thallium) exceeding SSSLs. The thallium result was estimated at a concentration slightly exceeding its background concentration and the range of background

values (Appendix G). Thallium was not detected in the other groundwater samples collected at the site.

Volatile Organic Compounds. Four VOCs (2-butanone, acetone, chloromethane, and methylene chloride) were detected in groundwater samples collected at the Former Sandel Flamethrower Range, Parcel 97(7). The acetone and methylene chloride results were flagged with a "B" data qualifier, indicating that these compounds were also detected in an associated laboratory or field blank sample. The 2-butanone and chloromethane results (GSBP-97-MW02 and GSBP-97-MW04) were flagged with a "J" data qualifier, indicating that the results were estimated. VOC concentrations in groundwater were below SSSLs.

Semivolatile Organic Compounds. SVOCs were not detected in the groundwater samples collected at the Former Sandel Flamethrower Range, Parcel 97(7).

6.0 Summary, Conclusions, and Recommendations

IT, under contract with the USACE, completed an SI at the Former Sandel Flamethrower Range, Parcel 97(7), at FTMC in Calhoun County, Alabama. The SI was conducted to determine whether chemical constituents are present at the site and, if present, whether the concentrations present an unacceptable risk to human health or the environment. The SI at the Former Sandel Flamethrower Range, Parcel 97(7), consisted of the sampling and analysis of eight surface soil samples, nine subsurface soil samples, and five groundwater samples. In addition, one temporary and four permanent groundwater monitoring wells were installed in the residuum groundwater zone to facilitate groundwater sample collection and to provide site-specific geological and hydrogeological characterization information. As part of this SI, IT incorporated data previously collected by QST at the Former Sandel Flamethrower Range, Parcel 97(7).

The analytical results indicate that metals, VOCs, and SVOCs were detected in 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 impact to human receptors is expected to be minimal. Although the site is projected for passive recreation/mixed business reuse, the analytical data were screened against residential human health SSSLs to evaluate the site for possible unrestricted future use. In soils, VOC and SVOC concentrations were below SSSLs and therefore do not pose a threat to human health.

Several metals were detected in two groundwater samples at concentrations exceeding SSSLs and background concentrations. However, only two metals (aluminum and vanadium) also exceeded the background range. The limited distribution and low concentrations of these metals are not expected to pose a threat to human health.

VOCs and SVOCs were not detected in site media at concentrations exceeding ESVs. In addition, the site is located in a developed area of the Main Post near roads and buildings. Consequently, the potential threat to ecological receptors is expected to be low.

Based on the results of the SI, past operations at the Former Sandel Flamethrower Range, Parcel 97(7), do not appear to have 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. Therefore, IT recommends "No Further Action" and unrestricted land reuse at the Former Sandel Flamethrower Range, Parcel 97(7).

7.0 References

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